Annual Report

WC2NH Giant Barred Frog Population Monitoring

GeoLINK
environmental management and design

PO Box 119
Lennox Head NSW 2478
T 02 6687 7666

PO Box 1446
Coffs Harbour NSW 2450
T 02 6651 7666

PO Box 1267
Armidale NSW 2350
T 02 6772 0454

Unit 10 Warina Walk Arcade
156 Molesworth St
Lismore NSW 2480
T 02 6621 6677

info@geolink.net.au

Prepared for: PACIFICO

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Executive Summary

A population of Giant Barred Frogs (GBF) (*Mixophyes iteratus*) inhabit the Upper Warrell Creek (UWC) system which intercepts the Warrell Creek to Nambucca Heads Pacific Highway Upgrage route alignment. As such this population of GBFs and construction works are required to be managed in accordance with the WC2NH Giant Barred Frog Management Strategy (Lewis Ecological, 2014).

GeoLINK have been engaged by PACIFICO to undertake seasonal monitoring of two GBF management zones within the Project alignment. UWC has a resident population of GBFs which has been previously studied to establish a population baseline which recorded 47 GBFs including records of juveniles and sub-adults. Since the unexpected find of GBF tadpoles within Butchers Creek, a new GBF management area was established with eight survey zones created for monitoring. No GBFs have been recorded within the Butchers Creek survey zones during population monitoring.

Population monitoring undertaken in 2015/2016 has returned fewer records of frogs across the three monitoring periods of autumn, spring and summer with a total of 16 frogs captured at UWC. No sub-adults or juveniles were recorded during any survey periods. No GBFs have been recaptured from the baseline population monitoring of 2013/2014.

Since construction has commenced survey zones 8, 9 & 10 have now been fully or partially impacted by construction works. During baseline population monitoring these zones recorded the highest number of frog captures with 21 records in zones 8 & 9 and 6 in zone 10. During pre-clearing surveys (prior to disturbance to these areas) three frogs were captured and relocated outside of the works footprint, refer to **Illustration 2.1**. During 2015/2016 surveys frogs were observed within zones 2-13 whereas during population baseline monitoring frogs were recorded to be using the creek system more broadly with records spaning zones 2-20.

After only one year of monitoring it is difficult to draw conclusions regarding the dynamics of the UWC GBF population but this reduction in frog records since the baseline population monitoring may be attributable to several factors such as:

- Non-favourable surveys conditions due to lower than usual rainfall.
- Lower than average monthly rainfall records and smaller than usual flood events.
- Direct impacts to previously populated GBF habitat in zones 8, 9 and 10 at UWC.
- No successful breeding events during the years between monitoring and therefore no recruitment of juveniles.
- Reduced health in the population due to disease, although all frogs captured appeared to be in good health.

1. Introduction

1.1 Project Overview

The Pacific Highway Upgrade Program is a joint commitment by the Australian and New South Wales governments to improve the standard and safety of the Pacific Highway between Hexham and the Queensland border.

The NSW Minister for Planning approved the Warrell Creek to Urunga (WC2U) Pacific Highway Upgrade Project (the Project) under Part 3A (now repealed) of the Environmental Planning and Assessment Act 1979 (EP&A Act) on 19 July 2011, subject to the Minister's Conditions of Approval (CoA) being met.

The WC2U Project comprises approximately 42 km of dual carriageway road that would bypass the towns of Warrell Creek, Macksville, Nambucca Heads and Urunga on the Mid North Coast of NSW. The Project has been divided into two stages with Stage 1 consisting of approximately 22.5 km from Nambucca Heads to Urunga (NH2U) and Stage 2 consisting of the remaining 19.5 km of dual carriageway between Warrell Creek and Nambucca Heads (WC2NH). This report relates to Stage 2 (WC2NH) as 'the Proposal' which is shown in **Illustration 1.1**.

The Giant Barred Frog (GBF) (*Mixophyes iteratus*) was assessed in the Project Environmental Assessment (Sinclair Knight Merz [SKM] 2010a, SKM 2010b), in regard to relevant State and Federal legislation. The GBF is listed as an 'Endangered' species under both the *NSW Government Threatened Species Conservation Act 1995* (TSC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

An assessment of the impacts of the WC2NH Pacific Highway Upgrade Proposal on the GBF, in accordance with the *EPBC Act Policy Statement 1.1 Significant Impact Guidelines* (Department of Environment and Heritage – DoE 2013a) was prepared by Lewis Ecological (2014). This assessment found that the Proposal will have some substantial negative (incremental and cumulative) impacts to the GBF/ breeding aggregation/s whose home range encompass the Upper Warrell Creek and Butchers Creek Systems, mainly through habitat removal and fragmentation. None of the habitats present in the study area are registered on the current list of recommended or declared critical habitat in NSW (SKM, 2010). The majority of GBFs and habitat that supports the subject GBF population at Upper Warrell Creek would not be affected by the Proposal.

The EA described the Project, with effective implementation of the proposed mitigation measures, to be unlikely to result in a significant impact to the subject local GBF population.

1.2 GBF Habitat

Potential GBF habitat was identified during the Project Environmental Assessment and subsequently Lewis Ecological was engaged by Roads and Maritime Services (RMS) to conduct field surveys throughout nominated potential GBF habitat within the Project route alignment. A GBF population was recorded at Upper Warrell Creek and a management strategy prepared to mitigate impacts to this species namely the *WC2NH Giant Barred Frog Management Strategy.*

As part of construction works, scheduled de-fishing activities were undertaken at Butcher's Creek on the 31 August 2015. Suspected GBF (*Mixophyes iteratus*) tadpoles were trapped and their identification confirmed by Michael Mahony, frog expert from the University of Newcastle. Targeted GBF surveys were undertaken over several nights however no GBFs were recorded within the survey area. Differing opinions were also received on the identification of Barred Frogs at the site leading to the current thinking that M. iterates do not currently occur at the site. Based upon the precautionary principle Butchers Creek is currently being managed as potential GBF habitat in accordance with the *WC2NH Giant Barred Frog Management Strategy*; refer to **Illustration 1.2** for Butchers Creek GBF management zones.

GBF population monitoring has been undertaken within both the Upper Warrell Creek and Butchers Creek systems within 500 m either side of the project route alignment.

1.3 Purpose of this Report

The purpose of this report is to document the findings of the seasonal GBF population monitoring for the periods of autumn and spring of 2015 and summer 2016 Year 1 of population monitoring.

This report accompanies the 'Warrell Creek to Nambucca Heads Pacific Highway Upgrade: Giant Barred Frog Management Strategy (Lewis Ecological, 2014)'. The results of the 2015/2016 monitoring will be compared against the GBF population baseline monitoring undertaken by Lewis Ecological, 2014.

1.4 Subject Species – Giant Barred Frog

A detailed description of the biology and ecology of the GBF is provided within the *WC2NH Giant Barred Frog Management Strategy* (Lewis Ecological, 2014).

Information shown is for illustrative purposes only

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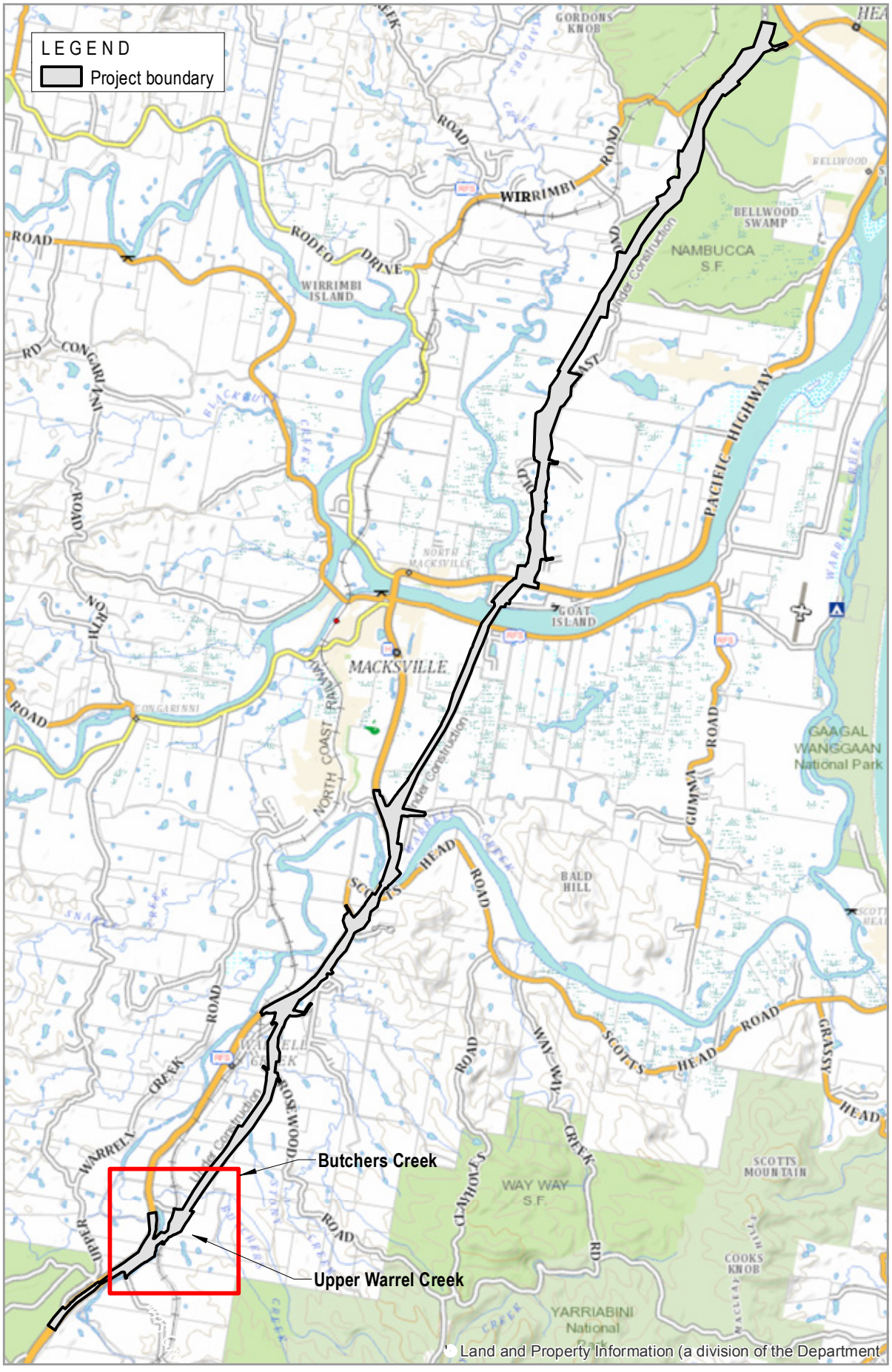
Source of base data: SIX Maps



0 1.5 km

North

Site Context

Information shown is for illustrative purposes only

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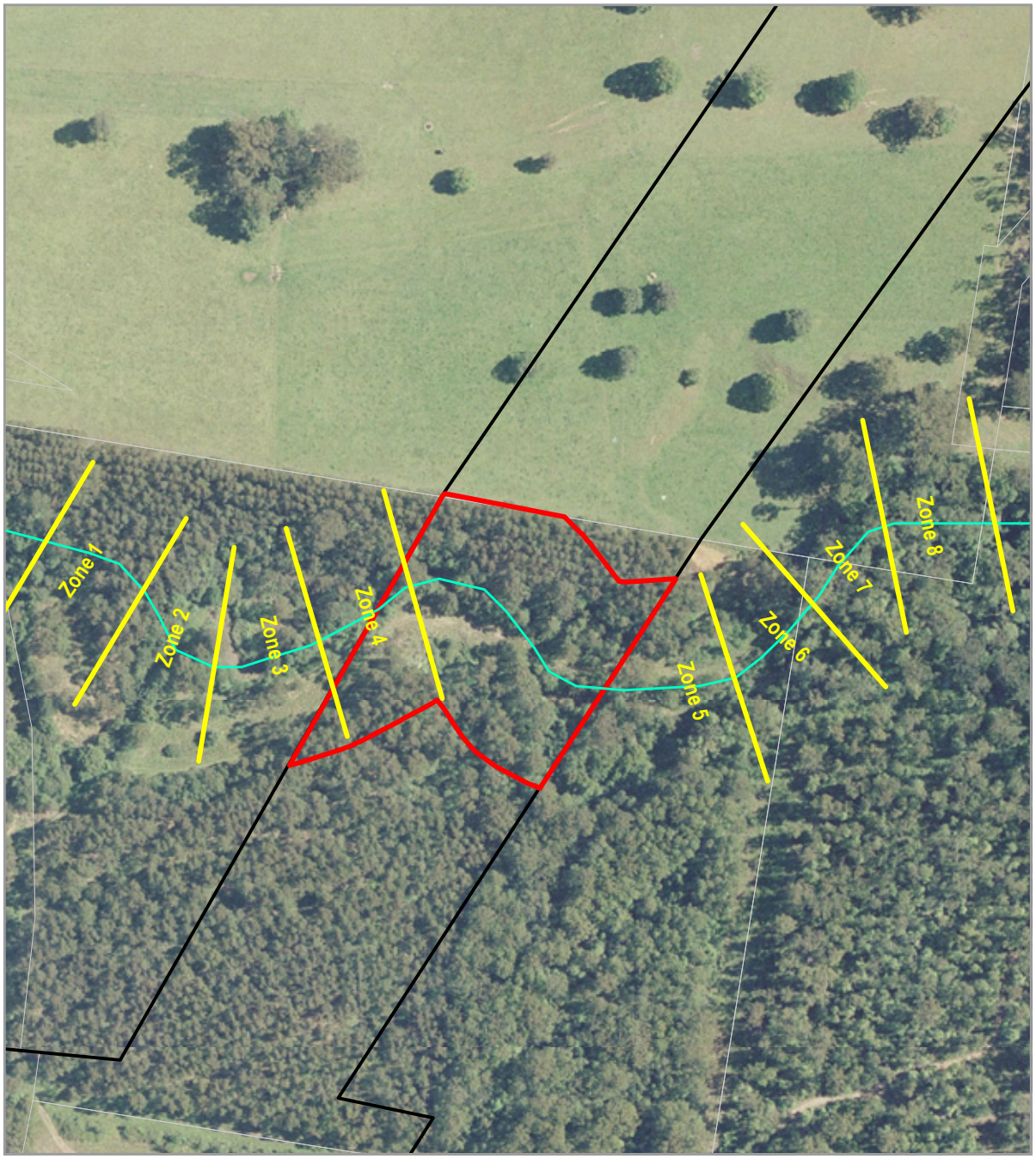
Source of base data: Pacifico



LEGEND
- Project boundary
- Butchers Creek
- 50 Metre buffer

North

0 60

Butchers Creek GBF Management Zones

2. Methodology

Field surveys were performed in accordance with the methodology outlined in the *Giant Barred Frog Management Strategy* and *Baseline Monitoring for Giant Barred Frog* for the project (Lewis 2013). Both of the aforementioned plans have been approved by the Department of Planning and Environment (DP&E) and the Environmental Protection Authority (EPA). A summary of the monitoring methodology is included below.

2.1 Timing of Surveys

Field surveys were undertaken during the following periods:

- **Spring sampling**:
  - Undertaken at the Upper Warrell Creek site on the 19 November 2015 for habitat and water quality data and 20/11/2015 for GBF population surveys.
  - GBFs population surveys were conducted at Butcher's Creek on 19 November 2015 with habitat and water quality data being collected on the 19 November 2015.
  - Spring surveys were carried out in response to a rainfall trigger event of 14.2 and 14.8 mm being recorded on the 14 and 15 November respectively (Albert Drive WC2NH weather station).
- **Summer sampling**:
  - Undertaken at Butcher's Creek on 27 January 2016 in response to a rainfall trigger event of 17.2 mm recorded on the 24 January with an additional 20.4 mm being recorded in the seven days leading up to the field survey.
  - Upper Warrell Creek summer sampling was undertaken on the 10 and 11 February 2016 in response to a rainfall trigger event of 16.2 mm on the 5 February with an additional 17 mm being recorded in the seven days leading up to the field survey (Albert Drive WC2NH weather station).
- **Autumn sampling**:
  - Undertaken on the 5 May 2015 in response to a rainfall trigger event of 16.8 mm recorded on the 30 April 2015 with an additional 160.4 mm being recorded in the seven days leading up to the field survey.

2.2 Frog Surveys

Frog surveys involved:

- Surveys being performed within seven days of a rainfall event exceeding 10 mm in 24 hours using the Project Weather station located at Warrell Creek Construction Compound with data reading taken from the data provider Weathermation.
- Upper Warrell Creek has a 1.0 km transect with 450 m either side of the construction footprint (~100 m represents construction footprint) and divided into 20 x 50 m survey zones (**Illustration 2.1**).

Information shown is for illustrative purposes only

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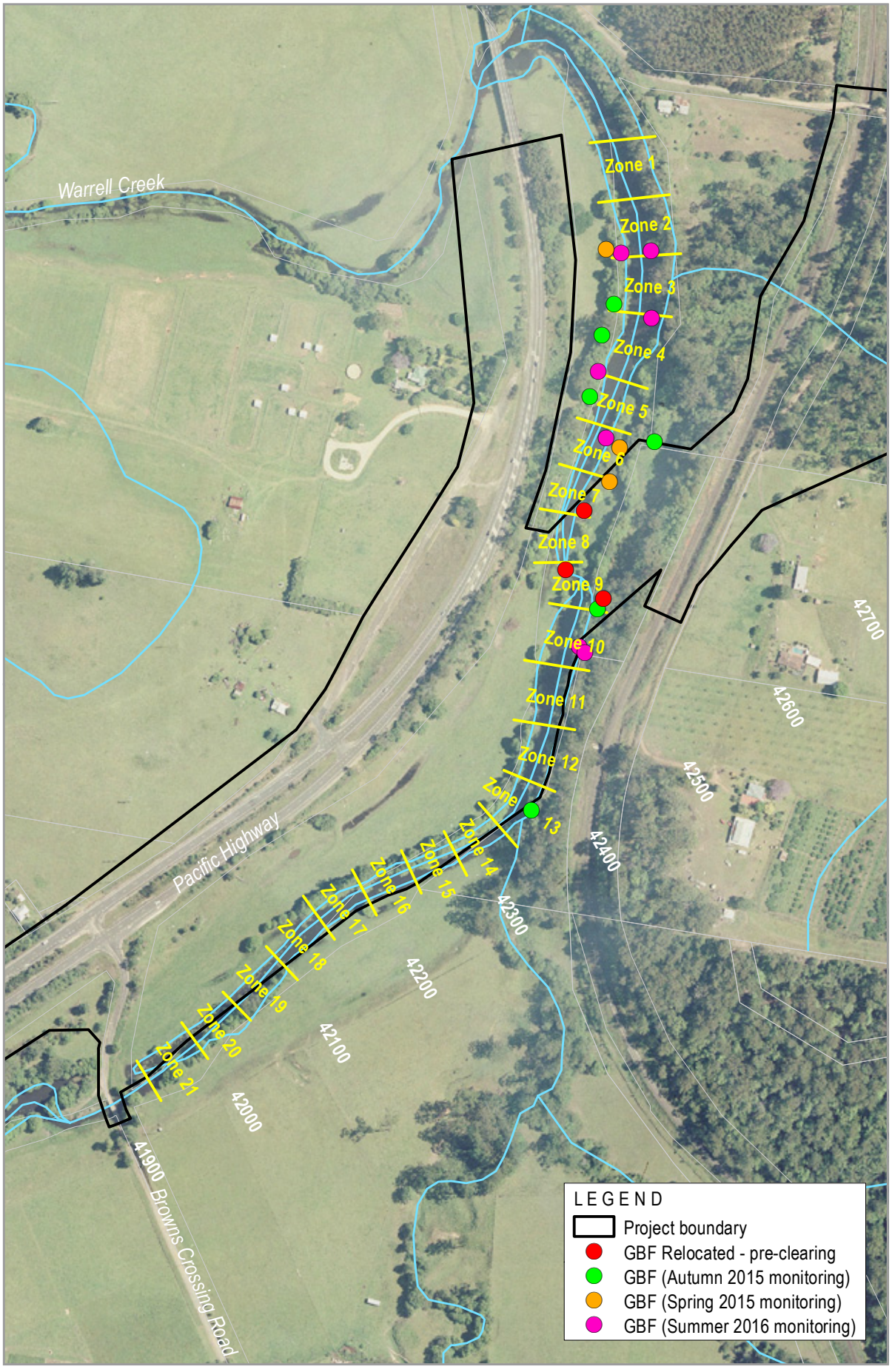
Source of base data: Pacifico



North

0 100

Upper Warrell Creek GBF Management Zones and GPS Capture Locations

- Butcher's Creek has an 800 m transect with 200 m either side of the construction footprint (~100 m represents construction footprint) and divided into 8 x 50 m survey zones (**Illustration 1.2**).
- Each field survey involved a meandering, nocturnal transect on both sides of the stream bank with all GBFs captured during spring and summer permanently marked using a PIT tag (i.e. micro-chipped) and specifically a Trovan Nanotransponder. Survey effort ranged from 3-5 hours (combined total of 6.5 hrs across 10 and 11 February 2016 at UWC) per transect with variability in time length attributed to variations in habitat, accessibility and the number of frogs being processed.

For each frog, the following information was collected:

- Location according to demarcated survey zone (20 x 50 m zones – UWC, 20 x 50 m zones Butchers Creek).
- Distance from the stream edge measured to the nearest 0.1 m.
- Position within the microhabitat (i.e. under litter, above litter, exposed, on rock/log).
- Sex (male, female, unknown).
- Age class (adult = >60 mm; sub adult = 40-60 mm; juvenile = <40 mm).
- Snout-vent length (mm).
- Weight (grams).
- Breeding condition with: males assessed on the colouration of their nuptial pads (i.e. no colour, light, moderate, dark) in accordance with a classification developed by Lewis Ecological Surveys (Table 2-1); females based on whether they are gravid (i.e. typically adult weighing > 100 grams) or not gravid (egg bearing); frogs with a snout vent length of <60 mm were classified as immature.

2.3 Swabbing for Chytrid Fungus

Swabbing for Chytridiomycosis or Chytrid fungus was undertaken during the spring and summer monitoring events as detailed in **Section 2.1**, above. The objective of this was to record the presence of Chytrid fungal disease in the population during construction and record any observations of frog health condition during construction in comparison to the pre-construction baseline monitoring. Chytrid Fungus is currently listed as a key threatening process for frogs pursuant to the NSW Threatened Species Conservation Act (1995).

All frogs captured during the spring and summer monitoring event were swabbed for Chytrid fungus. This involved the use of a sterile swab and wiping the outer skin with a sterile cotton-tipped swab. The swab is wiped over the body creases, such as under the arms and inside of the thighs and groin, to collect loose skin samples. Swabs were then placed into a sterile container and held in a refrigerator until they could be delivered to Newcastle University for testing.

All handling procedures were undertaken in accordance with the Hygiene Protocols for the Control of Disease in Frogs (DECW 2008).

2.4 Tadpole Surveys

Tadpole surveys were undertaken during the spring and summer surveys using the following procedure:

- At the Upper Warrell Creek site the 1.0 km transect was divided up into 20 x 50 m zones with seven zones in the downstream corridor, five zones partially or totally within the construction corridor and eight zones upstream of the road corridor.

- Within each zone, one bait trap (~300 mm x 200 mm) was installed and left operating for a minimum of 3 hours. This equated to 20 bait traps and a minimum of 60 hours of survey effort.
- At the Butcher's Creek site the 800 m transect was divided up into 20 x 50 m zones with four zones in the downstream corridor and four zones in the upstream corridor.

Some dip-netting was undertaken to confirm the presence of Giant Barred Frog tadpoles during both the spring and summer monitoring. During these surveys the presence of exotic and native fish and shrimp were also recorded.

Table 2.1 Key Developed for Determining Reproductive Condition in Male GBFs

Nuptial Pad Colour	*Comments*
No Colour	■ Males may be active or dormant but don't present as being sexually active to mate with females. ■ No colour can occur at any time throughout the year but pronounced periods include dry springs and late autumn with the onset of winter.
Light	■ Some colouration indicating frogs are likely to become active (late winter) or have been active but generally not breeding. For example, prevailing weather conditions are unsuitable. ■ Frogs with light nuptials are generally on the shoulder periods of breeding events and a small percentage of the male population is likely to classify into this category at almost any time of the year apart from June and July.
Moderate	■ Males are normally active, will often readily respond to calls. Ready to mate with gravid females if weather conditions are suitable. These frogs may occasionally be involved in intraspecific aggression indicating their readiness to mate with females. ■ Colouring may be evident between August-May and is considered cyclic and surrounding breeding events.
Very Dark	■ Males are normally active, ready to mate with gravid females if conditions are suitable. ■ Some observations of intraspecific aggression can occur between males at this stage. ■ Colouring may be evident between August-May and is considered cyclic with early season suspected of being driven through warming air temperature whilst prevailing rainfall conditions are considered the primary queue during summer and autumn.

2.5 Abiotic Data

The following abiotic data variables were collected during the survey:

- Rainfall measured in four scales:
  - During the survey.
  - Within past 24 hours.
  - Within past 7 days.
  - Within past 30 days.
- Relative humidity measured with wet/dry bulb thermometer at the start and finish of the frog survey and averaged.
- Air temperature measured with a thermometer at the start and finish of the frog survey and averaged.

- Wind speed measured in subjective scale (0= no wind, 1 = light rustles of leaves on trees, 2 = leaves and branches moving and 3 = whole canopy moving).
- Water level measured with a permanently installed water staff or an electronic device if available from the Bureau of Meteorology (BOM).

2.6 Habitat Data

The following habitat data was recorded at each of the 20 demarcated zones at Upper Warrell Creek and 8 zones at Butchers Creek:

- Land use: Description of existing land uses of dairy cattle farming, beef cattle farming, private natural reserve.
- Broad vegetation type within the immediate riparian zone (primary stream bank): Riparian Rainforest, Dry Sclerophyll Forest, Woodland, Mallee; Heath/Shrub; Sedgeland, Grassland or Cleared Land.
- In stream physical characteristics including.
    - Stream width and depth (metres).
    - Presence of pools and/or riffles.
    - Bed composition (sand, clay, rock, organic or other to be specified).
    - Type of emergent vegetation if present.
- Stream bank characteristics including bank profile expressed as steep, benched or a gradual incline from the water's edge.
- Vegetation associated with the stream bank in terms of its foliage projection cover (fpc) for overstorey trees, shrubs and groundcover.
- Groundcover composition including a measure of vegetative ground cover, litter cover, soil cover and exposed rock expressed as a composition percentage of 100%.
- The depth of litter was also measured and assigned to one of the following categories:
    - Deep (>10 mm).
    - Moderate (20-100 mm).
    - Shallow (>0-20 mm).
    - Absent (0 mm).

2.7 Water Quality Data

Water quality monitoring via water samples was undertaken on the day of the summer survey (29/01/2016) and at the next pronounced wet weather period triggering runoff (18/02/2016 following by another dry weather sampling event on the 25/02/2016). The samples were measured for:

- Heavy metals including arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.
- Hydrocarbons from the following groups:
    - Naphthalene group including TRH>C10-C16, TRH>C10-C16 less Naphthalene (F2), TRH>C16-C34, TRH>34-C40, TRH C6-C10 and TRH C6-C10 LESS BTEX (F1).
    - BTEX group including Benzene, Ethylbenzene, m&p-Xylenes, o-Xylene, Toluene and Xylenes – total.
- Nutrients including Nitrogen (as N), Suspended Solids and Total Phosphorus.

- Field physicochemical data including dissolved oxygen, conductivity, pH, temperature and turbidity.

Water quality data was analysed by Coffey Geotechnics using a National Association of Testing Authorities (NATA) accredited laboratory.

Water quality data was analysed by Coffs Harbour Environmental Laboratory (Nata Accredited Laboratory).

3. Results

3.1 Abiotic Data

Autumn sampling was undertaken on the 5 May 2015 in response to a rainfall trigger event of 16.8 mm recorded on the 30 April with an additional 160.4 mm being recorded in the seven days leading up to the field survey. This monitoring was conducted during the wettest month compared to both spring and summer survey efforts and also recorded the highest relative humidity of the three survey periods starting at 79% increasing to 95.5% by 21:00. As would be expected autumn had the lowest air temperatures recorded of the three monitoring periods ranging from 24.2°C at 17:30 decreasing to 17.5°C by 21:00.

Spring sampling was undertaken at the Upper Warrell Creek site on the 19 November 2015 and at Butcher's Creek on 20 November 2015, in response to a rainfall trigger event of 14.2 and 14.8 mm being recorded on the 14 and 15 November respectively (Albert Drive WC2NH weather station). Spring temperatures ranged from 29.7°C and 25.9°C decreasing to 22.2°C and 20.1°C respectively across both sites. The lack of breeze contributed to the humidity remaining high throughout the monitoring period with records ranging from 56.2% and 54.6% increasing to 86.9% and 89.1% towards midnight.

Summer sampling was undertaken at Butcher's Creek on 27 January 2016 in response to a rainfall trigger event of 17.2 mm recorded on the 24 January 2016 with an additional 20.4 mm being recorded in the seven days leading up to the field survey. High relative humidity was recorded throughout the monitoring period ranging from 73% to 85.8 towards midnight. The temperature at the commencement of monitoring recorded 25.6°C dropping to 21.8°C at 23:55. Wind conditions were still throughout the survey period.

Upper Warrell Creek summer sampling was undertaken on the 10 and 11 February 2016 in response to a rainfall trigger event of 16.2 on the 5 February with an additional 17 mm being recorded in the seven days leading up to both field surveys (Albert Drive WC2NH weather station). Only 72.2 mm of rain fell in the 30 days prior to the monitoring period which is considerably lower than the monthly average rainfall for January/ February. Monthly average rainfall for January is 147.6 mm and for February is 170.7 mm according to historical measurements at Smokey Cape Lighthouse, (BOM, 2016). Summer sampling at this location recorded the highest air temperatures and high relative humidity.

Table 3.1 Abiotic Conditions during Giant Barred Frog Population Monitoring 2015/ 2016

Date	*Time*	*Time (24 hours)*	*Air Temp °C*	*Water Temp°C*	*Relative Humidity %*	*Wind*	*Rain*
05/05/2015 UWC	Start time	17:30	24.2	-	79	1	0
	Finish time	21:00	17.5	-	95.5	1	0
19/11/2015 UWC	Start time	19:30	25.9	22.65 Daytime	56.2	0	0
	Finish time	00:30	20.1		86.9	0	0
20/11/2015 Butchers	Start time	19:30	29.7	21.47 Daytime	54.6	0	0
	Finish time	23:30	22.2		89.1	0	0
27/01/2016 Butchers	Start time	21:00	25.6	22.6 Daytime	73	0	0
	Finish time	23:55	21.8		85.8	0	0
10/02/2016 UWC	Start time	20:00	30	24.77 Daytime	56	1	0
	Finish time	00:30	19.8		91.1	1	0
11/02/2016 UWC	Start time	21:00	26.6	-	87.1	1	0
	Finish time	23:00	22		65.4	1	0

Table 3.2 Rainfall Data During Giant Barred Frog Population Monitoring 2015/ 2016

Rain	*During (mm)*	*Past 24 hours (mm)*	*Past 7 days (mm)*	*Past 30 Days (mm)*
05/05/15 UWC	0	.2	172.2	260.2
19/11/2015 UWC	0	0	30	163
20/11/2015 Butchers	0	0	30	163
27/01/2016 Butchers	0	15	37.6	105.4
10/02/2016 UWC	0	.4	21	72.2
11/02/2016 UWC	0	0	21	72.2

3.2 Giant Barred Frog Demography

3.2.1 Captures and Age Classes

A total of 16 GBFs were recorded during the autumn/ spring/ summer population monitoring, all frogs were captured within the Upper Warrell Creek system. Six frogs were captured during autumn, three during spring and seven during summer. A summary of the numbers of GBFs captured during the monitoring is provided in **Figure 3.1** with locations of frogs captured shown in **Illustration 2.1.**

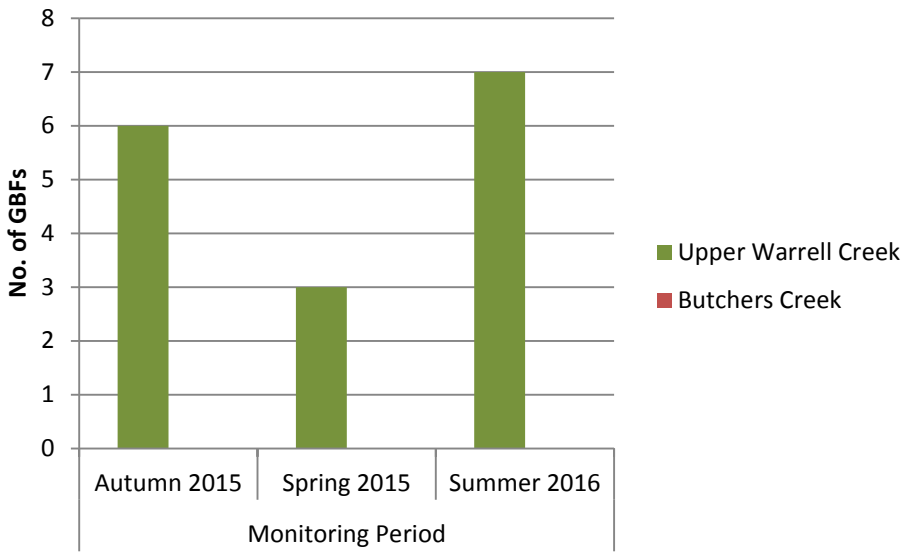


Figure 3.1 Giant Barred Frog records across three monitoring periods 2015/2016

All frogs were classified as adults, no sub adults or juveniles have been recorded during any population monitoring surveys for the 2015/ 2016 monitoring period. The heaviest frogs were captured in autumn with the largest captured weighing 142 g and measuring 103 mm, this frog was recorded as female. GBFs captured during spring were quite similar in weight and length, weighing between 80 and 85 grams with snout to vent length between 85-97 mm. During summer monitoring weights were more varied measuring between 60 and 109 grams with lengths ranging between 75 and 92 mm. The smallest frog captured was a male during summer at 60 g and 76 mm.

A summary of capture data including weight, snout to vent length and microchip data for GBFs captured during the monitoring is summarised **Table 3.3** below, all raw data recorded is provided in **Appendix A**.

Three frogs were captured during spring surveys and were microchipped for the first time. Two of the seven frogs captured during the summer monitoring were captured during spring monitoring. No frogs captured and microchipped during Lewis Ecological surveys have been identified during the population survey efforts 2015/ 2016.

During the summer survey at Upper Warrell Creek an additional three male GBFs were heard calling from the eastern bank of zones 1-4 but could not be located for capture and therefore no specific data could be recorded for those individuals.

Due to technical equipment issues no microchip capture data was collected during autumn surveys.

Table 3.3 Summary of Giant Barred Frog Capture Data During Population Monitoring 2015/2016

Date of Capture	*Frog ID #*	*Weight (grams)*	*Snout to Vent Length (mm)*	*Sex*	*Age Class*	*Nuptial Pad colour*	*Recaptured Y/N*
05/05/15	Unknown	97	81	Male	Adult	Moderate	Unknown
05/05/15	Unknown	142	103	Female	Adult	Light	Unknown
05/05/15	Unknown	124	86	Unknown	Adult	Light	Unknown
05/05/15	Unknown	115	86	Unknown	Adult	Black	Unknown
05/05/15	Unknown	123	100	Unknown	Adult	Dark	Unknown
05/05/15	Unknown	121	91	Unknown	Adult	Med/dark	Unknown
20/11/15	00077E8DB9	97	85	Male	Adult	Light grey	No
20/11/15	00077E8297	93	82	Male	Adult	Light grey	No
20/11/15	00077E9014	85	80	Unknown	Adult	Light grey	No
10/02/16	00077E9014	99	91	Unknown	Adult	Dark	Yes - in spring
10/02/16	00077E8297	95	83	Unknown	Adult	Dark	Yes - in spring
10/02/16	00078ABC23	60	76	Male	Adult	Moderate	No
10/02/16	00078ABD42	71	76	Male	Adult	Moderate	No
11/02/16	00078ABE43	109	92	Unknown	Adult	Light	No
11/02/16	00078ABC3B	74	75	Unknown	Adult	Light	No
11/02/16	00078ABC9A	74	78	Unknown	Adult	Light	No

3.2.2 Calculating Population Size

A comparison of predicted population size was not undertaken as part of the year 1 monitoring due to its limited value given the early stage of the monitoring program. Comparisons of predicted population size would be undertaken during the Year 3 monitoring and post-monitoring.

3.3 Presence of Chytrid Fungus

All frogs captured during the spring and summer sampling periods were swabbed for Chytrid fungus. At the time of completing this report the results of chytrid analysis had not been received. Results will be included in subsequent reports.

3.4 Habitat Use

3.4.1 Frog Distribution along the Transect

During 2015/ 2016 population monitoring frogs were captured within zones 2-13 only during base line monitoring frogs were observed in zones 2-20. A core section of habitat has been removed within zones 8-10 due to construction of the piling pad and creek crossing. This is the area where the highest number of frogs were captured during baseline monitoring. Twenty-one GBFs were captured in zones 8 and 9 and a further six frogs were captured in zone 10 during the population baseline monitoring. Zones 8, 9 and 10 have now been fully or partially impacted by construction works.

3.4.2 How the Frogs are using the Existing Habitat

The mean distance from the stream edge of captured frogs during summer is 1.7 m. Spring monitoring recorded a mean distance from the stream edge of 2.3 m. One frog was recorded at 7.0 m from the stream edge during autumn which was the greatest distance from the stream edge of all records for annual monitoring.

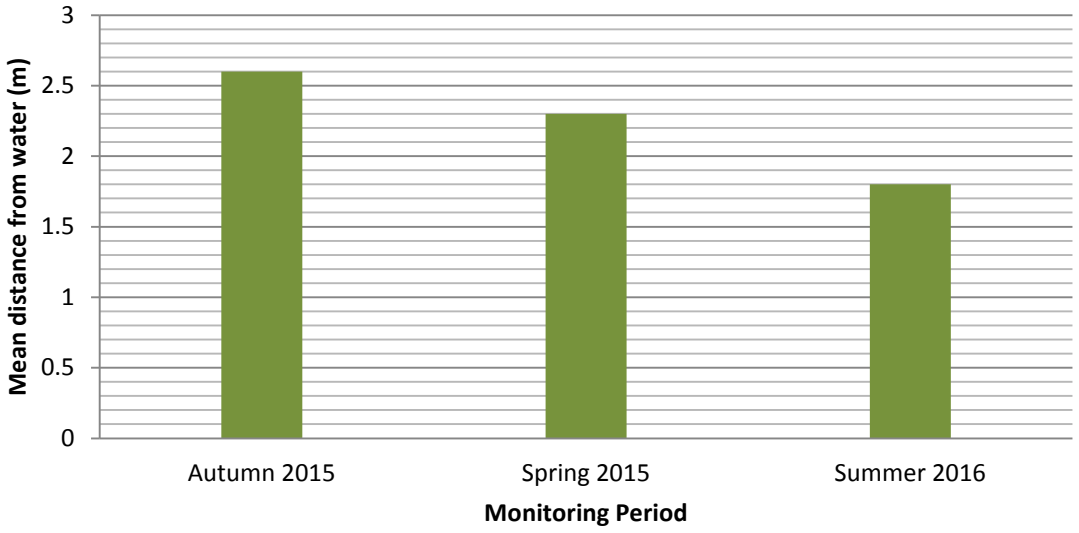


Figure 3.2 Mean distance of Giant Barred Frogs captured in proximity to the stream edge over three monitoring periods 2015/2016

3.4.3 Recaptured Frogs

Two GBFs were recaptured during the summer monitoring that were previously captured and microchipped in spring. Frog ID # 00077E9014 increased in length by 11 mm and weight by 14 grams. This frog was first captured in spring on the western bank of zone 2 and was recaptured during summer in zone 4 having moved south by a minimum distance of 100 m. Frog ID # 00077E8297 was first detected on the eastern bank and northern end of zone 7 in spring then was recaptured during summer within the northern end of zone 6, having moved north by a minimum distance of ~40 m. This frog increased slightly in length from 82 mm to 83 mm and from 93 g to 95 g.

3.4.4 Breeding Cues

No juveniles or sub adults were recorded during any of the monitoring periods. No confirmed females were observed as being gravid. During summer two males were confirmed by calling in response to call playback the remaining summer GBFs were recorded as 'unknown sex'. Two GBFs were recorded side by side within 1.0 m from each other in zone 10 however one large individual may have been a female due its large weight of 109 grams. Spring monitoring recorded two confirmed males and one unknown. Autumn results show one male, one female (142 g) and four frogs of undeterminable sex. Details of nuptial pads for each frog captured are shown in **Table 3.3.**

No tadpoles were recorded during any opportunistic dip netting or bait trap surveys.

3.5 Habitat Condition

Habitat conditions have been described in detail within the *WC2NH GBF Baseline Monitoring* (Lewis Ecological, 2014)'. Since the Upper Warrell Creek habitat conditions were originally described, including the riparian zone and instream physical features, little has changed within this GBF management area. More dynamic characteristics such as ground cover, leaf litter, water levels have recorded change as would be expected but the riparian zone data largely remains the same. Refer to Upper Warrell Creek habitat data in **Appendix A** below.

The general land use and broad classification type has been described in detail within the Baseline Monitoring of the WC2NH Giant Barred Frog Management strategy (Lewis Ecological, 2014). Since that report was written the land use has remained largely the same with the exception of the construction of the WC2NH project alignment. To facilitate construction of the Upper Warrell Creek bridge a piling pad has been installed and a large trafficable creek crossing within zones 8 and 9 with some impacts to zone 10. These structures have directly impacted GBF habitat and as a result a number of frogs were captured during autumn and relocated outside of the works footprint as part of pre-clearing surveys and the establishment of the GBF temporary fence and frog exclusion zone.

Water quality monitoring data for both sites during spring and summer monitoring periods are detailed in **Appendix B**.

3.5.1 The Addition of Butchers Creek GBF Management Zone

The previous land use within the surrounding area is predominantly cleared agricultural land for livestock grazing, however prior to construction the creek riparian zone was previously intact and comprised a predominantly native riparian zone. The remaining riparian vegetation within zones 1-8 consists of Moist Open Forest – Flooded Gum and is recognised as a mapped vegetation community for Project vegetation tracking purposes. Riparian species consist predominantly of Flooded Gum (*Eucalyptus grandis*), Turpentine (*Syncarpia glomifera),* Brush Box (*Lophostemon confertus*), Bangalow Palm (*Archontophoenix cunninghamiana*), Maidens Blush (*Sloanea australis*), Red Ash (*Alphitonia excelsa*), Camphor laurel (*Cinnamomum camphora*) and Forest Oak (*Allocasuarina torulosa*).

This creek does not flow permanently and has a pebble and sand substrate which encourages water to flow under the creek bed unless in high flow events. Selected pools are retained during dry periods with these pools expanding and retracting depending on the frequency and size of rainfall events within the catchment.

Since the potential GBF unexpected find at Butchers Creek, this area has been nominated as a GBF management zone. This area has GBF temporary exclusion fencing installed and the area is managed in accordance with the *WC2NH GBF Management Strategy*. Monitoring zones have been established and habitat and abiotic data recorded for this area; refer to raw data in **Appendix A**.

4. Discussion

4.1 Capture and Age Class

A smaller number of GBFs have been captured during the seasonal population monitoring for the 2015/ 2016 period than was recorded during the baseline population monitoring undertaken in 2013/ 2014 which recorded a total count of 47 frogs including juveniles and sub-adult animals.

A total of 16 GBFs were recorded during the autumn/ spring/ summer population monitoring, all frogs were captured within the Upper Warrell Creek system. All frogs were classified as adults, no sub adults or juveniles have been recorded during any population monitoring surveys. Six frogs were captured during autumn, three during spring and seven during summer. All GBFs captured appeared to be in good health with no visible signs of disease or illness.

After only one year of monitoring it is difficult to draw conclusions regarding the dynamics of this population of frogs at Upper Warrell Creek but the reduction in frog records since the baseline population monitoring may be attributable to several factors such as:

- Non-favourable surveys conditions due to lower than usual rainfall.
- Lower than average monthly rainfall records and smaller than usual flood events.
- Direct impacts to previously populated GBF habitat in zones 8, 9 and 10 at UWC.
- No successful breeding events during the years between monitoring and therefore no recruitment of juveniles.
- Reduced health in the population due to disease, although all frogs captured appeared to be in good health.

Three frogs were captured during spring surveys which were microchipped for the first time. Two of the seven frogs captured during the summer monitoring were captured during spring monitoring. No frogs captured and microchipped during Lewis Ecological surveys have been identified or recaptured during the population survey efforts of 2015/ 2016.

Since the observation of GBF tadpoles within Butchers Creek an additional GBF management area has been established with 8 survey zones created for monitoring. No GBFs have been recorded within the Butchers Creek survey zones to date.

4.2 Habitat Use

A core section of habitat has been removed within zones 8-10 due to construction of the piling pad and creek crossing. This is the area where the highest number of frogs were captured during baseline monitoring. Twenty-one GBFs were captured in zones 8 and 9 and a further six frogs were captured in zone 10 during the population baseline monitoring. Zones 8, 9 and 10 have now been fully or partially impacted by construction works. During pre-clearing surveys (prior to disturbance to these areas) three frogs were captured and relocated outside of the works footprint, refer to **Illustration 2.1.**

During 2015/ 2016 surveys frogs were observed within zones 2-13 whereas during population baseline monitoring frogs were recorded to be using the creek system more broadly with records spaning zones 2-20.

4.3 Recaptured Frogs

Two GBFs were recaptured during the summer monitoring that were previously captured and microchipped in Spring. Frog ID # 00077E9014 increased in length by 11 mm and weight by 14 g. This frog was first captured in spring on the western bank of zone 2 and was recaptured during summer in zone 4 having moved south by a minimum distance of 100 m. Frog ID # 00077E8297 was first detected on the eastern bank and northern end of zone 7 in spring then was recaptured during summer within the northern end of zone 6, having moved north by a minimum distance of ~40 m. This frog increased slightly in length from 82 mm to 83 mm and from 93 g to 95 g.

References

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Lewis Ecological (2014). *WC2NH Giant Barred Frog Management Strategy*. December 2014 for Roads and Maritime Services.

SKM (2010). *Environmental Assessment Volume 2 - Working paper 1 Flora and Fauna.* January 2010 for Roads and Traffic Authority.

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Appendix A

GBF Population Monitoring Raw Data

GBF UWC Spring 19-20 November 2015

Notes:

- Water quality and habitat data was collected on the 19/11/15. Due to a delay in delivery of the microchip reader, the frog surveys could not proceed on the proposed date. The GBF population and weather data therefore was collected on 20/11/15.

Table A1 GBF monitoring data sheet

	Frog # 1	***Frog # 2***	***Frog # 3***
GPS Location and survey zone #:	489324/6594397	489315/6594367	489312/6594575
GPS release point: if frog is loated within the work zone (must be <100m from capture point)	Same as above	Same as above	Same as above
Distance from stream edge:	1	3	3
Position within the microhabitat: (under leaf litter/above litter/ exposed/on a rock)	above leaf litter undercut bank with exposed tree roots	above leaf litter under the tree canopy	above leaf litter at the base of the tree
Sex: (female/male/unknown)	Male	Male	Unknown
Age class: (adult >60mm; sub adult 40-60mm; juvneile <40mm	Adult	Adult	Adult
Snout to vent length (mm):	85	82	80
Weight (grams)**:**	97	93	85
Breeding condition: **Males:** colour of nuptial pads no colour/light/moderate/dark see table 2.1 of GBFMP for classification **Females:** gravid (typically weighing >100 grams) or not **Immature** = Frogs <60mm	light grey	light grey	light grey
Chytrid swab taken Y/N: Wipe the swab under armpits & in groin, keep sample in fridge until delivered to lab	y	y	y
Microchip ID:	00077E8DB9	00077E8297	000077E9014

Table A2 Abiotic data taken once at start of survey on 20/11/2015 (using weathermation data for rainfall)

Survey start time: 19.30 hrs
Survey finish time: 00:30 hrs (next day)
Survey duration: 5 hours

Component	***Data***
Rainfall during the survey (mm):	0
Rainfall within the past 24 hrs (mm):	0
Rainfall within the past 7 days (mm):	30
Rainfall within the past 30 days (mm):	163
Relative humidity start of survey %:	56.2
Relative humidity end of survey: %:	86.9
Air temp start of survey (degrees Celsius):	25.9
Air temp end of survey (degrees Celsius):	20.1
Wind speed: 0=no wind; 1=light rustles in the leaves; 2 branches moving; 3 = whole canopy moving	0

Table A3 Water quality data taken once at start of survey on 19/11/2015

Component	*Data*
Water level:	marker is zero
Location:	GPS point **WQN** 489509 6594432
DO (mg/L or %):	9.0 mg/L / 106.7 %DO
Conductivity (mS/cm):	0.221 mS/cm
pH:	6.28
Temperature (degrees Celsius):	22.65
Turbidity (NTU):	0
Samples taken for lab analysis Y/N:	Y
Lab analysis: **Heavy Metals** - Arsenic, cadmium, chromium, coppper, lead, mercury, nickel and zinc **Hydrocarbons** - Napthalene TRH>C10-C16, TRH>C10-C16 less napthalene (F2), TRH>C16-C34, TRH>34-C40, TRHC6-C10, and TRHC6-C10 less BTEX (F1) **BTEX** Group including Benzene, Wthylbenzene, m&P-xylenes, o-Xylene, Toluene and Xylene - total **Nutrients -** Nitrogen (as N), Suspended Solids and Total Phosphorus	

Habitat and tadpole trap data

The habitat and tadpole trap data collected on 19/11/2015 is shown below in **Table A4**.

Notes:

- All emergent vegetation was observed at the edge of the creek on or close to the bank.
- Tadpole traps were set for 3 hours from 1:00 pm to 4:00 pm and were retreived at midnight catch data for the nocturnal period was 2x gambusia in zone 6 and 1 x glass shrimp in zone 20.

Table A4 Habitat data collected on 19/11/2015 at the 20 demarcated zones

	Zone # 1	*Zone # 2*	*Zone # 3*	*Zone # 4*	*Zone # 5*	*Zone # 6*	*Zone # 7*	*Zone # 8*	*Zone # 9*	*Zone # 10*	*Zone # 11*	*Zone # 12*	*Zone # 13*	*Zone # 14*	*Zone # 15*	*Zone # 16*	*Zone # 17*	*Zone # 18*	*Zone # 19*	*Zone # 20*
Landuse: dairy or beefcattle grazing etc.	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	rock crossing	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Dairy cattle	Dairy cattle
Broad veg type within the immediate riparian zone: riaparian rainforest/ dry sclerophyll/ woodland mallee/ heath/ shrubsedgeland or cleared land	Cleared pasture	Sclerophyll - Water Gum	Sclerophyll - Water Gum	floded gum, water gum, camphor laurel	red ash, water gum, camphor laurel, scentless rosewood	red ash, water gum, camphor laurel, flooded gum	red ash, water gum, camphor laurel, smallleaf privot	Camphor, water gum, privot	Water gum, Red Ash, Privot	nil	water gum	creek sandpaper fig water gum	creek sandpaper fig water gum	water gum	water gum, camphor	water gum, camphor	water gum, camphor	water gum	water gum, snadpaper fig, large leaf privot	water gum
Instream physical features	logs	log	nil	nil	nil	log	nil	nil	silt curtain	piped rock crossing with riffles	nil	dead tree	log							
Stream width (m):	20	25	35	35	25	30	30	15	15	10	20	18	18	15	12	10	12	15	8	3 small island
Stream depth (m):	>1.5	>1.5	>1.5	>1.5	>1.5	>1.5	>1	>1	>1	80cm	1m	>1.5	>1.5	>1	>1	>1	>1	>1	0.7	0.5
Presence of pools and or riffles:	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	riffles pools either side of the piped crossing	deep channel	deep channel	deep channel	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m
Bed composition:	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	rock	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer
Type of emergent vegetation if present:	Juncus sp. Persicaria Strigosa, Eleocharis sp.	Nymphaea caerulea	lomandra	lomandra	lomandra	lomandra	lomandra	lomandra	lomandra	Juncus spp. Persicaria strigosa, Setaria lomandra	Juncus spp.	nil	Nymphaea caerulea, Persicaria	lomandra	lomandra	lomandra	lomandra	lomandra	lomandra, persicaria spp.	Lomandra
Stream bank characteristics:	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	imported rock	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam
Bank profile: Undercut/steep/benched/gradual incline from the waters edge	gradual incline	benched	steep incline	undercut to steep	steep	moderate	steep	moderate	gradual incline	not natural	moderate	steep	steep	steep	steep	steep benched	steep benched	moderate benched	moderate	moderate
Vegetation associated with the stream bank regarding foliage projection cover (fpc) for overstorey trees/shrubs/ground cover	grass 100%	80%	90%	80%	70%	70%	60%	70%	60%	100% grass	70%	80% grass 20% leaf litter	70%	80%	50%-60%	60%	80%	70%	70%	3
Groundcover compostion: including a measure of vegetative groundcover/litter cover/soil cover/exposed rock expressed as a composition %	kikuyu 100%	Moss 40% Leaf litter 25% Exposed soil 20% Grass 15%	Moss 10% Leaf litter 70% Exposed soil 20% Grass 0%	Moss 10% Leaf litter 80% Exposed soil 10% Grass 0%	Moss 15% Leaf litter 65 % Exposed soil 20% Grass 0%	Moss 10% Leaf litter 70 % Exposed soil 20% Grass 0%	Moss 10% Leaf litter 80% Exposed soil 10% Grass 0%	Moss 20% Leaf litter 50% Exposed soil 30 % Grass 0 %	Moss 30% Leaf litter 50% Exposed soil 20% Grass 0%	wetland species 100 %	Moss 20% Leaf litter 20% Exposed soil 20% Grass 40%	Moss0 % Leaf litter 30% Exposed soil 0% Grass 70 %	Moss 0% Leaf litter 0% Exposed soil 0% Grass 100%	Moss 10% Leaf litter 40% Exposed soil 20% Grass 30%	Moss 10% Leaf litter 70% Exposed soil 20% Grass 0%	Moss 20% Leaf litter 50% Exposed soil 30% Grass 10%	Moss 20% Leaf litter 50 % Exposed soil 15% Grass 15%	Moss 20% Leaf litter 30% Exposed soil 10% Grass 30%	Moss 20% Leaf litter 60% Exposed soil 10% Grass 10%	Moss 10% Leaf litter 60% Exposed soil 10% Grass 10%
Depth of Litter: Deep = >100mm / Moderate = 20 - 100mm / Shallow = < 20mm / Absent	nil	shallow	moderate	moderate	moderate	shallow	moderate	shallow	shallow	nil	shallow	moderate	nil	shallow	moderate	moderate	moderate	shallow	moderate	shallow
Tadpole Trap Data: 1 trap per survey zone and in the water for 3 hours	nil	nil	3 x empire gudgeons	nil	4 x empire gudgeon 1 x flathead gudgeon	2 x striped gudgeon 1 x firetail gudgeon	2x firetail gudgeon 2 x striped gudgeon	nil	nil	nil	nil	nil	nil	1 x striped gudgeon 2 x Flathead gudgeon	nil	2 x empire gudgeons				1 x Shrimp
Dip net results:			nil			nil			1 x glass shrimp 2x Gambusia											

GBF Butchers Creek Spring 20 November 2015

Notes:

- Water quality and habitat data was collected on the 19/11/15. Due to a delay in delivery of the microchip reader, the frog surveys could not proceed on the proposed date. The GBF population and weather data therefore was collected on 20/11/15.

Table A5 GBF monitoring data sheet

	Frog # 1	*Frog # 2*	*Frog # 3*	*Frog # 4*	*Frog # 5*
GPS Location and survey zone #:	**No Giant Barred Frogs (M. iteratus) were recorded at the Butchers Creek site**				
GPS release point: if frog is loated within the work zone (must be <100m from capture point)					
Distance from stream edge:					
Position within the microhabitat: (under leaf litter/above litter/ exposed/on a rock)					
Sex: (female/male/unknown)					
Age class: (adult >60mm; sub adult 40-60mm; juvneile <40mm					
Snout to vent length (mm):					
Weight (grams)**:**					
Breeding condition: **Males:** colour of nuptial pads no colour/light/moderate/dark see table 2.1 of GBFMP for classification **Females:** gravid (typically weighing >100 grams) or not **Immature** = Frogs <60mm					
Chytrid swab taken Y/N: Wipe the swab under armpits & in groin, keep sample in fridge until delivered to lab					
Microchip ID:					

Table A6 Abiotic data taken once at start of survey on 20/11/2015 (using weathermation data for rainfall)

Survey start time: 19.30 hrs
Survey finish time: 23:30 hrs
Survey duration: 4 hours

Component	*Data*
Rainfall during the survey (mm):	0
Rainfall within the past 24 hrs (mm):	0
Rainfall within the past 7 days (mm):	30
Rainfall within the past 30 days (mm):	163
Relative humidity start of survey %:	54.6
Relative humidity end of survey: %:	89.1
Air temp start of survey (degrees Celsius):	29.7
Air temp end of survey (degrees Celsius):	22.2
Wind speed: 0=no wind; 1=light rustles in the leaves; 2 branches moving; 3 = whole canopy moving	no wind

Table A7 Water quality data taken once at start of survey on 19/11/2015

Component	*Data*
Water level:	Marker was zero
Location:	E494531 N6604304
DO (mg/L or %):	4.78 mg/L or 55.6 %DO
Conductivity (mS/cm):	0.447
pH:	6.07
Temperature (degrees Celsius):	21.47
Turbidity (NTU):	2.0
Samples taken for lab analysis Y/N:	Y
Lab analysis: **Heavy Metals** - Arsenic, cadmium, chromium, coppper, lead, mercury, nickel and zinc **Hydrocarbons** - Napthalene TRH>C10-C16, TRH>C10-C16 less napthalene (F2), TRH>C16-C34, TRH>34-C40, TRHC6-C10, and TRHC6-C10 less BTEX (F1) **BTEX** Group including Benzene, Wthylbenzene, m&P-xylenes, o-Xylene, Toluene and Xylene - total **Nutrients -** Nitrogen (as N), Suspended Solids and Total Phosphorus	

Habitat and tadpole trap data

The habitat and tadpole trap data collected on 19/11/2015 is shown below in **Table A8**.

Notes:

- All emergent vegetation was observed at the edge of the creek on or close to the bank.
- Tadpole traps were set for 4 hours from 3:00 pm to 7:00 pm.

Table A8 Habitat data and tadpole trap data collected on 19/11/2015 at the 8 demarcated zones

	Zone # 1	***Zone # 2***	***Zone # 3***	***Zone # 4***	***Zone # 5***	***Zone # 6***	***Zone # 7***	***Zone # 8***
Landuse: dairy or beefcattle grazing etc.	Forest riparian zone	Forest riparian zone	Forest riparian zone	Forest riparian zone	Project alignment	Forestry / Cattle	Forestry / Cattle	Forestry / Cattle
Broad veg type within the immediate riparian zone: riaparian rainforest/ dry sclerophyll/ woodland mallee/ heath/ shrubsedgeland or cleared land	Maidens Blush Bangalow Palm Flooded Gum	Bangalow palm Blackbutt Tallowwood Turpentine Maidens Blush	Casaurina Flooded Gum Camphor Laurel Syzigium	Callicoma Casurina Flooded Gum Camphor Laurel	Callicoma Flooded Gum Camphor Laurel	Camphor Laurel Red Ash Blue Gum	Camphor Laurel Privot Lantana	Camphor Laurel Brush Box Casurina Blackbutt
Instream physical features	grey from tannins	black from tannins	nil	nil	nil	nil	nil	nil
Stream width (m):	4	5	3.5	8	4	3	3	3
Stream depth (m):	0.4	1-1.5	0.6	1 to 2	1	0.5	0.3	0.4
Presence of pools and or riffles:	Pool	Pool	Pool	Pool	Pool	Pool	Pool	Pool
Bed composition:	Rock	Rock	Rock	Rock	Rock and detriatus	Rock	Rock	Rock
Type of emergent vegetation if present:	nil	nil	nil	nil	lomandra along bank	nil	nil	nil
Stream bank characteristics:	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam
Bank profile: Undercut/steep/benched/gradual incline from the waters edge	gradual	undercut	undercut / tree roots	gradual/ undercut	Benched	undercut	gradual	undercut
Vegetation associated with the stream bank regarding foliage projection cover (fpc) for overstorey trees/shrubs/groundcover	70%	80%	70%	70%	40%	60%	40%	70%
Groundcover compostion: including a measure of vegetative groundcover/litter cover/soil cover/exposed rock expressed as a composition %	Moss 0% Leaf litter 50% Exposed soil 0% Rock 30% Grass 20%	Moss 0% Leaf litter 50% Exposed soil 0% Rock 50% Grass 0%	Moss 0% Leaf litter 50% Exposed soil 0% Rock 50% Grass 0%	Moss 0% Leaf litter 50% Exposed soil 0% Rock 50% Grass 0%	Moss % Leaf litter % Exposed soil % Rock % Grass %	Moss % Leaf litter 20% Exposed soil % Rock 20% Grass 60%	Moss % Leaf litter % Exposed soil % Rock % Grass %	Moss % Leaf litter % Exposed soil % Rock % Grass %
Depth of litter: Deep = >100mm / Moderate = 20 -100mm / Shallow = < 20mm / Absent	Shallow	Shallow	nil	Shallow	Shallow	Moderate	Shallow	Deep
Tadpole trap data Traps to be placed 1 per survey zone and in the water for 3 hours	nil	nil	nil	nil	nil	nil	nil	nil
Dip net results:			nil			nil		

GBF Butchers Creek Summer 27 January 2016

Notes:

- Water quality, habitat, GBF population and weather data was all collected on 27 January 2016.

Table A9 GBF monitoring data sheet

	Frog # 1	*Frog # 2*	*Frog # 3*	*Frog # 4*	*Frog # 5*
GPS Location and survey zone #:	**No Giant Barred Frogs (M. iteratus) were recorded at the Butchers Creek site**				
GPS release point: if frog is loated within the work zone (must be <100m from capture point)					
Distance from stream edge:					
Position within the microhabitat: (under leaf litter/above litter/ exposed/on a rock)					
Sex: (female/male/unknown)					
Age class: (adult >60mm; sub adult 40-60mm; juvneile <40mm					
Snout to vent length (mm):					
Weight (grams)**:**					
Breeding condition: **Males:** colour of nuptial pads no colour/light/moderate/dark see table 2.1 of GBFMP for classification **Females:** gravid (typically weighing >100 grams) or not **Immature** = Frogs <60mm					
Chytrid swab taken Y/N: Wipe the swab under armpits & in groin, keep sample in fridge until delivered to lab					
Microchip ID:					

Table A10 Abiotic data taken once at start of survey on 27/01/2016 (using weathermation data for rainfall)

Survey start time: 21.00 hrs
Survey finish time: 23:55 hrs
Survey duration: 3 hours

Component	*Data*
Rainfall during the survey (mm):	0
Rainfall within the past 24 hrs (mm):	15
Rainfall within the past 7 days (mm):	37.6
Rainfall within the past 30 days (mm):	105.4
Relative humidity start of survey %:	73
Relative humidity end of survey: %:	85.8
Air temp start of survey (degrees Celsius):	25.6
Air temp end of survey (degrees Celsius):	21.8
Wind speed: 0=no wind; 1=light rustles in the leaves; 2 branches moving; 3 = whole canopy moving	no wind

Table A11 Water quality data taken once at start of survey on 27/01/2016

Component	*Data*
Water level:	5 cm less than previous reading
Location:	E489653 N6594910
DO (mg/L or %):	9.55 mg/L or 112.9%DO
Conductivity (mS/cm):	0.205
pH:	5.52
Temperature (degrees Celsius):	22.6
Turbidity (NTU):	1.5
Samples taken for lab analysis Y/N:	Y
Lab analysis: **Heavy Metals** - Arsenic, cadmium, chromium, coppper, lead, mercury, nickel and zinc **Hydrocarbons** - Napthalene TRH>C10-C16, TRH>C10-C16 less napthalene (F2), TRH>C16-C34, TRH>34-C40, TRHC6-C10, and TRHC6-C10 less BTEX (F1) **BTEX** Group including Benzene, Wthylbenzene, m&P-xylenes, o-Xylene, Toluene and Xylene - total **Nutrients -** Nitrogen (as N), Suspended Solids and Total Phosphorus	

Habitat and tadpole trap data

The habitat and tadpole trap data collected on 27/01/2016 is shown below in **Table A12**.

Notes:

- All emergent vegetation was observed at the edge of the creek on or close to the bank.
- Tadpole traps were set for 5 hours from 4:00 pm to 9:00 pm.

Table A12 Habitat data and tadpole trap data collected on 27/01/2016 at the 8 demarcated zones

	Zone # 8 East	***Zone # 7***	***Zone # 6***	***Zone # 5***	***Zone # 4***	***Zone # 3***	***Zone # 2***	***Zone # 1 West***
Landuse: dairy or beefcattle grazing etc.	Forest riparian zone	Forest riparian zone	Forest riparian zone	Forest riparian zone	Project alignment	Forestry / Cattle	Forestry / Cattle	Forestry / Cattle
Broad veg type within the immediate riparian zone: riaparian rainforest/ dry sclerophyll/ woodland mallee/ heath/ shrubsedgeland or cleared land	Maidens Blush Bangalow Palm Flooded Gum	Bangalow palm Blackbutt Tallowwood Turpentine Maidens Blush	Casaurina Flooded Gum Camphor Laurel Syzigium	Callicoma Casurina Flooded Gum Camphor Laurel	Callicoma Flooded Gum Camphor Laurel	Camphor Laurel Red Ash Blue Gum	Camphor Laurel Privot Lantana	Camphor Laurel Brush Box Casurina Blackbutt
Instream physical features	grey from tannins	black from tannins	nil	nil	nil	nil	nil	nil
Stream width (m):	4	6	3	0.8	4	3	3	3
Stream depth (m):	1	1-1.5	0.5	0.1	1	0.7	0.5	0.5
Presence of pools and or riffles:	Pool	Pool	Pool	Pool	Pool	Pool	Pool	Pool
Bed composition:	Rock	Rock	Rock	Rock / Leaf litter	Rock and detriatus	Rock	Rock	Rock / leaf litter
Type of emergent vegetation if present:	nil	nil	nil	nil	lomandra along bank	lomandra along bank	lomandra along bank	nil
Stream bank characteristics:	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam
Bank profile: Undercut/steep/benched/gradual incline from the waters edge	gradual & steep	undercut	undercut / tree roots	gradual/ undercut	Benched	undercut	gradual	undercut
Vegetation associated with the stream bank regarding foliage projection cover (fpc) for overstorey trees/shrubs/groundcover	70%	80%	70%	70%	40%	60%	40%	70%
Groundcover compostion: including a measure of vegetative groundcover/litter cover/soil cover/exposed rock expressed as a composition %	Moss 0% Leaf litter 65% Exposed soil 0% Rock 35% Grass 0%	Moss 0% Leaf litter 80% Exposed soil 0% Rock 20% Grass 0%	Moss 0% Leaf litter 60% Exposed soil 0% Rock 40% Grass 0%	Moss 0% Leaf litter 50% Exposed soil 0% Rock 50% Grass 0%	Moss % Leaf litter 70% Exposed soil % Rock 30% Grass %	Moss % Leaf litter 60% Exposed soil % Rock % Grass 40%	Moss % Leaf litter % Exposed soil % Rock % Grass 100%	Moss 0% Leaf litter 30% Exposed soil 10% Rock 60% Grass 0%
Depth of litter: Deep = >100mm / Moderate = 20 - 100mm / Shallow = < 20mm / Absent	Moderate	Deep	Moderate	Moderate	Moderate	Moderate	Absent	Shallow

	Zone # 8 East	***Zone # 7***	***Zone # 6***	***Zone # 5***	***Zone # 4***	***Zone # 3***	***Zone # 2***	***Zone # 1 West***
Tadpole trap data Traps to be placed 1 per survey zone and in the water for 3 hours	nil	nil	1 tiny yellow tadpole <10 mm	nil	nil	1 tiny yellow tadpole <10 mm 1 freshwater snail	nil	nil
Dip net results:	nil	no dip netting	2 tiny tadpoles	no dip netting	1 tadpole likely tree frog species	nil	nil	no dip netting

GBF UWC Summer 10-11 February 2016

Notes:

- Due to lower than expected frog capture numbers on the survey undertaken on 10/02/2016, a second survey was undertaken on 11/02/2016. GBF and abiotic data was collected across the two surveys on 10/02/2016 and 11/02/2016. Habitat, tadpole trap data and weather data was only collected once on 10/02/2016.

Table A13 GBF monitoring data sheet

	Frog # 1	***Frog # 2***	***Frog # 3***	***Frog # 4***	***Frog # 5***	***Frog # 6***	***Frog # 7***
Date:	10/02/16	10/02/16	10/02/16	10/02/16	11/02/16	11/02/16	11/02/16
GPS Location and survey zone #:	489318/6594467	489314/6594406	489355/6594571	489316/6594568	489352/6594497	489288/6594219	489293/6594214
GPS release point: if frog is loated within the work zone (must be <100m from capture point)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above
Distance from stream edge:	3	1	1.5	3	1	1.5	1.5
Position within the microhabitat: (under leaf litter/above litter/ exposed/on a rock)	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine	above leaf litter/ Eye Shine
Sex: (female/male/unknown)	Unknown	Unknown	Male	Male	Unknown (Croaked)	Unknown (Croaked)	Unknown (Croaked)
Age class: (adult >60mm; sub adult 40-60mm; juvneile <40mm	Adult	Adult	Adult	Adult	Adult	Adult	Adult
Snout to vent length (mm):	91	83	76	76	92	75	78
Weight (grams)**:**	99	95	60	71	109	74	74
Breeding condition: **Males:** colour of nuptial pads no colour/light/moderate/dark see table 2.1 of GBFMP for classification **Females:** gravid (typically weighing >100 grams) or not **Immature** = Frogs <60mm	Dark grey	Dark grey	Moderate	Moderate	Translucent/Light	1 m from frog #7, Translucent/Light	1 m from frog #6, Translucent/Light
Chytrid swab taken Y/N: Wipe the swab under armpits & in groin, keep sample in fridge until delivered to lab	Y	Y	Y	Y	Y	Y	Y
Previously chipped:	Y	Y	N	N	N	N	N
Microchip ID:	00077E9014	00077E8297	00078ABC23	00078ABD42	00078ABE43	000078ABC3B	000078ABC9A

Table A14 Abiotic data taken once at start of each survey on 10/02/2016 and 11/02/2016 (using weathermation data for rainfall)

Survey on 10/02/2016		***Survey on 11/02/2016***	
Survey start time:	20:00	**Survey start time:**	21:00
Survey finish time:	00:30 (next day)	**Survey finish time:**	23:00
Survey duration:	4.5 hours	**Survey duration:**	2 hours

Component	***Data***	
	10/02/2016	***11/02/2016***
Rainfall during the survey (mm):	0	0
Rainfall within the past 24 hrs (mm):	0.4	0
Rainfall within the past 7 days (mm):	21	21
Rainfall within the past 30 days (mm):	72.2	72.2
Relative humidity start of survey %:	56	65.4
Relative humidity end of survey: %:	91.10	87.1
Air temp start of survey (degrees Celsius):	30	26.6
Air temp end of survey (degrees Celsius):	19.8	22
Wind speed: 0=no wind; 1=light rustles in the leaves; 2 branches moving; 3 = whole canopy moving	1	0

Table A15 Water quality data taken once at start of the first survey on 10/02/2016

Component	***Data***
Water level:	20 cm lower that spring measurement
Location:	GPS point **WQN** 489303 6594456
DO (mg/L or %):	141.40%DO
Conductivity (mS/cm):	0.247 mS/cm
pH:	6.01
Temperature (degrees Celsius):	24.77
Turbidity (NTU):	4.1
Samples taken for lab analysis Y/N:	Y
Lab analysis: **Heavy Metals** - Arsenic, cadmium, chromium, coppper, lead, mercury, nickel and zinc **Hydrocarbons** - Napthalene TRH>C10-C16, TRH>C10-C16 less napthalene (F2), TRH>C16-C34, TRH>34-C40, TRHC6-C10, and TRHC6-C10 less BTEX (F1) **BTEX** Group including Benzene, Wthylbenzene, m&P-xylenes, o-Xylene, Toluene and Xylene - total **Nutrients -** Nitrogen (as N), Suspended Solids and Total Phosphorus	

Habitat and tadpole trap data

The habitat and tadpole trap data collected on 10/02/2016 is shown below in **Table A16**.

Notes:

- All emergent vegetation was observed at the edge of the creek on or close to the bank.
- Tadpole traps were set for 3 hours from 1:00 pm to 2:00 pm and were retrieved from UWC crossing north from 5:00 pm-6:00 pm and from the crossing south from 10:00 pm-11:00 pm.
- Tadpole traps were set for 3 hours from 1:00 pm to 4:00 pm and were retrieved at midnight catch data for the nocturnal period was 2x gambusia in zone 6 and 1 x glass shrimp in zone 20.

Table A16 Habitat data collected on 10/02/2016 at the 20 demarcated zones

	Zone # 1	*Zone # 2*	*Zone # 3*	*Zone # 4*	*Zone # 5*	*Zone # 6*	*Zone # 7*	*Zone # 8*	*Zone # 9*	*Zone # 10*	*Zone # 11*	*Zone # 12*	*Zone # 13*	*Zone # 14*	*Zone # 15*	*Zone # 16*	*Zone # 17*	*Zone # 18*	*Zone # 19*	*Zone # 20*
Landuse: dairy or beefcattle grazing etc.	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	rock crossing	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Beef cattle	Dairy cattle	Dairy cattle
Broad veg type within the immediate riparian zone: riaparian rainforest/ dry sclerophyll/ woodland mallee/ heath/ shrubsedgeland or cleared land	Cleared pasture	Sclerophyll - Water Gum	Sclerophyll - Water Gum	floded gum, water gum, camphor laurel	red ash, water gum, camphor laurel, scentless rosewood	red ash, water gum, camphor laurel, flooded gum	red ash, water gum, camphor laurel, smallleaf privot	Camphor, water gum, privot	Water gum, Red Ash, Privot	nil	water gum	creek sandpaper fig water gum	creek sandpaper fig water gum	water gum	water gum, camphor	water gum, camphor	water gum, camphor	water gum	water gum, snadpaper fig, large leaf privot	water gum
Instream physical features	logs	log	nil	nil	nil	nil	nil	nil	silt curtain	piped rock crossing with riffles	nil	dead tree	log				log			
Stream width (m):	15.00	15	20	20	18	20	18	15	10	5	23	17	12	10	8	8	8	3	2	3 small island
Stream depth (m):	>1.5	>1.5	>1.5	>1.5	>1.5	>1.5	>1	>1	>1	0.6	1m	>1.5	>1.5	>1	>1	>1	>1	>1	0.5	0.3
Presence of pools and or riffles:	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	deep channel	riffles pools either side of the piped crossing	deep channel	deep channel	deep channel	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m	shallow channel ~1m
Bed composition:	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	rock	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer	gravel covered in detriatus layer
Type of emergent vegetation if present:	Juncus sp. Persicaria Strigosa, Eleocharis sp.	Nymphaea caerulea	lomandra	lomandra	lomandra	lomandra, Nymphaea caerulea	lomandra	lomandra	lomandra	Juncus spp. Persicaria strigosa, Setaria lomandra	Juncus spp.	nil	lomandra	lomandra	lomandra	lomandra	lomandra, Nymphaea caerulea	lomandra	lomandra, persicaria spp.	Lomandra
Stream bank characteristics:	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	imported rock	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam	sandy soil - loam
Bank profile: Undercut/steep/benched/gradual incline from the waters edge	gradual incline	benched	steep incline	undercut to steep	steep	moderate	steep	moderate	gradual incline	Rock **grass**	steep	vertical steep	steep/undercut	moderate	steep	steep benched	steep benched	moderate benched	Ggentle	moderate
Vegetation associated with the stream bank regarding foliage projection cover (fpc) for overstorey trees/shrubs/ground cover	grass 100%	80%	90%	80%	70%	70%	60%	70%	60%	100% grass	70%	80%grass 20% leaf litter	70%	80%	50%-60%	60%	80%	70%	70%	3
Groundcover compostion: including a measure of vegetative groundcover/litter cover/soil cover/exposed rock expressed as a composition %	kikuyu 100%	Leaf litter 260% Exposed soil 20% Grass 20%	Leaf litter 60% Exposed soil 10% Grass 40%	Moss 0% Leaf litter 100% Exposed soil 0% Grass 0%	Moss 0% Leaf litter 35 % Exposed soil 35% Grass 0%	Moss 0% Leaf litter 60 % Exposed soil 0% Grass 40%	Moss 0% Leaf litter 50% Exposed soil 10% Grass 40%	Moss 10% Leaf litter 60% Exposed soil 30 % Grass 0 %	Moss 10% Leaf litter 40% Exposed soil 60% Grass 0%	Large rock 50% Herbs 50%	Moss 0% Leaf litter 50% Exposed soil 30% Grass 20%	Moss0 % Leaf litter 20% Exposed soil 0% Grass 80 %	Moss 0% Leaf litter 30% Exposed soil 0% Grass 60%	Moss 0% Leaf litter 60% Exposed soil 20% Grass 20%	Moss 20% Leaf litter 20% Exposed soil 20% Grass 40%	Moss 0% Leaf litter 20% Exposed soil 20% Grass 60%	Moss 10% Leaf litter 40 % Exposed soil 10% Grass 40%	Moss 10% Leaf litter 70% Exposed soil 10% Grass 10%	Moss 10% Leaf litter 50% Exposed soil 30% Grass 20%	Moss 10% Leaf litter 60% Exposed soil 10% Grass 10 %
Depth of Litter: Deep = >100mm / Moderate = 20 - 100mm / Shallow = < 20mm / Absent	nil	moderate	moderate	Deep	Shallow	moderate	moderate	moderate	shallow	nil	moderate	moderate	shallow	moderate	shallow	shallow	shallow	moderate	moderate	shallow
Tadpole Trap Data: 1 trap per survey zone and in the water for 3 hours	nil	fire tail gudgeons	nil	nil	fire tail gudgeons	empire gudgeon	nil	nil	nil	Empire Gudgeon x4	nil	nil	nil	nil	nil					1 x Shrimp
Dip net results:	Glass shrimp	nil	nil	Glass shrimp	nil	nil	nil	fire tail gudgeons	Empire Gudgeon	Glass shrimp	nil	nil	nil	Glass shrimp	nil	Glass shrimp, 1 x Empire gudgeon				

Appendix B

Water Quality Monitoring Results

GEOLINK
FRANK MAKIN
23 GORDON STREET
COFFS HARBOUR NSW 2450

BATCH NUMBER: 15/2448
No. of SAMPLES: 2
DATE COLLECTED: 19-20/11/15
DATE RECEIVED: 20/11/15
TIME RECEIVED: 16:50
DATE TESTING COMMENCED: 23/11/15

REPORT OF ANALYSIS

SAMPLE REFERENCE	SAMPLE DESCRIPTION
15/2448/1	BUTCHERS CREEK
15/2448/2	UPPER WARRELL CREEK

ANALYSIS	METHOD NO	UNITS	15/2448/1	15/2448/2
Total Suspended Solids	APHA 2540 D	mg/L	3	2
Total Nitrogen	EL30F	mg/L	0.20	0.39
Total Phosphorus	EL18F	mg/L	<0.03	<0.03

ANALYSIS	METHOD NO	UNITS	15/2448/1	15/2448/2
METAL SUITE				
Arsenic*	EG020T	mg/L	<0.001	<0.001
Cadmium	EL9A	mg/L	<0.002	<0.002
Chromium	EL9A	mg/L	<0.003	<0.003
Copper	EL9A	mg/L	<0.004	<0.004
Lead	EL9A	mg/L	<0.010	<0.010
Mercury*	EG035T	mg/L	<0.0001	<0.0001
Nickel	EL9A	mg/L	<0.005	<0.005
Selenium*	EG020T	mg/L	<0.01	<0.01
Zinc	EL9A	mg/L	0.008	0.004
BTEX*				
Benzene	EP080	ug/L	<1	<1
Toluene	EP080	ug/L	<2	<2
Ethylbenzene	EP080	ug/L	<2	<2
meta- & para-Xylene	EP080	ug/L	<2	<2
ortho-Xylene	EP080	ug/L	<2	<2
^Total Xylenes	EP080	ug/L	<2	<2
^Sum of BTEX	EP080	ug/L	<1	<1
Naphthalene	EP080	ug/L	<5	<5
TOTAL PETROLEUM HYDROCARBONS*				

ANALYSIS	METHOD NO	UNITS	15/2448/1	15/2448/2
TPH C6-C9 Fraction	EP080/071	ug/L	<20	<20
TPH C10-C14 Fraction	EP080/071	ug/L	<50	<50
TPH C15-C28 Fraction	EP080/071	ug/L	<100	<100
TPH C29-C36 Fraction	EP080/071	ug/L	<50	<50
TPH C10-C36 Fraction (sum)	EP080/071	ug/L	<50	<50
TOTAL RECOVERABLE HYDROCARBON*				
C6-C10 Fraction	EP080/071	mg/kg	<20	<20
C6 - C10 Fraction minus BTEX^	EP080/071	mg/kg	<20	<20
>C10 - C16 Fraction	EP080/071	mg/kg	<100	<100
>C16 - C34 Fraction	EP080/071	mg/kg	<100	<100
>C34 - C40 Fraction	EP080/071	mg/kg	<100	<100
>C10 - C40 Fraction (sum)^	EP080/071	mg/kg	<100	<100
>C10-C16 Fraction-Naphthalene^	EP080/071	mg/kg	<100	<100

Comments

Sample(s) collected by client and analysed as received in accordance with "Standard Methods for the Examination of Water
& Wastewater", 22nd Edition, 2012, APHA. Raw data sheets stating analysis dates are available upon request.
Tests marked with '#' are not covered by NATA Accreditation.
*Analysis conducted by a subcontracted laboratory (NATA Accreditation Number 825) WO/N:ES1537294.

Approved: 11/03/16
B J Wadleigh
Laboratory Manager

NATA

Accredited for compliance with ISO/IEC 17025.
[Accreditation Numbers: 12359 (Chemical) & 14565 (Microbiological)]

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian and International standards.

GEOLINK
JESSICA O'LEARY
23 GORDON STREET
COFFS HARBOUR NSW 2450

BATCH NUMBER: 16/0378
No. of SAMPLES: 1
DATE COLLECTED: 10/02/16
DATE RECEIVED: 15/02/16
TIME RECEIVED: 15:35
DATE TESTING COMMENCED: 15/02/16

REPORT OF ANALYSIS

SAMPLE REFERENCE	SAMPLE DESCRIPTION
16/0378/1	UPPER WARRELL CREEK

ANALYSIS	METHOD NO	UNITS	16/0378/1
Total Suspended Solids	APHA 2540 D	mg/L	2
Total Nitrogen	EL30F	mg/L	0.28
Total Phosphorus	EL18F	mg/L	<0.03

ANALYSIS	METHOD NO	UNITS	16/0378/1
METAL SUITE			
Arsenic*	EG020T	mg/L	<0.001
Cadmium	EL9A	mg/L	<0.002
Chromium	EL9A	mg/L	<0.003
Copper	EL9A	mg/L	<0.004
Lead	EL9A	mg/L	<0.010
Mercury*	EG035T	mg/L	<0.0001
Nickel	EL9A	mg/L	<0.005
Selenium*	EG020T	mg/L	<0.01
Zinc	EL9A	mg/L	0.011
TOTAL PETROLEUM HYDROCARBONS*			
TPH C6-C9 Fraction	EP080/071	ug/L	<20
TPH C10-C14 Fraction	EP080/071	ug/L	<50
TPH C15-C28 Fraction	EP080/071	ug/L	<100
TPH C29-C36 Fraction	EP080/071	ug/L	<50
TPH C10-C36 Fraction (sum)	EP080/071	ug/L	<50
TOTAL RECOVERABLE HYDROCARBON*			
C6-C10 Fraction	EP080/071	ug/L	<20
C6 - C10 Fraction minus BTEX	EP080/071	ug/L	<20

ANALYSIS	METHOD NO	UNITS	16/0378/1
>C10 - C16 Fraction	EP080/071	ug/L	<100
>C16 - C34 Fraction	EP080/071	ug/L	<100
>C34 - C40 Fraction	EP080/071	ug/L	<100
>C10 - C40 Fraction (sum)	EP080/071	ug/L	<100
>C10-C16 Fraction-Naphthalene	EP080/071	ug/L	<100
BTEX*			
Benzene	EP080	ug/L	<1
Toluene	EP080	ug/L	<2
Ethylbenzene	EP080	ug/L	<2
meta- & para-Xylene	EP080	ug/L	<2
ortho-Xylene	EP080	ug/L	<2
^Total Xylenes	EP080	ug/L	<2
^Sum of BTEX	EP080	ug/L	<1
Naphthalene	EP080	ug/L	<5

Comments

Sample(s) collected by client and analysed as received in accordance with "Standard Methods for the Examination of Water
& Wastewater", 22nd Edition, 2012, APHA. Raw data sheets stating analysis dates are available upon request.
Tests marked with '#' are not covered by NATA Accreditation.
*Analysis conducted by a subcontracted laboratory (NATA Accreditation Number 825) WO/N:ES1603574.

Approved: 3/03/16
B J Wadleigh
Laboratory Manager

NATA

Accredited for compliance with ISO/IEC 17025.
[Accreditation Numbers: 12359 (Chemical) & 14565 (Microbiological)]

The results of the tests, calibrations and/or measurements included in this document are traceable to Australian and International standards.