DURALIE COAL MINE
GIANT BARRED FROG STUDY

GLOUCESTER BASIN
Part of Gloucester Coal

Revision Status Register

Section/Page/ Annexure	Revision Number	Amendment/Addition	Distribution	DP&I Approval Date
All	GBFS-R01-A	Original	DECCW (now OEH)	-
All	GBFS-R01-B	Edits made to address comments from OEH	OEH, DoP (now DP&I)	-
All	GBFS-R01-C	Edits made to allow for the development of the Giant Barred Frog monitoring program in the preparation of the Giant Barred Frog Management Plan	OEH, DP&I	-
All	GBFS-R02-A	Edits made to reflect amended Project Approval conditions by Order of The Land and Environment Court of NSW dated 10 November 2011	OEH, DP&I	6 March 2012

MARCH 2012
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1 INTRODUCTION

The Duralie Coal Mine is an existing mine situated approximately 35 km south of Gloucester in the Gloucester Valley, New South Wales (NSW) (Figure 1). Duralie Coal Pty Ltd (DCPL) (a wholly owned subsidiary of Gloucester Coal Ltd) owns and operates the Duralie Coal Mine. The NSW Minister for Urban Affairs and Planning granted Development Consent for the mine in August 1997.

The Duralie Extension Project provides an extension and continuation of mine operations at the Duralie Coal Mine. DCPL was granted approval for the Project under Section 75J of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act) on 26 November 2010 (NSW Project Approval [08_0203]) and under Sections 130 and 133 of the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC) on 22 December 2010 (Commonwealth Approval [EPBC 2010/5396]). On 10 November 2011, the NSW Project Approval (08_0203) was amended by Order of The Land and Environment Court of NSW. A copy of the amended NSW Project Approval (08_0203) and the Commonwealth Approval (EPBC 2010/5396) is available on the GCL website (http://www.gloucestercoal.com.au).

1.1 PURPOSE AND SCOPE

The NSW Project Approval requires the preparation and implementation of a Giant Barred Frog Study to obtain important habitat and biological information about the Giant Barred Frog in the Mammy Johnsons River (MJR) catchment.

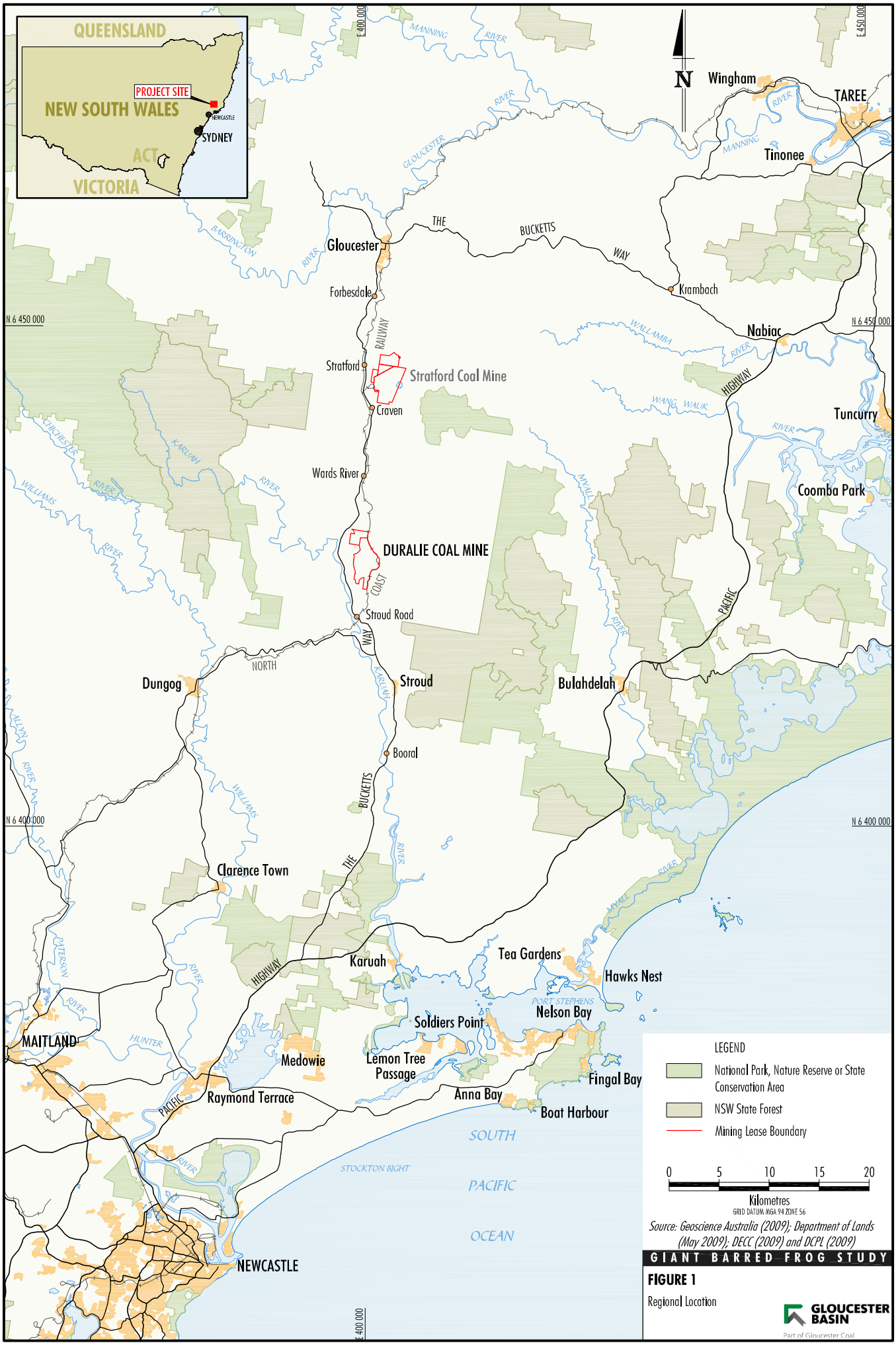
Condition 31 of Schedule 3 of the NSW Project Approval state:

> *31. The Proponent shall prepare a Giant Barred Frog Study to the satisfaction of the Director General. This study must:*
>
> *(a) be prepared, in consultation with OEH, by a suitably qualified and experienced person, whose appointment has been endorsed by the Director-General;*
>
> *(b) be submitted to the Director-General for approval within 2 months of this approval;*
>
> *(c) investigate the extent of the Giant Barred Frog population in the Mammy Johnsons River Catchment;*
>
> *(d) assess the condition of the Giant Barred Frog habitat where it is recorded within the Catchment, including the presence of any Chytrid fungus;*
>
> *(e) analyse the age structure of the frog population and the health of tadpoles; and*
>
> *(f) document the relevant hydrological conditions both prior to and during the study, including rainfall, water flows and quality in Mammy Johnsons River, both upstream and downstream of the confluence of Mammy Johnsons River and Coal Shaft Creek, and in Coal Shaft Creek.*

This Giant Barred Frog Study has been prepared by Biosphere Environmental Consultants (Dr. Arthur White) and DCPL.

1.2 OTHER RELEVANT APPROVAL CONDITIONS

Of relevance to this Giant Barred Frog Study, the NSW Project Approval and Commonwealth Approval require the preparation of a Giant Barred Frog Management Plan, which is to include a monitoring program for the Giant Barred Frog. The aim of the monitoring program is to assess whether impacts on the Giant Barred Frog population are occurring as a result of rainfall runoff from the mine's irrigation areas.



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1.3 REPORT STRUCTURE

The remainder of this Giant Barred Frog Study is structured as follows:

Section 2: Provides a brief outline of the biology, distribution and conservation status of the Giant Barred Frog.

Section 3: Details how the extent of the Giant Barred Frog population in the MJR catchment will be investigated.

Section 4: Outlines how the condition of the Giant Barred Frog habitat in the MJR catchment will be assessed.

Section 5: Describes how relevant hydrological conditions will be documented, both prior to and during the study.

Section 6: Details how the presence of Chytrid fungus in the MJR catchment will be assessed.

Section 7: Describes how the age structure of the Giant Barred Frog population will be analysed.

Section 8: Describes how the health of Giant Barred Frog tadpoles will be analysed.

Section 9: Describes how the Giant Barred Frog Long-Term Study will be developed.

Section 10: Outlines reporting and review of the Giant Barred Frog Study.

Section 11: Lists the references cited.

2 GIANT BARRED FROG – BIOLOGY, DISTRIBUTION AND CONSERVATION STATUS

A brief description of the biology, distribution and conservation status of the Giant Barred Frog is provided below. Further information is available in the various scientific literature and other publications.

2.1 BIOLOGY

2.1.1 Habitat

The Giant Barred Frog is associated with permanent flowing drainages, ranging from shallow rocky streams in rainforest to slow-moving rivers in lowland open forest (NSW Scientific Committee, 1999). Giant Barred Frogs are not found in ponds or ephemeral pools (Ehmann, 1997).

The Giant Barred Frog is known to inhabit various vegetation types including rainforest, moist eucalypt forest and nearby dry eucalypt forest (SEWPaC, 2012). Populations of the Giant Barred Frog have also been found in disturbed areas within vegetated riparian strips on cattle farms (SEWPaC, 2012). However, deep leaf litter provided by canopy vegetation and/or thick cover is necessary (Ehmann, 1997).

White (2008) conducted intensive surveys for the Giant Barred Frog to determine its current distribution in the greater Sydney Basin. The study recorded the Giant Barred Frog in second, third and fourth order streams, all permanent and slow flowing, that ranged in width from 1 m to 5 m wide (White, 2008). At most of the sties, the riparian corridor of the stream was relatively narrow and varied between 5 and 25 m away from the banks (*ibid*.).

Graded banks with undercuts and steep edges are typical of many known Giant Barred Frog sites (Ehmann, 1997).

2.1.2 Breeding

Male Giant Barred Frogs call in spring and summer (Anstis, 2002). A stream breeding species, the Giant Barred Frog breeds from late spring to summer around shallow, flowing, rocky permanent streams, where some riparian vegetation is present (Department of Environment, Climate Change and Water [DECCW], 2009; Lemckert and Brassil, 2000). Breeding is associated with rainfall events, however the Giant Barred Frog does not breed when streams are in full flow; rather at the time stream flow is receding.

Females lay eggs onto the moist creek banks or rocks above water level, from where tadpoles drop into the water when hatched (DECCW, 2009). The larval period of the Giant Barred Frog is from September to May (Goldingay *et al*. 1999; Mahony *et al.* 1997; in SEWPaC, 2012). The Giant Barred Frog has a long tadpole stage that may last up to 18 months (White, 2008). Tadpoles are large, growing to over 100 mm in length (SEWPaC, 2012).

2.1.3 Foraging

Adult Giant Barred Frogs feed primarily on large insects and spiders (NPWS, 2000), and tadpoles feed on plant material.

2.1.4 Movement

Various studies have found the Giant Barred Frog usually stays within approximately 50 m of its habitat (Streatfield, 1999 in SEWPaC, 2012; Lemckert and Brassil, 2000; Koch and Hero, 2007).

Streatfield (1999 in SEWPaC, 2012) monitored the spatial movements of four male and four female Giant Barred Frogs at Coomera River in Queensland. Over six weeks, it was found that the individuals moved a maximum distance of 268 m along the stream and 50 m away from the stream. After a night of activity, the displacement distances between diurnal refuges were found to be small, suggesting a high degree of fidelity to the previous day's shelter (Streatfield, 1999 in SEWPaC, 2012).

Lemckert and Brassil (2000) undertook a four year radio tracking study on the movements and habitat use of the Giant Barred Frog in the Coffs Harbour/Dorrigo area in NSW. The study found that frogs stayed within a 20 m band either side of the four streams monitored.

Koch and Hero (2007) radio tracked the Giant Barred Frog and demonstrated that males were found 7.2 m on average from the stream (range 0.5 to 32.0 m) and females were found on average 12.1 m from the stream (range 0 to 50 m).

Previous studies have shown that the Giant Barred Frog is not distributed evenly along streams; they cluster/reach highest densities around larger pools with overhanging banks (preferred breeding sites). In contrast they are not common near riffle zones. Studies have also found that adult males are territorial (i.e. they defend an area and exclude other males).

2.2 DISTRIBUTION

2.2.1 Australian Distribution

The general distribution of the Giant Barred Frog in Australia extends across the eastern coast and ranges from south-eastern Queensland to the Hawkesbury River in mid-eastern NSW (DECCW, 2009; Hines *et al*., 1999).

An indicative distribution map of the Giant Barred Frog in Australia sourced from the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC, 2012) is shown on Figure 2.

Figure 2
Indicative Distribution Map of the Giant Barred Frog

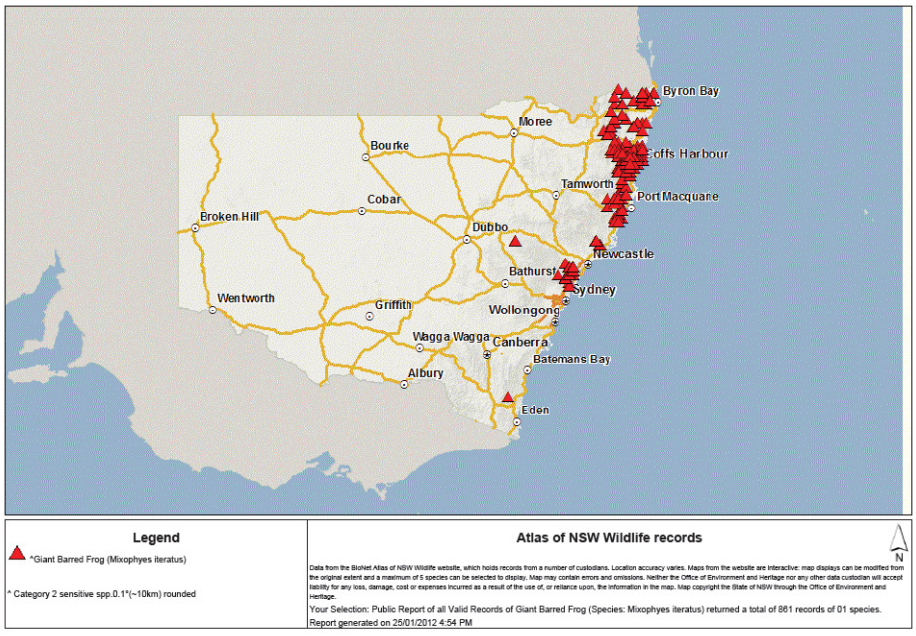
Source: SEWPaC (2012)

Note: This is an indicative distribution map of the present distribution of the species based on best available knowledge.

2.2.2 NSW Distribution

The results of a search for NSW Giant Barred Frog records since 1980 using the on-line Bionet - Atlas of NSW Wildlife are shown on Figure 3.

Figure 3
Bionet - Atlas of NSW Wildlife On-line Search – Giant Barred Frog Records



Source: Office of Environment and Heritage (2012)

Note: Records since 1980.

The Giant Barred Frog has been recorded at three locations outside of the MJR catchment within the wider surrounds (Figure 4):

- on Mill Creek, which runs parallel with and approximately 2 km to the east of the MJR (21 records, 2001);
- on Saggers Creek (a tributary of Mill Creek in the Myall River State Forest), approximately 8.5 km east of the MJR and approximately 6.5 km east of Mill Creek (2 records, 2003); and
- on Crawford River, approximately 16.5 km south-east of the MJR and approximately 10 km south-east of Saggers Creek (5 records, 2005).

All of the above mentioned streams are perennial streams.

2.2.3 Local Distribution – MJR Catchment

The approximate boundary of the MJR catchment is shown on Figure 5.

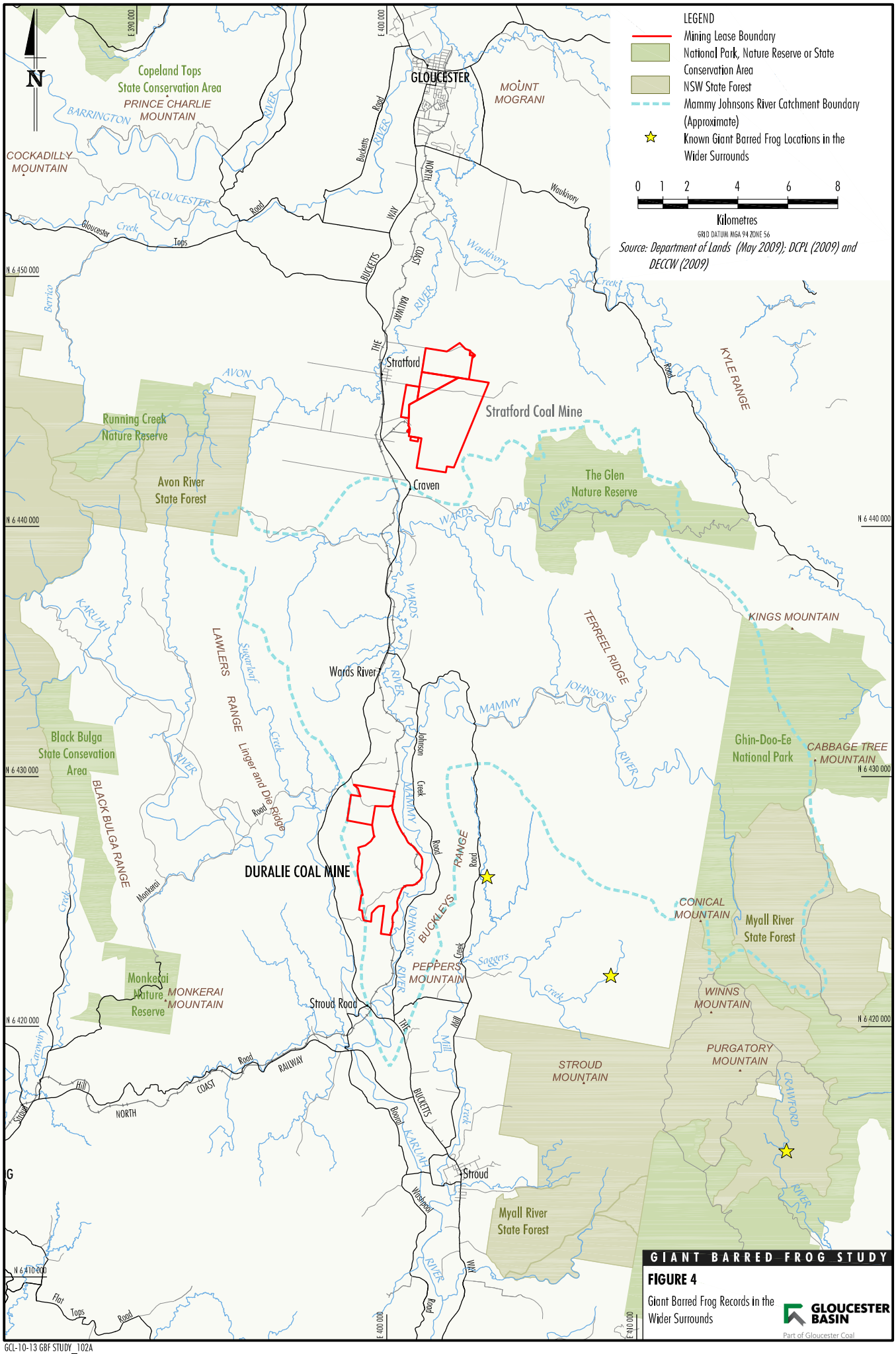
The Giant Barred Frog was first recorded in the MJR catchment in January/February 2009 (EcoBiological, 2009a). From January 2009 to March 2011 the Giant Barred Frog has been recorded at a number of locations in the MJR catchment and surrounding areas. Figure 5 shows the locations at which the Giant Barred Frog has been recorded. This includes the results of the EcoBiological (2009a and b; 2010) surveys, records from the Bionet - Atlas of NSW Wildlife, and the results of the Biosphere Environmental Consultants surveys (November 2010 to March 2011) which include both nocturnal surveys for adult frogs and tadpole survey results. It should be noted that, to date, nocturnal frog surveys have not been conducted by Biosphere Environmental Consultants along the Wards River, Glen Nature Reserve, Ghin-Doo-Ee National Park or Myall River State Forest. As a result the majority of Giant Barred Frog records are concentrated about the existing Giant Barred Frog monitoring sites (described in the Duralie Coal Mine Giant Barred Frog Management Plan).

One of the objectives of the Giant Barred Frog Study is to investigate the extent of the Giant Barred Frog population in the MJR catchment. A description of how the extent of the Giant Barred Frog population in the MJR catchment will be investigated is provided in Section 3.

2.3 CONSERVATION STATUS

The Giant Barred Frog (*Mixophyes iteratus*) is listed as Endangered under the NSW *Threatened Species Conservation Act, 1995* (TSC Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1995* (EPBC Act).

The distribution of the Giant Barred Frog in the MJR catchment and wider surrounds (Mill Creek, Saggers Creek and Crawford River) is relatively isolated from other known populations to the south and north (Figure 3). Given the distribution of the Giant Barred Frog, the population in the MJR catchment is of regional significance.



GIANT BARRED FROG STUDY

FIGURE 4

Giant Barred Frog Records in the Wider Surrounds

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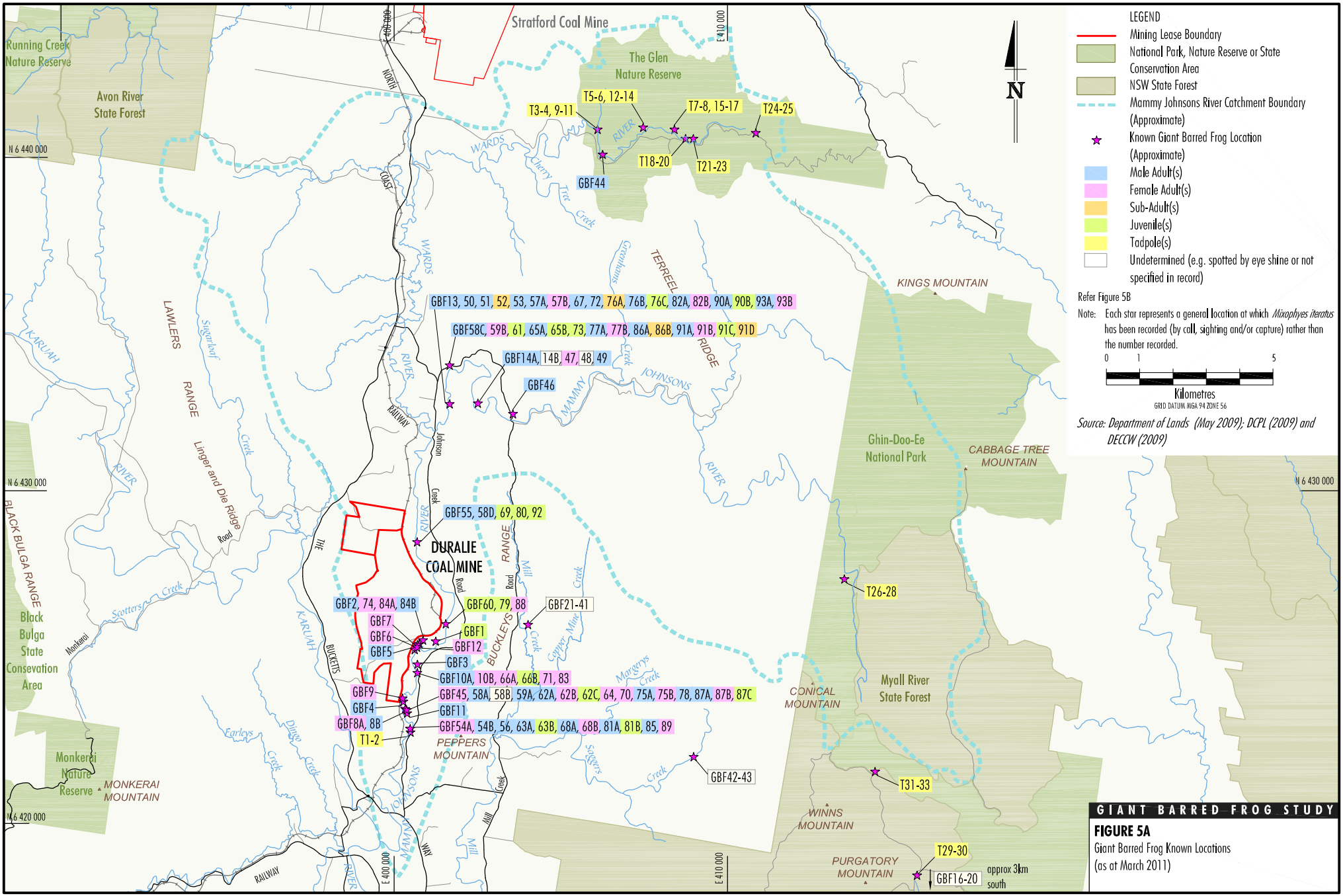

GIANT BARRED FROG STUDY

FIGURE 5A

Giant Barred Frog Known Locations (as at March 2011)

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Source of Information	Record	Date	Number of Individuals
1	GBF1	26/2/2009	1 recently metamporphosed juvenile was caught and released
	GBF2	26/2/2009	1 male sighted
	GBF3	25/2/2009	1 male calling
	GBF4	24/2/2009	1 male sighted/1 male calling
	GBF5	25/2/2009	1 male sighted
	GBF6	25/2/2009	1 female sighted
	GBF7	25/2/2009	1 female sighted
	GBF8A, 8B	24/2/2009	1 female sighted/6-7 calling males
	GBF9	24/2/2009	1 female sighted
	GBF10A, 10B	25/2/2009	2 male & 1 female sighted
	GBF11	24/2/2009	2 males calling
	GBF12	25/2/2009	1 female sighted
2	GBF13	28/1/2009 to 30/1/2009	3-4 calling males heard, 3 males captured
	GBF14A, 14B	28/1/2009 to 30/1/2009	2 males heard, several spotted by eye shine
3	GBF16-20	12/1/2005 to 13/1/2005	5 sightings
	GBF21-41	20/12/2001	21 sightings
	GBF42-43	11 and 13/11/2003	2 sightings
4	GBF44	2/11/2010	1 male calling, approximately 500-700 m from site
5	GBF45	29/11/2010	1 female captured (Site D3)
	GBF46	30/11/2010	1 male calling (Site D10)
	GBF47	30/11/2010	1 female captured on western bank (Site D8)
	GBF48	30/11/2010	3 individuals sighted (eye shine) on eastern bank (Site D8)
	GBF49	30/11/2010	1 male calling on eastern bank (Site D8)
	GBF50	30/11/2010	1 male captured [western bank] (Site D9)
	GBF51	30/11/2010	1 male captured [western bank] (Site D9), ~50 m upstream of survey site coordinate
	GBF52	30/11/2010	1 sub-adult captured [western bank] (Site D9) ~50 m upstream of survey site coordinate
	GBF53	30/11/2010	2 males calling on opposite [eastern] bank (Site D9)
	GBF54A, 54B	13/12/2010	1 female captured (Site D2), 1 male captured & 2 males calling not captured (Site D2)
	GBF55	13/12/2010	1 male captured (Site D11)
	GBF56	14/12/2010	1 male recaptured; one male calling not caught (Site D2)
	GBF57A, 57B	14/12/2010	1 male recaptured, 1 female (Site D9)
	GBF58A, 58B	15/12/2010	1 male captured, 1 other seen but not caught (Site D3)
	GBF58C	15/12/2010	1 male caught (Site D9)
	GBF58D	15/12/2010	1 male caught (Site D11)
	GBF59A	5/01/2011	1 male caught (Site D3)
	GBF59B	5/01/2011	1 female caught (Site D28)
	GBF60	7/01/2011	1 juvenile caught (Site D7)
	GBF61	7/01/2011	1 juvenile caught (Site D28)
	GBF62A, 62B, 62C	8/01/2011	1 male, 2 females and 1 juvenile caught (Site D3)
	GBF63A, 63B	27/01/2011	1 male and 1 juvenile captured (Site D2)
	GBF64	27/01/2011	1 female recapture (Site D3)
	GBF65A, 65B	27/01/2011	2 males (one recapture) and 3 juveniles (Site D28)
	GBF66A, 66B	28/01/2011	1 female and 1 juvenile (Site D4)
	GBF67	28/01/2011	1 male recaptured (Site D9)
	GBF68A, 68B	29/01/2011	1 male and 1 female captured (Site D2)
	GBF69	29/01/2011	1 juvenile captured (Site D11)
	GBF70	30/01/2011	1 female recaptured (Site D3)
	GBF71	30/01/2011	2 females (one recaptured) found (Site D4)
	GBF72	30/01/2011	2 males captured (Site D9)
	GBF73	30/01/2011	1 juvenile captured (Site D28)
	GBF74	31/01/2011	1 female captured (Site D6)
	GBF75A, 75B	16/02/2011	1 male (new) and 1 female (recapture) site D3
	GBF76A, 76B, 76C	17/02/2011	1 sub-adult (new), 1 male recaptured and 1 juvenile (Site D9)
	GBF77A, 77B	17/02/2011	1 male recapture and 1 female (new)(Site D28)
	GBF78	18/02/2011	1 male recaptured (Site D3)
	GBF79	18/02/2011	1 juvenile (Site D7)
	GBF80	18/02/2011	2 juveniles (Site D11)
	GBF81A, 81B	19/02/2011	3 males (1 recaptured) and 1 juvenile (Site D2)
	GBF82A, 82B	19/02/2011	2 males (1 recaptured) and 1 female (Site D9)
	GBF83	20/02/2011	1 female captured (Site D4)
	GBF84A, 84B	10/03/2011	1 female, 1 male captured (Site D6)
	GBF85	10/03/2011	I male recaptured (Site D2)
	GBF86A, 86B	10/03/2011	1 male, 2 males recaptured and 1 sub-adult captured (Site D28)
	GBF87A, 87B, 87C	11/03/2011	1 male (recaptured), 1 female (recaptured), 1 juvenile (Site D3)
	GBF88	11/03/2011	1 female (Site D7)
	GBF89	12/03/2011	1 female (Site D2)
	GBF90A, 90B	12/03/2011	2 males recaptured, 1 juvenile (Site D9)
	GBF91A, 91B, 91C, 91D	12/03/2011	1 male recaptured, 1 female, 1 juvenile, 2 sub-adults (Site D28)
	GBF92	13/03/2011	1 juvenile (Site D11)
	GBF93A, 93B	14/03/2011	1 male recaptured, 1 female recaptured (Site D9)

Source of Information

1 EcoBiological (2009a) Flora and Fauna Survey Report: Duralie Coal Mine, Gloucester, New South Wales.

2 EcoBiological (2009b) Flora and Fauna Survey Report: Gloucester Coal Properties East of Bucketts Way, Gloucester, New South Wales.

3 DECCW Atlas of NSW Wildlife (9/3/2009) [State Forests October 2008 Supply].

4 EcoBiological (2010) Surveys for Stratford Coal Pty Ltd - unpublished data.

5 Biosphere Environmental Consultants (2010-2011) Surveys for Duralie Coal Pty Ltd - unpublished data.

GIANT BARRED FROG STUDY

FIGURE 5B

Giant Barred Frog Known Locations Records Table (as at March 2011)

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3 EXTENT OF THE GIANT BARRED FROG POPULATION IN THE MJR CATCHMENT

One of the objectives of the Giant Barred Frog Study is to determine the extent of the Giant Barred Frog population in the MJR catchment. To determine the extent of the Giant Barred Frog population, a number of sites will be surveyed that span the length of the catchment (i.e. from the upper headwaters of the Wards River and the MJR to their confluence, and along the course of the MJR to its confluence with the Karuah River).

In order to select sites, the Mammy Johnsons River catchment was divided into 200 m sections. Sections that do not appear to contain habitat for the Giant Barred Frog were discarded, and the survey sites required were chosen at random from the remaining sections. Complete randomisation was not possible due to several logistical constraints, primarily land ownership/site access issues and associated safety considerations for the conduct of nocturnal surveys.

The areas where study sites are located are presented in Table 1 below.

Table 1
Location of Giant Barred Frog Study Sites

General Study Area	General Location	Provisional Number of Study Sites
1	Lower MJR, downstream of confluence with Coal Shaft Creek	10
2	Lower MJR, between Coal Shaft Creek and unnamed minor tributary	10
3	Lower MJR upstream of unnamed minor tributary to confluence with Wards River	8
4	Lower Wards River, from confluence with MJR to 1st Ford on Glen Road	8
5	Upper Wards River, from 1st Ford to Craven Trig Road Crossing, The Glen Nature Reserve	10
6	Middle MJR, from confluence with Wards River to start of Terreel Valley	4
7	Upper MJR, Ghin-Doo Ee National Park	10

A total of 60 study sites were surveyed throughout the MJR catchment.

Of relevance, an additional 20 sites located on Mill Creek, Saggers Creek or the Crawford River, which are located in catchments immediately adjacent to the MJR catchment, were surveyed as a component of the Giant Barred Frog monitoring program described in the Duralie Coal Mine Giant Barred Frog Management Plan.

The Giant Barred Frog Study will be implemented during the breeding season of the Giant Barred Frog (i.e. from September 2011 to March 2012)[1]. Where practicable, the surveys will not be conducted during periods of heavy rainfall or significant stream flow. Weather conditions will be recorded prior to and during the surveys as described in Section 5.

[1] The Giant Barred Frog Study has commenced. Following completion of the September 2011 to March 2012 surveys, a report outlining the results of the surveys will be provided to the OEH and Department of Planning and Infrastructure by July 2012.

The survey methods used during the Giant Barred Frog Study surveys are described in Sections 3.1 and 3.2 below.

3.1 NOCTURNAL FROG SURVEYS

Each study site consists of a 200 m long section of river bank (transect). A team of two surveyors will search the transect area for a period of 30 minutes (i.e. a total search time of 1 person hour per night per site).

The search will entail an initial listening period for three minutes where all calling frogs are identified and recorded. The surveyors will then move slowly through the transect area using headlamps to detect calling and non-calling Giant Barred Frogs. Call imitation will be used at the start, near the middle and at the end of each transect to try to elicit calling by male Giant Barred Frogs.

Any Giant Barred Frogs detected will be caught if possible. Captured frogs will be:

- sexed (i.e. male or female);
- if female, examined to determine if she is gravid[2];
- classified as adult, sub-adult or juvenile[3];
- weighed (using spring balances);
- measured for snout-vent length (using dial callipers);
- micro-chipped[4];
- visually inspected for signs of injury or disease;
- swabbed for Chytrid testing; and
- released at the site of capture.

Observations of behaviours including amplexus[5], oviposition[6] and egg masses[7] will also be noted.

In addition, each survey will record an estimate of the number of calling males at each site (both banks).

Other species of non-target riparian frogs will also be recorded including an estimate of the number of individuals of each species.

Each site will be surveyed on three nights (during the same survey period).

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2 Gravid: distended with or full of eggs.

3 Adult (individual with a snout vent length equal or greater than 40 mm and sex identifiable); Sub-adult (individual with a snout vent length of equal or greater than 40 mm, sex indeterminate); Juvenile (individual with a snout vent length of less than 40 mm).

4 Only individuals classified as adults or sub-adults will be micro-chipped.

5 Amplexus: refers to the conjugation of male and female frogs prior to and during spawning.

6 Oviposition: refers to the egg laying sites.

7 Egg masses: large quantities of eggs in water. The young that hatch from these eggs are known as spawn.

3.2 DIURNAL TADPOLE SURVEYS

Diurnal tadpole surveys will also be undertaken at each site. Ten sweeps using a long-handled net on one occasion during the survey period will be used to sample the water along the stream bank for tadpoles.

Tadpoles caught in the sweeps will be:

- measured for snout-vent length (using dial callipers);
- classified using a growth index (detailed in Section 7);
- visually inspected for external signs of injury (e.g. from fish or bird attack); and
- inspected using a magnifying glass to assess the condition of their buccal disc[8] and denticles[9], including the possible early stages of Chytrid infection.

All tadpoles will be released at the site of capture.

During the diurnal and nocturnal surveys, observations will also be made of other aspects of the natural history of the Giant Barred Frog, such as evidence of oviposition or amplexus, and the location of any observed egg masses.

The survey methods are consistent with the Department of the Environment, Water, Heritage and the Arts (2010) *Survey Guidelines for Australia's Threatened Frogs* and Department of Environment and Climate Change (2009) *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna-Amphibians*.

4 CONDITION OF THE GIANT BARRED FROG HABITAT

Biosphere Environmental Consultants has conducted initial habitat assessments at sites within the MJR catchment from November 2010 to March 2011. Habitat assessments have been completed at the sites shown on Figure 6.

Habitat attributes recorded at each site include stream characteristics (e.g. stream width, stream depth, flow rate, the presence of pools and riffles), water quality observations (e.g. clarity and presence of algae), stream bank characteristics (e.g. profile, composition, vegetation cover and litter depth) and potential impacts (e.g. siltation/clearing, pollution sources and introduced species). Any frogs caught will be swapped to detect the potential presence of the Chytrid fungus in the stream (Section 6).

A number of existing impacts are evident within the MJR catchment and these include historic vegetation clearing for agriculture, trampling of stream banks and vegetation by cattle, weed invasion and flood damage. The results of the habitat assessments are provided in Appendix A.

The Giant Barred Frog Study will use the habitat assessment results compiled to date to assess changes in habitat at each site at the time of the surveys[10]. Where a habitat assessment has not been completed for a particular site, a habitat assessment will be conducted.

The collection of stream water quality data is described in Section 5 below.

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8 Buccal disc: refers to the circular rim of tissue that surrounds the beak and feeding apparatus.

9 Denticles: refers to the keratinised ridges that occur either side of the beak inside of the buccal or oral disc.

10 The Giant Barred Frog Study has commenced. Following completion of the September 2011 to March 2012 surveys, a report outlining the results of the surveys will be provided to the OEH and Department of Planning and Infrastructure by July 2012.

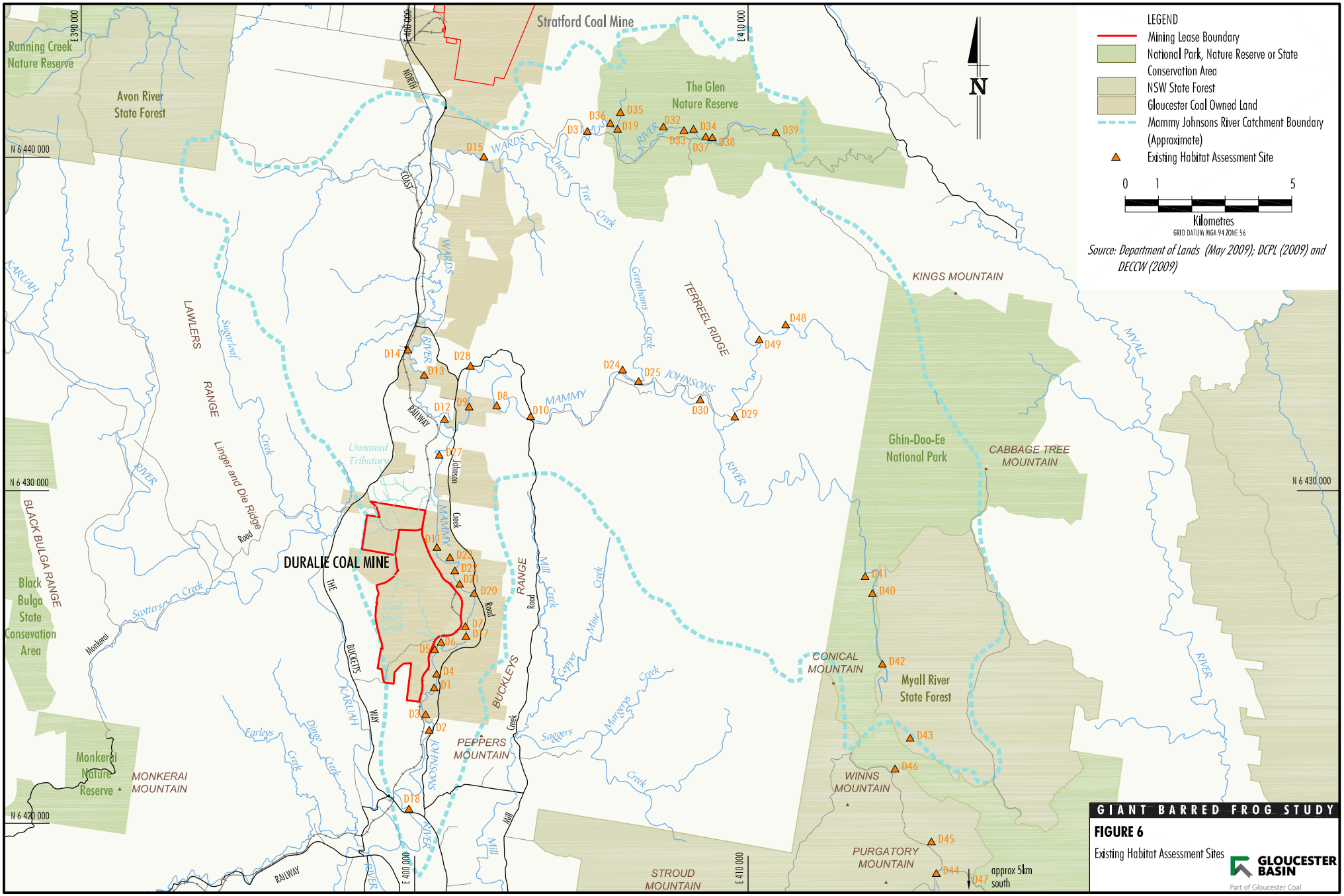

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FIGURE 6

Existing Habitat Assessment Sites

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5 RELEVANT HYDROLOGICAL CONDITIONS

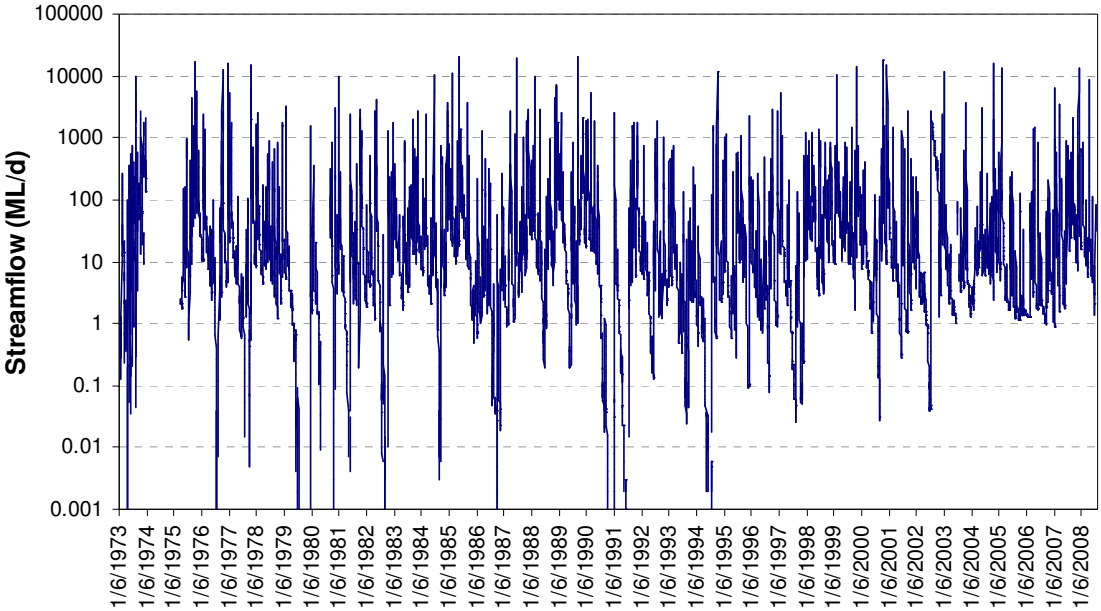
The MJR has a catchment area of 320 km^2 (Gilbert & Associates, 2010). Wards River is the only major tributary of the MJR, and rises in The Glen Nature Reserve (Figure 4). The MJR rises in the Myall River State Forest and Ghin-Doo-Ee National Park (Figure 4).

The upper reaches of the MJR and Wards River are geologically and vegetatively dissimilar to the middle and lower reaches of the MJR and Wards River. Once Wards River and MJR flow west from the headwater reserves, they flow through an undulating agricultural land that has been extensively cleared for cattle grazing. For most of the remainder of their courses southwards, the two streams are flanked by a narrow remnant riparian strip of trees often heavily weed infested with Privet and Lantana. The stream channels also change from being shallow and broad with a rocky base, to become narrow and deeply incised in a sedimentary plain.

In the lower section of its course, the MJR flows to the east of the Duralie Coal Mine. The Duralie Coal Mine is situated in the catchment of Coal Shaft Creek and an unnamed minor tributary (Figure 4). Coal Shaft Creek is a small tributary which has been diverted around the Duralie Coal Mine workings before rejoining the original Coal Shaft Creek alignment near the Duralie Coal Mine rail spur. The confluence of Coal Shaft Creek with the MJR is south of the Duralie Coal Mine rail loading infrastructure. The unnamed minor tributary flows north and east to join the MJR approximately 4 km upstream of the Coal Shaft Creek confluence (Figure 4). Both the Coal Shaft Creek and unnamed minor tributary are ephemeral streams. The MJR continues southwards until it flows into the Karuah River to the south of the town of Stroud Road (Figure 4).

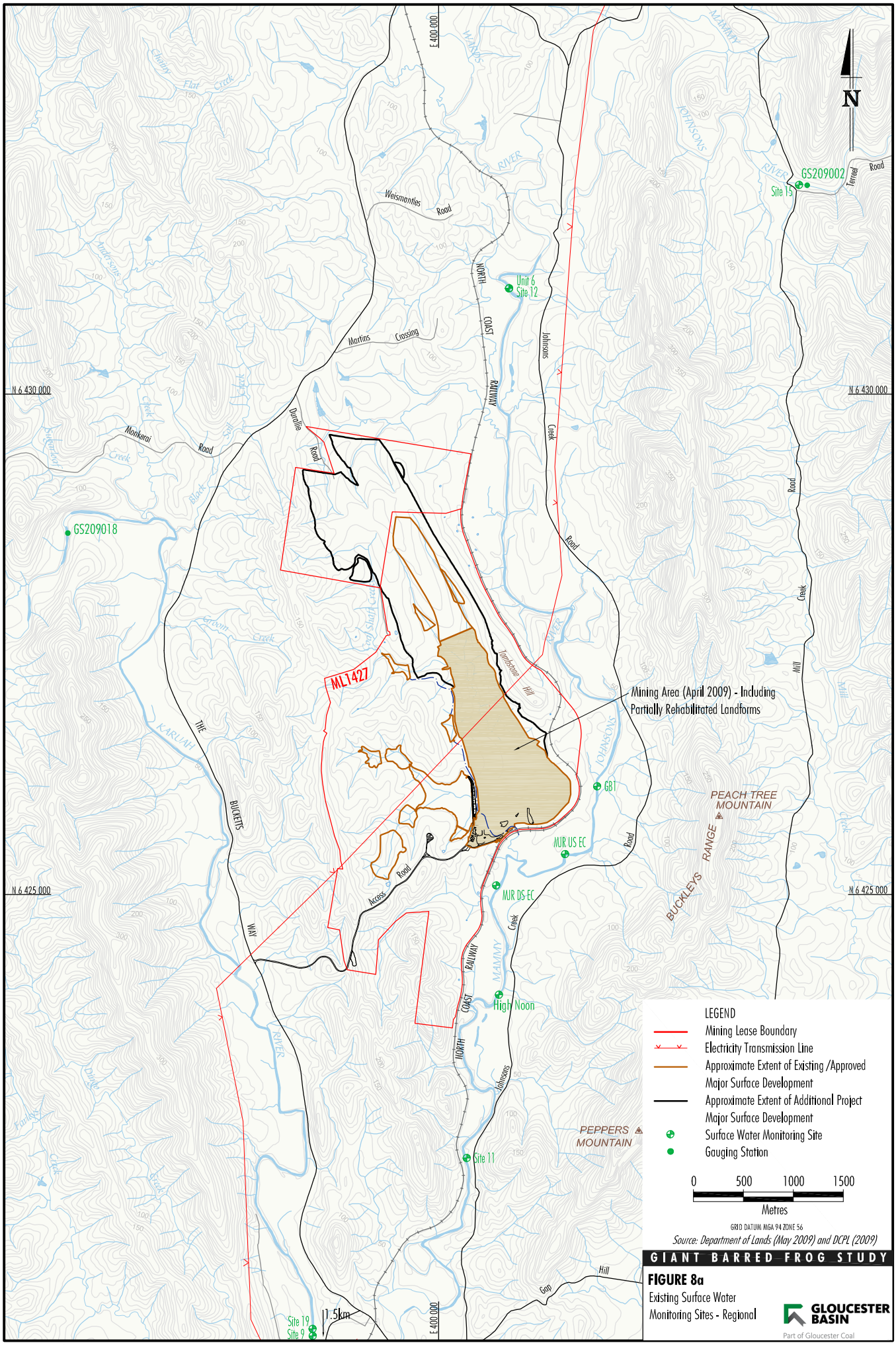
Figure 7 shows the recorded stream flow hydrograph from 1973 to 2008 for the gauging station on the MJR at Pikes Crossing[11] (GS209002). The location of the gauging station is shown on Figure 8a.

Figure 7
Recorded Stream Flow Hydrograph for Mammy Johnsons River at Pikes Crossing Gauging Station (GS209002)



Source: Gilbert & Associates (2010)

[11] The gauging station site is referred to by OEH as Pikes Crossing. Pikes Crossing is known by DCPL as Mavis Tersteeg Crossing.



GIANT BARRED FROG STUDY

FIGURE 8a

Existing Surface Water Monitoring Sites - Regional

GLOUCESTER BASIN
Part of Gloucester Coal

GCL-10-13 GBF Study_105A

Stream flows are characterised by low to moderate flows for long periods, with periods of higher discharge following heavy rains. Such a rainfall response is typical of small and medium sized upland catchments (Gilbert & Associates, 2010). In terms of low flow persistence, zero flow has been recorded on the Mammy Johnsons River on 5.3% of days. Averaged over the full period of available data, stream flow in Mammy Johnsons River is estimated to amount to some 28% of rainfall (Gilbert & Associates, 2010).

The hydrological conditions of the MJR of relevance to the Giant Barred Frog Study will be documented prior to and during the study[12], as described in Sections 5.1 to 5.3 below.

5.1 RAINFALL AND OTHER WEATHER DATA

Rainfall data will be obtained from the on-site weather stations located at the Duralie Coal Mine and Stratford Coal Mine to provide information on the amount of rain prior to each survey, the time since it last rained, and the amount of rainfall during the survey period.

The weather conditions experienced during each survey will also be described. Maximum and minimum temperatures and relative humidity data will also be obtained from the Duralie Coal Mine and Stratford Coal Mine weather stations for each survey period.

5.2 STREAM FLOW

Stream flow data will be obtained from the OEH for Gauging Station GS209002 to characterise flows on the MJR. Stream flow monitoring will also established at 'High Noon' (Figures 8a and 8b).

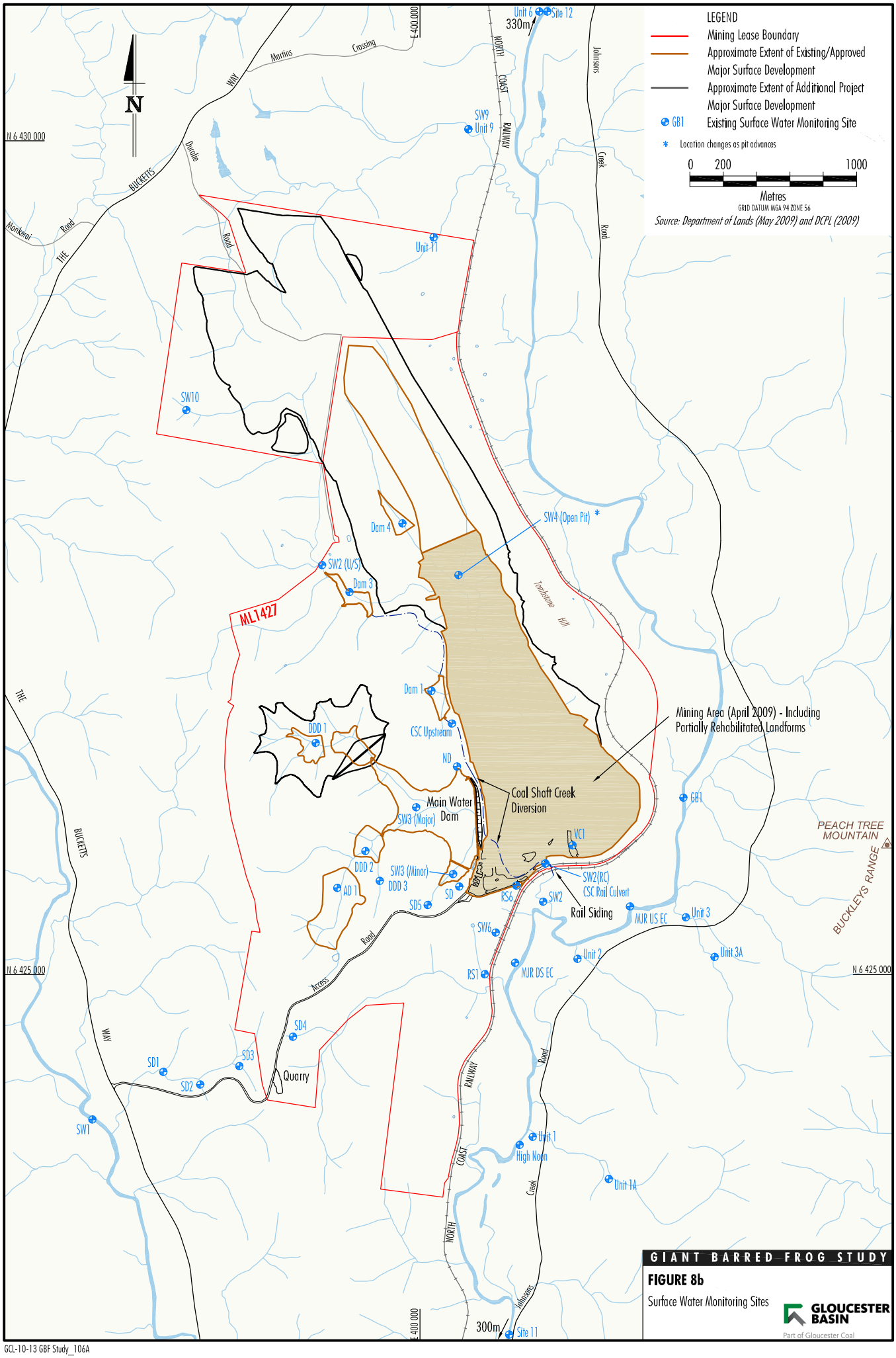
The general flow conditions experienced at each site during the surveys will be described on the basis of visual observations (Appendix A).

5.3 WATER QUALITY

DCPL monitors surface water quality on and around the Duralie Coal Mine by manual and/or continuous sampling from a series of selected locations, including the MJR, Karuah River, Coal Shaft Creek and other tributaries of the MJR (Figures 8a and 8b).

The surface water quality parameters sampled at sites located on the MJR, Karuah River, Coal Shaft Creek and other tributaries of the MJR are summarised in Table 2 (Figures 8a and 8b). The Duralie Coal Mine Water Management Plan will provide further details on the surface water quality program.

[12] The Giant Barred Frog Study has commenced. A report outlining the results of the surveys (including hydrological conditions of the MJR of relevance to the study) will be provided to the OEH and Department of Planning and Infrastructure by July 2012.



GIANT BARRED FROG STUDY

FIGURE 8b

Surface Water Monitoring Sites

GLOUCESTER BASIN
Part of Gloucester Coal

GCL-10-13 GBF Study_106A

Table 2
Stream Surface Water Quality Sampling

Site	Water Quality Parameters
SW1, SW2, SW4, SW6, SW10	pH, electrical conductivity, turbidity, total suspended solids, acidity, alkalinity, chloride, sulphate, calcium, magnesium, aluminium, iron, manganese and zinc
SW2(U/S), SW2(RC), SW3(Major), SW9, GB1, Site 9, Site 11, Site 12, Site 15, Site 19, Unit 1, Unit 1A, Unit 2, Unit 3, Unit 3A, Unit 6, Unit 9, Unit 11	pH, electrical conductivity, turbidity, total suspended solids, total dissolved solids, acidity, alkalinity, chloride, sulphate, carbonate, bicarbonate, calcium, magnesium, sodium, aluminium, iron, manganese, zinc, arsenic, boron, cadmium, copper, lead, chromium, mercury, nickel, selenium, silver, barium, uranium, molybdenum, nitrite, nitrate, total nitrogen, total phosphorus, fluoride and ammonia

DCPL maintains continuous EC sensors/loggers on MJR (upstream and downstream of the MJR's confluence with Coal Shaft Creek, at sites MJR Upstream [MJR US EC], MJR Downstream [MJR DS EC], High Noon and Unit 6), on tributaries of the MJR (sampling sites: Unit 1, Unit 1A, Unit 2, Unit 3, Unit 3A, Unit 9 and Unit 11) and at sites within the mining area (sampling sites North Drain [ND], South Drain [SD], CSC upstream and CSC Rail Culvert) (Figures 8a and 8b).

Biosphere Environmental Consultants has conducted initial water quality sampling at sites within the MJR catchment from November 2010 to March 2011. Water quality data has also been collected at habitat assessment sites (refer Section 4 and Figure 6) using a Yeo-Kal portable water meter. Turbidity, dissolved oxygen content, percent oxygen saturation, oxidation-reduction potential, pH, salinity, conductivity and water temperature have been recorded. The results of the water quality sampling conducted to date are provided in Appendix B.

Water quality at the Giant Barred Frog Study sites will be measured using a Yeo-Kal portable water meter for turbidity, dissolved oxygen content, percent oxygen saturation, oxidation-reduction potential, pH, salinity, conductivity and water temperature during the conduct of the Giant Barred Frog Study tadpole surveys. Stream water temperature will also be recorded during the conduct of the nocturnal Giant Barred Frog Study surveys.

6 PRESENCE OF CHYTRID FUNGUS

Chytridiomycosis or Frog Chytrid Disease is a highly contagious, highly virulent disease of frogs. The disease has been implicated in the demise of several frog species in Australia as well as being partly or wholly responsible for the decline of many other species. Frog Chytrid Disease is listed as a key threatening process for frogs under the NSW *Threatened Species Conservation Act, 1995*.

All Giant Barred Frogs captured during the Giant Barred Frog Study surveys will be swabbed for Chytrid testing[13]. In addition, six or more individuals of other riparian frog species encountered during each survey period (from a variety of survey sites) will also be swabbed for testing.

Swabbing involves 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. The swab is then placed into a sterile container and held in a chilled Esky while in the field. The swabs are placed in a freezer as quickly as possible and stored there until they are ready to be tested.

[13] The Giant Barred Frog Study has commenced. A report outlining the results of the surveys (including Chytrid testing) will be provided to the OEH and Department of Planning and Infrastructure by July 2012.

Testing will be carried out by a recognised laboratory, such as the Veterinary Quarantine Centre at Taronga Zoo, or by Newcastle University. The results of the testing will provide information about any previous exposure of the frogs in the MJR catchment to Chytrid. It will also detect those species that may still be carrying the disease.

The Giant Barred Frog Study will require field biologists to enter Giant Barred Frog habitat areas and to handle the frogs. To prevent the accidental spread of Chytrid while undertaking these activities, several steps will be undertaken in advance of each field trip: all survey equipment and field items will be sterilised prior to commencing survey work in the MJR catchment. All handling procedures will conform to the National Parks and Wildlife Service (NPWS) (2008) *Hygiene Protocols for the Control of Disease in Frogs.*

7 ANALYSIS OF THE AGE STRUCTURE OF THE GIANT BARRED FROG POPULATION

The age structure of the Giant Barred Frog population in the MJR catchment will be based on the growth rate classifications of tadpoles and the snout-vent length measurements of captured frogs, as described below.

Tadpoles caught during the surveys will be classified using a growth index (Table 3). Each tadpole will be assigned to a growth index category (A, B, C or D) based on the growth stage of the tadpole. The index is a simplified grouping of tadpole growth stages into categories that can be easily recognised in the field.

Table 3
Growth Index for Giant Barred Frog Tadpoles

Growth Index Category	Growth Stages	External Features	Age (Approximate Only)
A	1-23	Cornea transparent; external gills present	1-10 days
B	24-25	Cornea pigmented, no limb buds	10-20 days
C	26-42	Hind limbs present	20-120 days
D	43-46	Fore limbs present	80-300 days

The growth rate of frogs is not constant and is altered by environmental conditions such as food availability, temperature and other factors. The snout-vent lengths of Giant Barred Frogs will also be grouped into indices (Table 4).

Table 4
Growth Index for Giant Barred Frog Juveniles and Adults

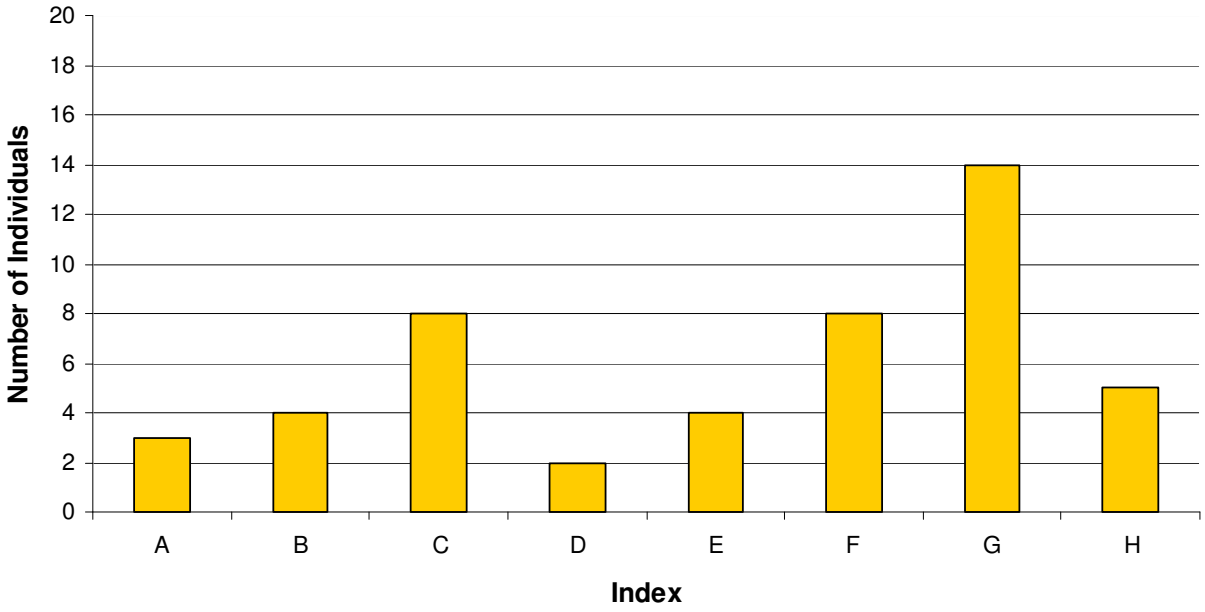
Growth Index Category	Snout-Vent Length Ranges (cm)
E	3-5
F	>5-7
G	>7-9
H	>9

Using this approach, the number of individuals captured in each growth index category can be graphically depicted, an example of which is provided in Figure 9. In general, a senescent population (i.e. an ageing population) would have few individuals in the growth index categories A-E and have most individuals in the growth index categories F to G. Regular recruitment in a population on the other hand would be expected to have a scattering of individuals across all growth index categories, and there may be more than one peak age class (e.g. a peak in indices A-D and another in indices E to H, such as in the example in Figure 9).

8 ANALYSIS OF THE HEALTH OF GIANT BARRED FROG TADPOLES

As described in Section 3.5.2, tadpoles captured during the diurnal surveys will be visually inspected for external signs of injury (e.g. from fish or bird attack) and using a magnifying glass to assess the condition of their buccal disc and denticles, including the possible early stages of Chytrid infection.

Figure 9
Example – Number of Individuals per Age Class



9 GIANT BARRED FROG LONG-TERM STUDY

In accordance with Condition 31A, Schedule 3 of the NSW Project Approval (Section 1.1), the Giant Barred Frog Study will be reviewed and expanded into a longitudinal study of the life cycle of the 'population' of the Giant Barred Frog over the lifetime of the mine and for a 5 year period after the mine ceases to operate (the Giant Barred Frog Long-term Study).

10 REPORTING AND REVIEW

The results of the Giant Barred Frog Study will be compiled following the completion of the September 2011 to March 2012 surveys and a report outlining the results of the surveys will be provided to the OEH and Department of Planning and Infrastructure by July 2012.

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APPENDIX A

HABITAT ASSESSMENT RESULTS

NOVEMBER 2010 TO MARCH 2011

Habitat Assessment Results

Attributes	**Habitat Assessment Site**					
Site Name[1]	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**
Date[2]	13/12/10	13/12/10	13/12/10	13/12/10	13/12/10	14/12/10
Location Description[3]	Mammy Johnsons River (MJR), DCPL water quality site 'High Noon'	MJR, DCPL water quality site 11	MJR, between 'High Noon' and site D2	MJR, north of site D1, 'High Noon'	MJR, downstream of Coal Shaft Creek confluence	MJR, upstream of Coal Shaft Creek confluence
GPS Co-ordinates[4]	400595.538 E; 6423982.952 N	400448.000 E; 6422707.000 N	400338.493 E; 6423179.003 N	400669.441 E; 6424391.962 N	400610.127 E; 6425132.418 N	400800.467 E; 6425346.017 N
Map Code[5]	9233-2N	9233-2N	9233-2N	9233-2N	9233-2N	9233-2N
Map Name[6]	Stroud Road	Stroud Road	Stroud Road	Stroud Road	Stroud Road	Stroud Road
Catchment Location[7]	Lower MJR	Lower MJR	Lower MJR	Lower MJR	Lower MJR	Lower MJR
Land Use[8]	Private (agriculture/cattle grazing)	Private (agriculture)	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing)
Broad Vegetation Category – Riparian Zone[9]	Open Forest	Closed Forest	Open Forest	Open Forest	Closed Forest	Closed Forest
Stream Width[10]	9 m max 4 m min	6 m max 4 m min	5 m max 3 m min	5 m max 3 m min	5 m max 3 m min	5 m max 2 m min
Stream Depth[11]	2 m max 0.5 m min	0.23 m max O.01 m min	2 m max 0.05 m min	2 m max 0.4 m min	2 m max 0.3 m min	2 m max 0.3 m min
Flow Rate[12]	1. m/s max 0. 3 m/s min	3 m/sec max 0.4 m/s min	0.5 m/sec max 0.2 m/s min	2 m/sec max 0.3 m/s min	0.8 m/s max 0.125 m/s min	0.5 m/sec max 0.01 m/s min
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Steep Clay, Rocky	 Gradual Clay, rocky	 Benched Clay	 Benched Clay	 Benched Clay, Sand	 Benched Clay, Sand, Rocky
Stream Base[16]	Clay, Rocky	Gravelly	Rocky	Rocky	Clay, Sand	Clay
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 60% 0% 20% 20%	 70% 20% 10% 0%	 20% 50% 10% 0%	 80% 5% 0% 0%	 50% 10% 40% 0%	 20% 20% 60% 0%
Litter Depth[18]	Absent	Deep	Moderate	Absent	Moderate	Moderate
Emergent Vegetation[19]	Sedges	Nil emergent vegetation *Vallisneria* sp. (submerged aquatic macrophyte) present	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Adjacent cleared agricultural land No Agricultural runoff/cattle Fleabane, Wandering Jew -	 Historic vegetation clearing No Agricultural runoff upstream Fleabane -	 Adjacent cleared agricultural land /cattle damage to banks No Agricultural runoff/cattle Privet and Lantana -	 Adjacent cleared agricultural land No Road dust, agricultural runoff/cattle Privet, Wandering Jew -	 Adjacent cleared agricultural land No Agricultural runoff/cattle Wandering Jew -	 Adjacent cleared agricultural land No Agricultural runoff/cattle Wandering Jew -
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil
Pools/Riffles[22] - riffles - pools	 No Yes - long, deep pool	 Yes - old creek crossing Yes - shallow on either side	 Yes - one small riffle Yes - long and shallow	 Yes – long gravel riffle Yes - upstream shallow, downstream deeper	 Yes – short gravel areas Yes - broad and shallow	 No Yes - deep channels

Habitat Assessment Results (Continued)

Attributes	Habitat Assessment Site					
Site Name[1]	**D7**	**D8**	**D9**	**D10**	**D11**	**D12**
Date[2]	14/12/10	14/12/10	15/12/10	15/12/10	15/12/10	1/12/10
Location Description[3]	MJR, DCPL water quality site GB1	MJR, eastern bend downstream of site D10	MJR, western bend downstream of site D8	MJR, Mavis Tersteeg Crossing	MJR, "Hattams" property	Confluence MJR and Wards River
GPS Co-ordinates[4]	401531.759 E; 6425821.828 N	402471.514 E; 6432447.897 N	401644.968 E; 6432408.970 N	403489.582 E; 6432121.046 N	400655 E; 6428277 N	400905.002 E; 6432039.192 N
Map Code[5]	9233-2N	9233-1S	9233-1S	9233-1S	9233-2N	9233-1S
Map Name[6]	Stroud Road	Craven	Craven	Craven	Stroud Road	Craven
Catchment Location[7]	Lower MJR	Mid MJR	Mid MJR	Mid MJR	Lower MJR	Mid Wards River
Land Use[8]	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing on eastern bank)	Private (agriculture/cattle grazing)	Road crossing	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing)
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest
Stream Width[10]	3 m max 2 m min	10 m max 5 m min	5 m max 3 m min	10 m max 2 m min	3 m max 1 m min	8 m max 3 m min
Stream Depth[11]	2 m max 0.3 m min	1 m max 0.2 m min	0.3 m max 0.1 m min	2 m max 0.5 m min	1 m max 0.4 m min	1 m max 0.3 m min
Flow Rate[12]	0.5 m/sec max 0.02 m/s min	0.1 m/sec max 0.05 m/s min	0.3 m/sec 0.05 m/s min	0.5 m/sec 0.1 m/s min	1 m/sec 0.05 m/s min	0.3 m/sec 0.05 m/s min
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Benched Clay	 Benched Clay, Sand	 Benched Clay, Sand	 Benched Clay, Sand, Rocky	 Benched Clay, Rocky	 Gradual Clay, Sand
Stream Base[16]	Gravelly	Clay, Sand	Sand, Rocky	Clay, Sand, Rocky	Clay, Sand	Sand, Rocky, Gravel
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 50% 40% 5% 0%	 80% 0% 20% 0%	 15% 50% 10% 0%	 60% 20% 20% 0%	 60% 0% 40% 0%	 30% 0% 10% 60%
Litter Depth[18]	Moderate	Deep	Deep	Moderate	Deep	Deep
Emergent Vegetation[19]	*Lomandra* sp.	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing	Adjacent cleared agricultural land	Adjacent cleared agricultural land	Adjacent cleared agricultural land	Adjacent cleared agricultural land /cattle damage to banks	Adjacent cleared agricultural land	Adjacent cleared agricultural land
- alteration to water flow	No	No	No	No	No	No
- potential pollution sources	Agricultural runoff/cattle	Agricultural runoff/cattle (eastern bank)	Agricultural runoff/cattle	Road crossing	Agricultural runoff/cattle	Agricultural runoff/cattle
- introduced species	Privet	Wandering Dew	Privet	Privet	Privet	Privet
- other	-	-	-	-	-	-
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil
Pools/Riffles[22] - riffles - pools	 Yes – short gravel areas Yes - broad and shallow	 No Yes - deep channel	 Yes - broad area below crossing Yes - broad and shallow	 No Yes - deep channel	 No Yes - broad, shallow and deep	 Yes-short gravel areas Yes - deep channel

Habitat Assessment Results (Continued)

Attributes	Habitat Assessment Site					
Site Name[1]	**D13**	**D14**	**D15**	**D18**	**D19**	**D20**
Date[2]	1/12/10	1/12/10	2/12/10	2/12/10	3/12/10	16/12/2010
Location Description[3]	Wards River, confluence unnamed creek, off 1243 Terreel Road	Wards River near Wards River township	Upper Wards River, off Glen Road	MJR, Bucketts Way Crossing, south of Stroud Road township	Wards River, The Glen Nature Reserve	MJR, north of site D7 twin houses
GPS Co-ordinates[4]	400294.232 E; 6433358.101 N	399808.223 E; 6434115.342 N	402086.554 E; 6439908.545 N	399839.468 E; 6420344.069 N	406094 E; 6440740 N	401795 E; 6426813 N
Map Code[5]	9233-1S	9233-1S	9233-1S	9233-2N	9333-4-S	9233-2N
Map Name[6]	Craven	Craven	Craven	Stroud Road	Warranulla	Stroud Road
Catchment Location[7]	Mid Wards River	Mid Wards River	Mid Wards River	Lower MJR	Upper Wards River	Lower MJR
Land Use[8]	Private (agriculture/cattle grazing)	Private (agriculture)	Private (agriculture/cattle grazing)	Road crossing	The Glen Nature Reserve	Private (agriculture/cattle grazing)
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Open Forest
Stream Width[10]	4 m max 1 m min	4 m max 1 m min	4 m max 2m min	5 m max. 3 m min.	5 m max. 1 m min.	5 m max. 3 m min.
Stream Depth[11]	0.4 m max 0.3 m min	0.3 m max 0.1 m min	1 m	3 m max. 1 m min.	1 m max. 0.2 m min.	3 m max. 1 m min.
Flow Rate[12]	0.1 m/sec 0.01 m/s min	0.5 m/sec 0.01 m/s min	2 m/s max 0.3 m/s min	4 m/s max 0.5 m/s min.	2 m/sec max. 0.1 m/sec min.	4 m/s. max 0.5 m/s. min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Steady Flow	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Benched Clay, Sand	 Benched Clay	 Benched Clay, Sand	 Steep Sand	 Gradual Clay, Rocky	 Steep Clay, Sand
Stream Base[16]	Clay, Sand	Clay	Clay, Sand	Sand	Clay, Rocky	Clay, Sand
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 50% 0% 10% 40%	 60% 0% 10% 30%	 80% 0% 5% 15%	 95% 0% 5% 0%	 80% 5% 10% 5%	 50% 0% 20% 30%
Litter Depth[18]	Deep	Deep	Moderate	Moderate	Shallow	Deep
Emergent Vegetation[19]	Nil	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing	 Adjacent cleared agricultural land/cattle damage to banks	 Adjacent cleared agricultural land	 Adjacent cleared agricultural land/cattle damage to banks	 Adjacent cleared agricultural land	 Logging (20 years ago)	 Adjacent cleared agricultural land/cattle damage to banks
- alteration to water flow	No	No	No	No	No	No
- potential pollution sources	Agricultural runoff/cattle	Agricultural runoff	Agricultural runoff/cattle	Agricultural runoff	Nil	Agricultural runoff
- introduced species	Wandering Dew and Privet	Privet and Wandering Dew	Privet, Willows, Blackthorn, Wandering Dew	Privet, Lantana	Lantana	Privet and Wandering Dew
- other	-	-	-	-	-	-
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Flood debris	 Slightly turbid Nil Nil Nil	 Turbid Nil Nil Nil
Pools/Riffles[22] - riffles - pools	 Yes – short gravel areas Yes – long narrow pools	 No Yes – long, narrow pool	 No Yes single narrow pool	 No Yes - single narrow channel	 Yes - broad rocky/gravel riffles Yes - shallow and short	 Yes - small gravel bank Yes - broad and shallow

Habitat Assessment Results (Continued)

Attributes	Habitat Assessment Site					
Site Name[1]	**D21**	**D22**	**D23**	**D24**	**D25**	**D27**
Date[2]	16/12/2010	16/12/2010	16/12/2010	16/12/2010	16/12/2010	5/01/11
Location Description[3]	MJR, north of site D20, twin houses, south paddock	MJR, north of site D7 river crossing, twin houses	MJR, north of site D22 and south of site D11	MJR, Terreel Road crossing, 1.5 km upstream Mavis Tursteeg Crossing	MJR and Greenhams Creek 2 km upstream Mavis Tursteeg Crossing	MJR, river bend downstream of MJR Crossing – Johnson Creek Road
GPS Co-ordinates[4]	401559 E; 6427091 N	401213 E; 6427490 N	401067 E; 6427887 N	406245 E; 6433521 N	406726.008 E; 6433174.626 N	400748 E; 6430961 N
Map Code[5]	9233-2N	9233-2N	9233-2N	9333-4-S	9333-4-S	9233-1S
Map Name[6]	Stroud Road	Stroud Road	Stroud Road	Warranulla	Warranulla	Craven
Catchment Location[7]	Lower MJR	Lower MJR	Lower MJR	Mid MJR	Mid MJR	Lower MJR
Land Use[8]	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing) Water Reserve	Private (agriculture/cattle grazing)	Road crossing	Private (agriculture)	Private (agriculture/cattle grazing)
Broad Vegetation Category – Riparian Zone[9]	Open Forest	Open Forest	Open Forest	Closed Forest	Open Forest	Closed Forest
Stream Width[10]	7 m max. 3 m min.	5 m max. 3 m min.	5 m max. 3 m min.	3 m max. 1 m min.	3 m max. 1 m min.	20 m max. 5 m min.
Stream Depth[11]	4 m max. 1 m min.	4 m max. 0.2 m min.	3 m max. 0.5 m min.	2 m max. 0.2 m min.	2 m max. 0.2 m min.	4 m max. 10 cm min.
Flow Rate[12]	4 m/s. max 0.5 m/s min.	4 m/sec max. 0.5 m/sec min.	4 m/sec max. 0.5 m/sec min.	3 m/sec max. 0.2 m/sec min.	3 m/sec max. 0.4 m/sec min.	2 m/sec max. 0.3 m/sec min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Steep Clay, Sand	 Benched Clay, Rocky	 Steep Clay, Sand	 Steep Clay, Rocky	 Steep Clay, Rocky	 Steep Clay, Sand
Stream Base[16]	Clay, Sand	Clay, Rocky	Clay, Sand	Clay, Rocky	Clay, Rocky	Sand, Rocky
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 50% 0% 10% 40%	 50% 0% 10% 40%	 60% 0% 15% 25%	 70% 0% 20% 10%	 70% 0% 20% 10%	 40% 0% 10% 50%
Litter Depth[18]	Deep	Moderate	Moderate	Moderate	Moderate	Deep
Emergent Vegetation[19]	Nil	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Adjacent cleared agricultural land /cattle damage to banks No Agricultural runoff Privet and Wandering Dew -	 Adjacent cleared agricultural land/cattle damage to banks No Agricultural runoff Privet and Wandering Dew -	 Adjacent cleared agricultural land/cattle damage to banks No Agricultural runoff Privet and Lantana -	 Adjacent cleared agricultural land/cattle damage to banks No Agricultural runoff Lantana -	 Adjacent cleared agricultural land/cattle damage to banks No Agricultural runoff Privet and Wandering Dew -	 Adjacent cleared agricultural land No Agricultural runoff/ cattle Privet -
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Turbid Nil Nil Nil	 Some tannin staining Nil Nil Flood debris
Pools/Riffles[22] - riffles - pools	 No Yes - broad shallow pool	 Yes - broad gravel bar Yes - broad and shallow	 No Yes - broad, narrow channel	 Yes - gravel bar Yes - broad and shallow	 Yes - small gravel bar at confluence Yes - broad and shallow	 Yes. Short gravel areas Yes - 50 cm deep and 50 m long

Habitat Assessment Results (Continued)

Attributes	**Habitat Assessment Site**					
Site Name[1]	**D28**	**D29**	**D30**	**D31**	**D32**	**D33**
Date[2]	6/01/11	7/01/11	7/01/11	8/01/11	8/01/11	8/01/11
Location Description[3]	MJR, upstream of Site D9	Terreel Creek, above confluence with MJR	MJR, off Upper Terreel Road	Wards River, upper crossing before reaching The Glen Nature Reserve	Wards River, The Glen Nature Reserve	unnamed tributary of Wards River The Glen Nature Reserve road crossing
GPS Co-ordinates[4]	401684 E; 6433635 N	409612 E; 6432108 N	408572 E; 6432626 N	405189 E; 6440675 N	407470 E; 6440810 N	408086 E; 6440696 N
Map Code[5]	9233-1S	9333-4-S	9333-4-S	9333-1-S	9333-4-S	9333-4-S
Map Name[6]	Craven	Warranulla	Warranulla	Craven	Warranulla	Warranulla
Catchment Location[7]	Mid MJR	Mid MJR	Mid MJR	Mid MJR	Upper Wards River	Upper Wards River
Land Use[8]	Private (agriculture/cattle grazing)	Private (agriculture)	Private (agriculture)	Private (agriculture)	The Glen Nature Reserve	The Glen Nature Reserve/Road Crossing
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Open Forest	Open Forest	Open Forest	Closed Forest	Open Forest
Stream Width[10]	8 m max. 3 m min.	1.5 m max. 1 m min.	3m max 0.5 m min	3 m max. 2 m min.	3 m max. 2 m min.	1 m max. 1 m min.
Stream Depth[11]	4 m max. 10 cm min.	0.5 m max. 0.1 m min.	0.5 m max. 0.2 m min.	0.3 m max. 0.1 m min.	0.3 m max. 0.1 m min.	0.2 m max. 0.2 m min.
Flow Rate[12]	1 m/sec max. 0.1 m/sec min.	0.15 m/sec max. 0.05 m/sec min.	0.5 m/s max o.1 m/s min	0.8 m/sec max. 0.3 m/sec min.	0.5 m/sec max. 0.1 m/sec min.	0.5 m/sec max. 0.0 m/sec min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Ephemeral/Often dry for long periods
Stream Bank - profile[14] - composition[15]	 Steep Clay, Rocky	 Steep Rocky	 Benched Rocky	 Gradual Rocky	 Gradual Sand, Rocky	 Gradual Rocky
Stream Base[16]	Rocky	Rocky	Rocky	Rocky	Rocky, Gravel	Rocky
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 80% 10% 10% 0%	 90% 10% 0% 0%	 90% 10% 0% 0%	 80% 20% 0% 0%	 90% 0% 5% 5%	 90% 5% 5% 0%
Litter Depth[18]	Deep	Moderate	Moderate	Moderate	Moderate	Shallow
Emergent Vegetation[19]	Nil	Nil	Yes (species unknown)	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing	 Adjacent cleared agricultural land	 Adjacent cleared agricultural land	 Adjacent cleared agricultural land/cattle damage to banks	 Adjacent cleared agricultural land	 Nil	 Nil
- alteration to water flow	No	No	No	No	No	No
- potential pollution sources	Agricultural runoff/ cattle	Agricultural runoff/ cattle	Agricultural runoff/ cattle	Agricultural runoff/ cattle	Nil	Road culverts
- introduced species	Privet	Fleabane, Fireweed, Lantana	Fleabane, Fireweed, Lantana	Crofton, Willows, Thistles, Purpletop	Crofton Weed	Crofton Weed, Fleabane & Thistles
- other	-	-	-	-	-	-
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Slight tannin staining Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Slight tannin staining Nil Nil Nil	 Slight tannin staining Nil Nil Nil	 Turbid Nil Nil Debris from road embankment construction
Pools/Riffles[22] - riffles - pools	 Yes - gravel bank Yes - broad shallow and deep pools	 Yes - small gravel bank Yes - shallow pools	 No Yes - long shallow pools	 Yes – long gravel banks Yes - shallow rocky pools	 Yes - long and gravelly Yes - short and shallow	 No Yes - at culvert

Habitat Assessment Results (Continued)

Attributes	**Habitat Assessment Site**					
Site Name[1]	**D34**	**D35**	**D36**	**D37**	**D38**	**D39**
Date[2]	8/01/11	30/1/11	30/1/11	30/1/11	30/1/11	30/1/11
Location Description[3]	Wards River, The Glen Nature Reserve, Craven Trig fire trail crossing	Etheridges Creek, The Glen Nature Reserve, ~400 m upstream of Wards River Crossing	Wards River, The Glen Nature Reserve Yates Fire Trail Etheridges Creek Fire Trail Crossing 400 m downstream from Etheridges major crossing	Wards River The Glen Nature Reserve 1st Ford upstream, on Terreel Creek Road	Wards River The Glen Nature Reserve Waukivory Road – 2nd Ford Steel girder bridge	Wards River 3rd Ford Waukivory Road
GPS Co-ordinates[4]	408375 E; 6440738 N	406181 E; 6441240 N	405875 E; 6440916 N	408740 E; 6440511 N	408940 E; 6440488 N	410846 E; 6440630 N
Map Code[5]	9333-4-S	9333-4-S	9333-4-S	9333-4-S	9333-4-S	9333-4-S
Map Name[6]	Warranulla	Warranulla	Warranulla	Warranulla	Warranulla	Warranulla
Catchment Location[7]	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River
Land Use[8]	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest
Stream Width[10]	3 m max. 2 m min.	2 m max. 1 m min.	4 m max. 1 m min	2 m max. 0.5 m min.	2 m max. 0.3 m min.	2 m max. 0.5 m min.
Stream Depth[11]	0.3 m max. 0.2 m min.	0.3 m max. 0 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0 m min.
Flow Rate[12]	0.4 m/sec max. 0.1 m/sec min.	0.2 m/sec max. 0 m/sec min.	0.7 m/sec max. 0.1 m/sec. min.	0.5 m/sec max. 0.1 m/sec min.	0.5 m/sec max. 0.1 m/sec min.	0.5 m/sec max. 0 m/sec min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Ephemeral/Often with water
Stream Bank - profile[14] - composition[15]	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Rocky	 Gradual Rocky
Stream Base[16]	Clay, Rocky	Clay	Rocky	Rocky	Rocky	Rocky
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 80% 5% 10% 5%	 40% 20% 30% 10%	 40% 20% 30% 10%	 60% 20% 10% 10%	 30% 30% 30% 10%	 40% 20% 40% 0%
Litter Depth[18]	Shallow	Deep	Moderate	Moderate	Moderate	Moderate
Emergent Vegetation[19]	Nil	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Nil No Nil Crofton Weed (minor) -	 Nil No Nil Nil -	 Nil No Nil Nil -	 Nil No Nil Nil Some road dust	 Nil No Nil Nil Some road dust	 Nil No Nil Nil Some road dust
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Slight tannin staining Nil Nil Nil	 Tannin stained Nil Nil A lot of decomposing leaves in base of pools	 Tannin stained Nil Nil A lot of decomposing leaves in base of deeper pools	 Tannin stained Nil Nil Decomposing leaves in pools	 Tannin stained Nil Nil Decomposing leaves in pools	 Tannin stained Nil Nil Decomposing leaves in pools
Pools/Riffles[22] - riffles - pools	 Yes – rocky bars and gravel banks present Yes – single pool near bridge	 Yes - wide and gravel Yes - shallow, small, not always flowing	 Yes – rocky bars across creek Yes - shallow and elongate	 Yes - long stretches of rocky gravels Yes - narrow, shallow and widely separated	 Yes – long, gravel banks in river Yes – small and shallow	 Yes - long stretches of dry gravel Yes - one pool under bridge

Habitat Assessment Results (Continued)

Attributes	**Habitat Assessment Site**					
Site Name[1]	**D34**	**D35**	**D36**	**D37**	**D38**	**D39**
Date[2]	8/01/11	30/1/11	30/1/11	30/1/11	30/1/11	30/1/11
Location Description[3]	Wards River, The Glen Nature Reserve, Craven Trig fire trail crossing	Etheridges Creek, The Glen Nature Reserve, ~400 m upstream of Wards River Crossing	Wards River, The Glen Nature Reserve Yates Fire Trail Etheridges Creek Fire Trail Crossing 400 m downstream from Etheridges major crossing	Wards River The Glen Nature Reserve 1st Ford upstream, on Terreel Creek Road	Wards River The Glen Nature Reserve Waukivory Road – 2nd Ford Steel girder bridge	Wards River 3rd Ford Waukivory Road
GPS Co-ordinates[4]	408375 E; 6440738 N	406181 E; 6441240 N	405875 E; 6440916 N	408740 E; 6440511 N	408940 E; 6440488 N	410846 E; 6440630 N
Map Code[5]	9333-4-S	9333-4-S	9333-4-S	9333-4-S	9333-4-S	9333-4-S
Map Name[6]	Warranulla	Warranulla	Warranulla	Warranulla	Warranulla	Warranulla
Catchment Location[7]	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River	Upper Wards River
Land Use[8]	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve	The Glen Nature Reserve
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest
Stream Width[10]	3 m max. 2 m min.	2 m max. 1 m min.	4 m max. 1 m min	2 m max. 0.5 m min.	2 m max. 0.3 m min.	2 m max. 0.5 m min.
Stream Depth[11]	0.3 m max. 0.2 m min.	0.3 m max. 0 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0.1 m min.	0.5 m max. 0 m min.
Flow Rate[12]	0.4 m/sec max. 0.1 m/sec min.	0.2 m/sec max. 0 m/sec min.	0.7 m/sec max. 0.1 m/sec. min.	0.5 m/sec max. 0.1 m/sec min.	0.5 m/sec max. 0.1 m/sec min.	0.5 m/sec max. 0 m/sec min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Ephemeral/Often with water
Stream Bank - profile[14] - composition[15]	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Clay, Rocky	 Gradual Rocky	 Gradual Rocky
Stream Base[16]	Clay, Rocky	Clay	Rocky	Rocky	Rocky	Rocky
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 80% 5% 10% 5%	 40% 20% 30% 10%	 40% 20% 30% 10%	 60% 20% 10% 10%	 30% 30% 30% 10%	 40% 20% 40% 0%
Litter Depth[18]	Shallow	Deep	Moderate	Moderate	Moderate	Moderate
Emergent Vegetation[19]	Nil	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Nil No Nil Crofton Weed (minor) -	 Nil No Nil Nil -	 Nil No Nil Nil -	 Nil No Nil Nil Some road dust	 Nil No Nil Nil Some road dust	 Nil No Nil Nil Some road dust
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Slight tannin staining Nil Nil Nil	 Tannin stained Nil Nil A lot of decomposing leaves in base of pools	 Tannin stained Nil Nil A lot of decomposing leaves in base of deeper pools	 Tannin stained Nil Nil Decomposing leaves in pools	 Tannin stained Nil Nil Decomposing leaves in pools	 Tannin stained Nil Nil Decomposing leaves in pools
Pools/Riffles[22] - riffles - pools	 Yes – rocky bars and gravel banks present Yes – single pool near bridge	 Yes - wide and gravel Yes - shallow, small, not always flowing	 Yes – rocky bars across creek Yes - shallow and elongate	 Yes - long stretches of rocky gravels Yes - narrow, shallow and widely separated	 Yes – long, gravel banks in river Yes – small and shallow	 Yes - long stretches of dry gravel Yes - one pool under bridge

Habitat Assessment Results (Continued)

Attributes	Habitat Assessment Site					
Site Name[1]	**D40**	**D41**	**D42**	**D43**	**D44**	**D45**
Date[2]	12/03/2011	12/3/11	12/3/11	12/3/11	13/3/11	13/3/11
Location Description[3]	MJR, Ghin-Doo-Ee National Park Opposite Strike-a-Light Road	MJR, Ghin-Doo-Ee National Park Opposite Strike-a-Light Road	MJR, Myall River State Forest South of Blueberry Road Junction	MJR, Myall River State Forest Quake Trail Crossing	Crawford River Myall River State Forest Knob Road Crossing	Crawford River Myall River State Forest Daryl and Bobbys Crossing
GPS Co-ordinates[4]	413740 E; 6426810 N	413520 E; 6428320 N	414038 E; 6424690 N	414872 E; 6422470 N	415654 E; 6418412 N	415510 E; 6419360 N
Map Code[5]	9333-3-N	9333-3-N	9333-4-N	9333-4-N	9333-4-N	9333-4-N
Map Name[6]	Markwell	Markwell	Markwell	Markwell	Markwell	Markwell
Catchment Location[7]	Upper MJR	Upper MJR	Upper MJR	Upper MJR	Crawford River	Crawford River
Land Use[8]	Ghin-Doo-Ee National Park	Ghin-Doo-Ee National Park	Myall River State Forest	Myall River State Forest	Myall River State Forest	Myall River State Forest
Broad Vegetation Category – Riparian Zone[9]	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest	Closed Forest
Stream Width[10]	5 m max. 3 m min.	5 m max. 1 m min.	5 m max. 1 m min	5 m max. 0.5 m min	5 m max. 2 m min	2 m max. 0 m min
Stream Depth[11]	0.3 m max. 0.05 m min.	0.4 m max. 0.05 m min.	0.3 m max. 0.05 m min.	0.4 m max. 0.05 m min.	0.5 m max. 0.1 m min.	0.4 m max. 0 m min.
Flow Rate[12]	0.4 m/sec max. 0.05 m/sec min.	0.5 m/sec max. 0.05 m/sec min.	0.5 m/sec max. 0.05 m/sec. min.	0.3 m/sec max. 0.05 m/sec. min.	0.3 m/sec max. 0.05 m/sec. min.	0.5 m/sec max. 0 m/sec. min.
Stream Flow Regularity[13]	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges	Ephemeral/Often with water	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Gradual Sand, Rocky	 Gradual Sand, Rocky	 Gradual Rocky	 Gradual Rocky	 Gradual Clay	 Gradual Clay, Sand
Stream Base[16]	Sand, Rocky	Sand, Rocky	Rocky	Rocky	Clay	Clay, Sand
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 90% 0% 10% 0%	 75% 20% 5% 0%	 60% 25% 15% 0%	 70% 20% 10% 0%	 60% 10% 30% 0%	 60% 10% 30% 0%
Litter Depth[18]	Moderate	Shallow	Shallow	Shallow	Absent	Shallow
Emergent Vegetation[19]	Nil	Nil	Nil	Nil	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Nil No Nil Lantana, Fleabane Some road dust	 Nil No Nil Lantana, Fleabane Some road dust	 Nil No Nil Verbena, Fleabane -	 Nil No Nil Nil -	 Nil No Nil Nil -	 Nil No Nil Cattle, pigs -
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil
Pools/Riffles[22] - riffles - pools	 Yes - long stretches of cobbles/gravel Yes - long, narrow, shallow	 Yes - long stretches of cobbles/gravel Yes - long, narrow, shallow	 Yes - long stretches of cobbles/gravel Yes - small, rocky pools	 Yes - rocky bars across river Yes - small, rocky pools	 Yes - large areas of cobbles across river Yes - long, shallow pools	 Yes - large areas of gravel across river Yes - long, shallow pools

Habitat Assessment Results (Continued)

Attributes	Habitat Assessment Site			
Site Name[1]	**D46**	**D47**	**D48**	**D49**
Date[2]	13/3/11	14/3/11	14/3/11	14/3/11
Location Description[3]	Crawford River Myall River State Forest Kinnane's Trail Crossing	Crawford River Myall River State Forest Masons Bend	Terreel Creek Between Terreel and Strangers Corner	Terreel Creek Terreel
GPS Co-ordinates[4]	414418 E; 6421545 N	415695 E; 6413107 N	411136 E; 6434868 N	410345 E; 6434422 N
Map Code[5]	9333-4-N	9333-3-S	9333-4-S	9333-4-S
Map Name[6]	Markwell	Buladelah	Warranulla	Warranulla
Catchment Location[7]	Crawford River	Crawford River	Terreel Creek	Terreel Creek
Land Use[8]	Myall River State Forest	Myall River State Forest	Private (agriculture/cattle grazing)	Private (agriculture/cattle grazing)
Broad Vegetation Category – Riparian Zone[9]	Open Forest	Open Forest	Open Forest	Woodland
Stream Width[10]	2 m max. 0 m min	8 m max. 3 m min.	2 m max. 0 m min	2 m max. 0 m min
Stream Depth[11]	0.4 m max. 0 m min.	1.0 m max. 0.1 m min.	0.3 m max. 0 m min.	0.2 m max. 0 m min.
Flow Rate[12]	0.3 m/sec max. 0 m/sec. min.	0.5 m/sec max. 0.05 m/sec min.	0.2 m/sec max. 0 m/sec. min.	0.2 m/sec max. 0 m/sec. min.
Stream Flow Regularity[13]	Ephemeral/Often with water	Permanent/Periodic Surges	Permanent/Periodic Surges	Permanent/Periodic Surges
Stream Bank - profile[14] - composition[15]	 Gradual Sand, Rocky	 Gradual Sand, Rocky	 Gradual Sand, Rocky	 Gradual Sand
Stream Base[16]	Sand, Rocky	Sand, Rocky	Sand, Rocky	Sand
Stream Bank Vegetation (% Cover)[17] - vegetation - surface rock - leaf litter - bare ground	 50% 15% 35% 0%	 60% 20% 10% 10%	 70% 10% 20% 0%	 80% 5% 0% 15%
Litter Depth[18]	Shallow	Moderate	Absent	Absent
Emergent Vegetation[19]	Nil	*Vallisneria* (submerged)	Nil	Nil
Potential Impacts[20] - siltation/land clearing - alteration to water flow - potential pollution sources - introduced species - other	 Nil No Nil Cattle -	 Nil No Nil Nil Some road dust	 Adjacent cleared agricultural land No Agricultural runoff/cattle Cattle, pasture weeds -	 Adjacent cleared agricultural land No Agricultural runoff/cattle Cattle, pasture weeds -
Water Characteristics[21] - water clarity - water smell - algae present - visible contaminants	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil	 Tannin stained Nil Nil Nil
Pools/Riffles[22] - riffles - pools	 Yes - large areas of gravel across river Yes - long, shallow pools	 Yes - long stretches of cobbles/gravel Yes - broad and deep	 Yes - long stretches of cobbles/gravel Yes - small, shallow pools	 Yes - long stretches of gravel and coarse sand Yes - small, shallow pools

Habitat Assessment Table - Explanatory Notes

1 Name allocated to habitat assessment location.

2 Date of habitat assessment.

3 General description of the site's location according to local features.

4 GPS Coordinates (MGA).

5 Department of Lands Topographic and Orthophotomap Code.

6 Department of Lands Topographic and Orthophotomap Name.

7 General location within the Mammy Johnsons River catchment (Upper Wards River, Mid Wards River, Upper MJR, Mid MJR or Lower MJR).

8 General description of land use.

9 The broad vegetation category of the riparian zone: Closed Forest; Open Forest; Woodland; Mallee; Heath/Shrub; Sedgeland; or Grassland.

10 Estimate of minimum and maximum stream width (metres).

11 Estimate of minimum and maximum stream depth (metres).

12 Visual estimate of flow rate (metres per second).

13 Stream flow regularity: Permanent/Steady Flow; Permanent/Periodic Surges; Ephemeral/Often with Water; or Ephemeral/Often Dry for Long Periods.

14 Profile of the stream bank: Steep; Benched; or Gradual.

15 Composition of the stream bank: Clay; Sand; Rocky; Organic; and/or Other (to be specified).

16 Stream Base: Clay; Sand; Rocky; Organic; and/or Other (to be specified).

17 Stream Bank Vegetation (% cover) for Vegetation, Surface Rock, Leaf Litter and Bare Ground.

18 Estimate of the litter depth on the stream bank: Deep (>10 cm); Moderate (2-10 cm); Shallow (>0-2 cm); or Absent (0 cm).

19 The presence or absence of emergent vegetation in the stream, and where possible identification of particular species.

20 A visual assessment of potential impacts including:

- siltation/land clearing – evidence of vegetation clearance and/or sedimentation/erosion processes adjacent to the stream.
- alteration to water flow – the presence of any known weirs, dams or other constructions.
- potential pollution sources – sources of pollution such as runoff from agricultural lands, cattle defecation etc.
- introduced species – introduced flora or fauna observed at the site at the time of the habitat assessment.
- other – any other potential impacts.

21 A visual assessment of water characteristics including water clarity, water smell, algae present and visible contaminants.

22 Whether pools//riffles are present and if so, a general description of their characteristics.

APPENDIX B

YEO-KAL WATER QUALITY SAMPLING RESULTS

NOVEMBER 2010 TO MARCH 2011

Habitat Assessment Sites - Water Quality Sampling Results

Site Number	Date	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Redox Potential (ORP) (mV)	pH (pH Units)	Salinity (mg/L)	Electrical Conductivity (µS/cm)	Temperature (°C)
D1	13/12/10	16.9	4.2	49.6	-35	6.8	130	188	19.8
D2	13/12/10	13.6	4.9	53.2	-39	7.1	130	197	19.6
D3	13/12/10	12.7	4.4	47.8	-67	6.9	140	206	19.8
D4	13/12/10	16.6	4.2	46.5	-93	6.6	130	185	21.4
D5	13/12/10	16.8	4.2	47.4	-48	6.8	130	188	20.0
D6	14/12/10	14.7	5.5	63.0	-13	6.7	130	187	20.1
D7	14/12/10	42.9	4.4	48.3	+43	6.8	130	194	19.8
D8	14/12/10	13.9	7.2	73.9	+62	7.0	120	165	19.9
D9	15/12/10	20.4	4.4	48.5	+57	6.8	120	165	21.2
D10	15/12/10	15.5	6.8	74.5	+63	7.1	100	148	21.4
D11	15/12/10	14.3	6.2	66.2	+71	7.1	120	199	19.5
D12	1/12/10	7.3	4.3	52.7	+171	7.1	120	176	21.2
D13	1/12/10	6.9	4.5	55.1	+167	7.0	120	165	21.6
D14	1/12/10	9.4	3.9	45.3	+154	7.0	120	174	21.5
D15	2/12/10	4.5	5.3	60.1	+134	6.9	100	135	22.1
D18	2/12/10	23.7	2.3	24.1	+234	7.3	220	398	23.4
D19	30/1/2011	12.9	6.2	69.1	+271	6.9	110	172	22.2
D20	16/12/2010	26.8	4.8	54.9	+234	7.3	135	188	22.6
D21	16/12/2010	27.5	4.9	55.3	+241	7.2	130	168	22.0
D22	16/12/2010	23.0	4.7	52.6	+238	7.2	130	171	21.9
D23	16/12/2010	26.1	4.5	50.3	+199	7.1	130	176	21.8
D24	16/12/2010	27.3	5.6	62.1	+176	7.0	90	134	21.1
D24	7/1/2011	18.6	6.6	72.7	+143	6.8	130	194	22.2
D25	16/12/2010	25.9	6.2	64.6	+171	6.9	95	152	20.8
D27	5/1/2011	8.6	6.0	66.6	-101	6.8	170	279	21.6

Habitat Assessment Sites - Water Quality Sampling Results (Continued)

Site Number	Date	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Redox Potential (ORP) (mV)	pH (pH Units)	Salinity (mg/L)	Electrical Conductivity (µS/cm)	Temperature (°C)
D28	6/1/2011	6.4	5.7	63.8	+76	7.1	160	257	21.1
D29	7/1/2011	10.8	5.9	68.0	+88	6.7	180	259	22.2
D30	7/1/2011	11.3	6.4	72.7	+167	6.7	120	182	21.5
D31	8/1/2011	21.1	5.5	54.4	+237	7.1	130	186	23.3
D32	30/1/2011	7.4	6.4	73.3	+245	6.8	110	157	22.1
D33	30/1/2011	84.6	3.3	46.0	+249	6.5	90	114	23.7
D34	30/1/2011	8.2	9.3	102.4	+257	7.9	100	128	19.7
D35	30/1/2011	21.6	3.2	40.8	+260	6.7	120	184	19.0
D36	30/1/2011	17.1	4.8	53.7	+273	6.8	120	178	19.6
D37	30/1/2011	9.6	5.9	67.8	+236	6.8	120	183	19.5
D38	30/1/2011	15.0	4.9	55.6	+252	7.1	120	176	19.4
D39	30/1/2011	8.1	1.2	13.7	+84	6.2	100	155	18.6
D40	12/3/2011	8.7	6.7	76.3	+341	7.1	120	177	19.3
D41	12/3/2011	8.4	6.8	78.2	+331	7.1	100	132	19.4
D42	12/3/2011	8.3	7.4	83.4	+335	7.2	90	110	18.7
D43	12/3/2011	6.3	7.5	84.6	+340	7.2	80	102	18.6
D44	13/3/2011	9.1	2.7	28.9	+273	6.5	100	127	19.9
D45	13/3/2011	5.9	4.5	48.4	+327	6.5	70	96	19.7
D46	13/3/2011	10.3	4.2	47.5	+272	6.7	110	144	21.3
D47	13/3/2011	45.6	2.3	25.4	+280	7.1	180	224	20.4
D48	14/3/2011	10.7	2.2	23.1	+238	6.7	90	115	21.7
D49	14/3/2011	12.3	1.7	20.5	+268	6.6	110	160	24.2

Giant Barred Frog Monitoring Sites – Additional Water Quality Sampling Results

Site Number	Date	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Redox Potential (ORP) (mV)	pH (pH Units)	Salinity (mg/L)	Electrical Conductivity (µS/cm)	Temperature (°C)
D2	5/1/2011	5.8	4.0	48.6	-110	7.1	180	295	22.2
	27/1/2011	8.5	4.3	47.6	-143	7.0	180	314	25.5
	16/2/2011	6.6	3.9	45.1	+141	7.1	180	290	22.2
	10/3/2011	18.5	4.4	50.4	+84	7.1	180	265	21.7
D3	5/1/2011	8.9	4.6	53.7	-125	7.1	190	298	21.7
	27/1/2011	18.8	3.6	42.9	-101	7.0	180	307	25.7
	16/2/2011	37.9	2.8	32.5	+182	7.2	190	309	22.2
	10/3/2011	25.7	4.2	47.4	+230	7.1	160	262	21.7
D4	5/1/2011	9.2	5.4	58.6	-6	7.0	180	291	22.2
	28/1/2011	16.8	3.4	40.6	+87	7.0	170	283	25.5
	16/2/2011	14.4	3.3	38.7	+162	6.8	200	344	21.3
	10/3/2011	28.9	3.8	41.5	+150	7.0	160	200	23.5
D5	5/1/2011	6.0	6.5	71.3	-32	6.9	190	285	22.1
	28/1/2011	17.9	3.8	46.5	+73	7.0	180	305	23.8
	16/2/2011	9.6	2.9	34.6	+242	7.1	210	334	20.1
	10/3/2011	22.7	3.8	38.3	+235	7.9	150	249	21.8
D6	6/1/2011	8.7	5.9	64.7	+81	7.1	180	282	21.3
	29/1/2011	15.5	3.5	35.8	+159	7.0	190	317	22.2
	17/2/2011	6.9	2.5	29.0	+230	7.6	210	327	20.0
	10/3/2011	15.1	3.7	39.4	+244	7.1	160	251	21.6
D7	7/1/2011	11.1	6.1	67.7	+140	7.1	180	300	21.3
	29/1/2011	16.6	3.5	43.5	+146	7.0	180	296	22.1
	17/2/2011	13.5	3.9	44.0	+268	7.1	180	262	21.6
	11/3/2011	16.5	3.0	34.1	-44	7.1	180	282	19.8

Giant Barred Frog Monitoring Sites – Additional Water Quality Sampling Results (Continued)

Site Number	Date	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% Saturation)	Redox Potential (ORP) (mV)	pH (pH Units)	Salinity (mg/L)	Electrical Conductivity (µS/cm)	Temperature (°C)
D9	7/1/2011	8.8	5.9	64.6	+96	7.1	170	276	21.2
	28/1/2011	10.7	4.3	58.1	+78	6.8	120	205	24.1
	17/2/2011	17.6	4.2	46.7	+262	7.4	140	207	21.6
	11/3/2011	16.9	2.7	29.8	+241	6.8	140	202	21.2
D11	7/1/2011	8.7	5.6	63.2	+78	7.2	180	350	22.0
	27/1/2011	24.5	4.8	57.6	-50	7.0	160	258	25.6
	18/2/2011	6.1	4.5	54.4	+260	7.4	150	249	22.1
	11/3/2011	22.6	2.9	32.2	+239	6.8	160	244	20.1
D27	5/1/2011	8.6	6.0	66.6	-101	6.8	170	279	21.6
	28/1/2011	9.4	4.4	54.8	-23	7.0	150	244	23.4
	17/2/2011	11.3	4.6	50.7	+262	7.5	160	263	21.3
	11/3/2011	16.5	4.0	43.8	+269	7.1	150	226	19.8
D28	6/1/2011	6.4	5.7	63.8	+76	7.1	160	257	21.1
	27/1/2011	14.0	6.4	75.0	-35	7.0	130	204	25.5
	17/2/2011	7.6	5.5	64.1	+267	7.4	120	194	22.1
	11/3/2011	18.4	3.8	43.4	+249	7.1	140	209	21.2

Giant Barred Frog Monitoring Sites – Nocturnal Frog Surveys Water Temperature Results

Site Number	Date	Water Temperature (°C) during Nocturnal Frog Survey
D2	5/1/2011	22.4
	7/1/2011	22.3
	27/1/2011	24.2
	29/1/2011	22.0
	16/2/2011	21.8
	19/2/2011	23.0
	10/3/2011	21.3
	12/3/2011	21.9
D3	5/1/2011	22.3
	8/1/2011	21.7
	27/1/2011	24.0
	30/1/2011	22.3
	16/2/2011	21.8
	18/2/2011	22.0
	11/3/2011	21.4
	13/3/2011	22.2
D4	6/1/2011	22.4
	9/1/2011	21.4
	28/1/2011	24.1
	30/1/2011	22.5
	17/2/2011	22.2
	20/2/2011	22.8
	12/3/2011	21.9
	14/3/2011	23.5
D5	6/1/2011	22.6
	8/1/2011	21.9
	29/1/2011	22.2
	31/1/2011	23.5
	17/2/2011	22.2
	19/2/2011	25.9
	11/3/2011	21.4
	14/3/2011	22.0
D6	7/1/2011	22.3
	9/1/2011	21.4
	28/1/2011	23.1
	31/1/2011	23.3
	18/2/2011	22.0
	20/2/2011	22.9
	10/3/2011	21.3
	13/3/2011	22.0

Giant Barred Frog Monitoring Sites – Nocturnal Frog Surveys Water Temperature Results (Continued)

Site Number	Date	Water Temperature (°C) during Nocturnal Frog Survey
D7	7/1/2011	22.3
	9/1/2011	21.9
	29/1/2011	23.2
	31/1/2011	23.2
	18/2/2011	21.8
	20/2/2011	22.8
	11/3/2011	21.3
	13/3/2011	22.0
D9	5/1/2011	22.5
	8/1/2011	21.8
	28/1/2011	23.0
	30/1/2011	21.4
	17/2/2011	22.1
	19/2/2011	22.8
	12/3/2011	21.4
	14/3/2011	22.0
D11	6/1/2011	22.5
	9/1/2011	21.6
	27/1/2011	24.0
	29/1/2011	22.7
	16/2/2011	21.5
	18/2/2011	22.0
	10/3/2011	21.2
	13/3/2011	22.0
D27	6/1/2011	22.5
	8/1/2011	21.0
	28/1/2011	23.3
	31/1/2011	22.8
	16/2/2011	21.6
	19/2/2011	22.9
	11/3/2011	21.2
	14/3/2011	23.4
D28	5/1/2011	22.7
	7/1/2011	22.5
	27/1/2011	24.0
	30/1/2011	22.9
	17/2/2011	22.0
	20/2/2011	22.8
	10/3/2011	21.2
	12/3/2011	21.8