

NEWCASTLE COAL INFRASTRUCTURE GROUP
COAL EXPORT TERMINAL

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM

Revision	Distribution	DP&E Approval
CHEMP-R01	DoP (now DP&E), DECCW (now the OEH)	August 2010
CHEMP-R02	DP&I, OEH	7 August 2013
CHEMP-R03	DP&E, OEH, NPWS	11 November 2015



NOVEMBER 2015
Project No. NCIG-13-03
Document No 00709000.doc

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
EXECUTIVE SUMMARY	ES-1
1 INTRODUCTION	1
2 PRE-IMPACT ECOLOGICAL SURVEYS	9
3 PROGRAM CO-ORDINATION – CONSULTATIVE BOARD	12
4 GREEN AND GOLDEN BELL FROG RESEARCH PROGRAM	13
4.1 CONSTRUCTION OF RESEARCH PONDS	13
4.2 TRANSLOCATION OF GREEN AND GOLDEN BELL FROGS INTO THE RESEARCH ENCLOSURE	21
4.3 RESEARCH PROJECTS	21
4.3.1 Behavioural Ecology Research	21
4.3.2 Population Modelling Research	22
5 GREEN AND GOLDEN BELL FROG COMPENSATORY HABITAT PROGRAM	24
5.1 INTRODUCTION	24
5.2 GREEN AND GOLDEN BELL FROG OCCURRENCE ON KOORAGANG ISLAND/ASH ISLAND	27
5.2.1 Distribution	27
5.2.2 Habitat	28
5.2.3 Population	28
5.2.4 Other Compensatory Habitat Programs on Kooragang Island	31
5.3 CONSULTATION RELATING TO THE COMPENSATORY HABITAT PROGRAM	31
5.4 DESCRIPTION OF THE GREEN AND GOLDEN BELL FROG COMPENSATORY HABITAT	32
5.4.1 Objective	32
5.4.2 Location	32
5.4.3 Quantification (Size)	32
5.4.4 Compensatory Habitat Principles and Design	32
5.4.5 Existing Environment in the Compensatory Habitat Area and Surrounds	55
5.5 HOW THE COMPENSATORY HABITAT WILL BE SET UP	59
5.5.1 Compensatory Habitat at NCIG CET Underpasses	59
5.5.2 Delineating the Area on the Ground	60
5.5.3 Compensatory Habitat/Pond Construction	60
5.5.4 Revegetation	60
5.5.5 Amphibian Chytrid Fungus – Hygiene Protocols	61
5.6 ONGOING MANAGEMENT	61
5.6.1 Water Source	62
5.6.2 Water Quality	62
5.6.3 Native Vegetation Management	62
5.6.4 Weed Control	63
5.6.5 Control of Introduced Predators	63
5.6.6 Predatory Fish	63
5.6.7 Amphibian Chytrid Fungus	63
5.7 MONITORING	63
5.7.1 Monitoring Green and Golden Bell Frog Usage of the Habitat	64
5.7.2 Monitoring Habitat for the Green and Golden Bell Frog	65
5.8 ADAPTIVE MANAGEMENT	66
5.8.1 Translocation of Green and Golden Bell Frogs	66
5.8.2 Additional Linkages to the Core Population	66

6	SHOREBIRD COMPENSATORY HABITAT PROGRAM	67
6.1	INTRODUCTION	67
6.2	CONSULTATION RELATING TO THE COMPENSATORY HABITAT PROGRAM	67
6.3	DESCRIPTION OF THE SHOREBIRD COMPENSATORY HABITAT	72
6.3.1	Objective	72
6.3.2	Location	73
6.3.3	Quantification (Size)	73
6.3.4	Potential Benefits from the Compensatory Habitat	73
6.3.5	Compensatory Habitat Principles	74
6.4	HOW THE SHOREBIRD COMPENSATORY HABITAT WILL BE SET UP	75
6.4.1	Infrastructure	77
6.4.2	Removal of Mangroves	78
6.4.3	Management of Waste Materials	82
6.4.4	Revegetation of Saltmarsh	82
6.4.5	Power Line Management	82
6.4.6	Diesel/Petrol Spills	82
6.4.7	Acid Sulphate Soils	83
6.4.8	Weed Control	83
6.4.9	Environmental Induction Training	83
6.5	ONGOING MANAGEMENT	83
6.5.1	Mangrove Removal	84
6.5.2	Weed Control	84
6.5.3	Feral Predators	84
6.5.4	Remediation of Erosion	84
6.6	OTHER FACTORS	84
6.7	MONITORING	85
6.7.1	Monitoring Shorebird Usage of the Habitat	85
6.7.2	Monitoring Habitat for Shorebirds	85
6.8	ADAPTIVE MANAGEMENT	86
7	MIGRATORY SHOREBIRD MONITORING AND ECOLOGICAL STUDIES	87
8	AMELIORATIVE WORKS	87
9	CO-ORDINATION WITH OTHER DEVELOPMENTS	87
10	CONSERVATION BOND	88
11	TIMING AND RESPONSIBILITIES	89
11.1	EVALUATION OF A VIABLE BREEDING POPULATION – PURCHASE OF ADDITIONAL LAND	91
11.2	SECURITY OF THE COMPENSATORY HABITAT	91
11.3	CONSTRUCTION OF THE HIGH CAPACITY OPTIONAL INLET RAIL SPUR AND RAIL SIDING	91
12	REPORTING AND REVIEW	92
13	REFERENCES	93

LIST OF TABLES

Table 1	Condition 2.20, Schedule 2 of Project Approval (06_0009)
Table 2	Green and Golden Bell Frog Studies on Kooragang Island/Ash Island – 2000 to 2012
Table 3	Green and Golden Bell Frog Habitat Types and Key Features
Table 4	Green and Golden Bell Frog Detection Rates at Kooragang Island – 2009 to 2011
Table 5	Reconciliation of the Compensatory Habitat Program Against the Principles for Creating Habitat for the Green and Golden Bell Frog
Table 6	Reconciliation of the Compensatory Habitat Program Against the NSW Offset Principles
Table 7	Water Quality Parameters
Table 8	Records of Birds that Previously Used Fish Fry Flats
Table 9	Reconciliation of the Shorebird Compensatory Habitat Program Against the NSW Offset Principles
Table 10	Habitat Monitoring Methods
Table 11	Completed Compensatory Habitat and Ecological Monitoring Schedule for the Green and Golden Bell Frog

LIST OF FIGURES

Figure 1	Regional Location
Figure 2	Aerial Photo of NCIG CET Site (February 2012)
Figure 3	Approved Project General Arrangement
Figure 4a	Habitat Types within the NCIG CET Site
Figure 4b	Habitat Types within the NCIG CET Site – Rail Flyover Modification
Figure 5	Location of the Research Area Enclosure
Figure 6	Conceptual View of Green and Golden Bell Frog Research Area Ponds
Figure 7a	Conceptual Plan Views of Green and Golden Bell Frog Ponds
Figure 7b	Conceptual Long-sections of Green and Golden Bell Frog Ponds
Figure 7c	Conceptual Cross-sections of Green and Golden Bell Frog Ponds
Figure 8	Previously Proposed Green and Golden Bell Frog Compensatory Habitat (August 2010)
Figure 9	Plan View of the Proposed Green and Golden Bell Frog Compensatory Habitat
Figure 10	Existing Green and Golden Bell Frog Monitoring Sites
Figure 11	Proposed Green and Golden Bell Frog Habitat
Figure 12	Topographical Analysis
Figure 13	Vegetation Analysis
Figure 14	Conceptual Green and Golden Bell Frog Compensatory Habitat Design
Figure 15	Typical Pond Design
Figure 16	Habitat Design (Detail A)
Figure 17	Artist's Impression (Detail A)
Figure 18	Artist's Impression (Detail A Enlargement)

LIST OF FIGURES (Continued)

Figure 19	Habitat Design (Detail B)
Figure 20	Artist's Impression (Detail B)
Figure 21	Habitat Design (Detail C and D)
Figure 22	Artist's Impression (Detail C and D)
Figure 23	Habitat Design (Detail E)
Figure 24	Artist's Impression (Detail E)
Figure 25	Habitat Design (Detail F and G)
Figure 26	Artist's Impression (Detail F)
Figure 27	Artist's Impression (Detail G)
Figure 28	Habitat Design (Detail H)
Figure 29	Artist's Impression (Detail H)
Figure 30	Artist's Impression (Overall Habitat Area)
Figure 31	Vegetation Communities within the Green and Golden Bell Frog Compensatory Habitat
Figure 32	Shorebird Compensatory Habitat
Figure 33	Artist's Impression: Area E Existing Habitat
Figure 34	Artist's Impression: Area E Proposed Habitat
Figure 35	Historical Aerial Photographs of Kooragang Island
Figure 36	Vegetation Communities
Figure 37	Mangrove Removal Plan
Figure 38	Proposed Compensatory Habitat and Ecological Monitoring Schedule – December 2012 to 31 December 2019

LIST OF PLATES

Plate 1	Adult Green and Golden Bell Frog (<i>Litoria aurea</i>)
Plate 2	Tadpole Green and Golden Bell Frog (<i>Litoria aurea</i>)
Plate 3	NCIG Green and Golden Bell Frog Research Ponds (photos dated January/February 2013)
Plate 4	Exotic Rank Grassland on Ash Island
Plate 5	Frog Underpass and Associated Habitat

LIST OF ATTACHMENTS

Attachment 1	Director-General's Approval of Qualified Ecologist – Dr Arthur White
Attachment 2	Director-General's Approval of Qualified Ecologist – Professor David Goldney
Attachment 3	Green and Golden Bell Frog Habitat and Conservation - Ash Island
Attachment 4	Ash Island Vegetation Mapping and Survey
Attachment 5	Director-General's Approval of Environmental Representative – Nathan Juchau
Attachment 6	Hygiene Protocol for the Control of Disease in Frogs
Attachment 7	Green and Golden Bell Frog Monitoring Data Recording Sheet

EXECUTIVE SUMMARY

The Newcastle Coal Infrastructure Group (NCIG) Coal Export Terminal (CET) is located on Kooragang Island in Newcastle, New South Wales (NSW). This Compensatory Habitat and Ecological Monitoring Program (CHEMP) details the compensatory habitat and ecological monitoring program that NCIG will undertake in accordance with Conditions of Project Approval (06_0009).

Current Update

The previous version of the CHEMP (Revision 02), approved in August 2013, described the shorebird compensatory habitat program approximately 400 m west of the NCIG CET and accounted for the rail flyover modification. The shorebird compensatory habitat is located within crown land managed by the NPWS adjoining and outside the southern boundary of the Hunter Wetlands National Park.

This revision of the CHEMP (Revision 3) provides further detail on the Shorebird Compensatory Habitat component. Since August 2013, NCIG prepared a Review of Environmental Factors (REF) under Part 5 of the EP&A Act because the works are located on crown land managed by the NPWS. NCIG received approval of the *Shorebird Compensatory Habitat Review of Environmental Factors* (NCIG, 2014) on the 28 June 2015.

The outcome of the *Shorebird Compensatory Habitat Review of Environmental Factors* was further detail around the construction and management of the shorebird compensatory habitat. The details have been integrated into this revised CHEMP (predominantly Sections 6 and 11).

Ongoing Management

NCIG is responsible for the development and implementation of the compensatory habitat annual program of works to evaluate the effectiveness of the compensatory habitat created. This will principally involve the assessment and provision of further works recommended by the approved ecologist, consideration and possible amendment of the program by the NCIG Consultative Board including input from the results of funded research programs and the reporting of the annual works program as a component of the Annual Environmental Management Report. NCIG is committed to provide direct funding for all of the tasks that constitute the agreed annual works program.

1 INTRODUCTION

The Newcastle Coal Infrastructure Group (NCIG) Coal Export Terminal (CET) (the Project) is located on Kooragang Island in Newcastle, New South Wales (NSW) (Figure 1). The overall Project includes the construction and operation of a CET up to 66 million tonnes per annum (Mtpa), including associated rail and coal handling infrastructure and wharf/shiploading facilities on the south arm of the Hunter River.

NCIG is the proponent of the Project and is a consortium of the following group entities:

- Banpu Public Company Limited;
- BHP Billiton Group;
- Peabody Energy Corporation;
- Whitehaven Coal Limited; and
- Yankuang Group Co. Ltd.

NCIG was granted Project Approval (06_0009) under the NSW *Environmental Planning and Assessment Act, 1979* on 13 April 2007. Construction of Stage 1 of the Project commenced in January 2008, with operations of the Stage 1 Project components commencing in the third quarter of 2010. These works allowed the CET to operate up to the initial Project capacity of 30 Mtpa. The Stage 1 Project components included the construction of:

- rail infrastructure including one train unloading station;
- the southern portion of the coal storage area including two combined stacker/reclaimers; and
- wharf facilities including one shiploader and two shipping berths.

The Stage 2AA construction activities commenced in the fourth quarter of 2010. The construction phase continued until mid-2012 and increased the capacity of the CET to 53 Mtpa. The Stage 2AA Project components included the construction of:

- a second train unloading station and associated rail infrastructure;
- a portion of the coal storage area including a third combined stacker/reclaimer; and
- a second shiploader.

Stage 2F of the Project commenced in the second quarter of 2012 and the construction phase is expected to take approximately two years. When Stage 2F activities are complete the CET will be able to operate at the maximum approved capacity of 66 Mtpa. The Stage 2F Project components will include the construction of (Figures 2 and 3):

- the northern portion of the coal storage area including the fourth combined stacker reclaimer (*commenced in 2012*);
- wharf facilities including the third shipping berth (K10) (*commenced in 2012*); and
- northern rail spur incorporating the NCIG CET rail flyover modification components as described in the *Newcastle Coal Infrastructure Group Coal Export Terminal Rail Flyover Modification Environmental Assessment* (NCIG, 2012a) (*not yet commenced*).

The NCIG CET rail flyover modification components (MP 06_0009 MOD 2) were approved by the NSW Planning Assessment Commission as delegate of the Minister for Planning and Infrastructure on 13 May 2013.



0 500
Metres

Source: Aerial Photo NCIG (February 2012)

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 2
Aerial Photo of NCIG CET Site
(February 2012)

Newcastle Coal
INFRASTRUCTURE GROUP



The Project Approval (06_0009) requires the preparation and implementation of the *Compensatory Habitat and Ecological Monitoring Program* (CHEMP). The CHEMP was first approved in August 2010 by the NSW Department of Planning (DoP) (now NSW Department of Planning and Environment [DP&E]). Since this time, works have progressed and NCIG has undertaken consultation with various stakeholders (including the NSW National Parks and Wildlife Service [NPWS], University of Newcastle and the NCIG Consultative Board), and commissioned various specialist studies (e.g. statistical, biological, hydrological and soil characterisation) and completed the NCIG Research Ponds.

The CHEMP has been prepared in accordance with Condition 2.20 of Project Approval (06_0009). Table 1 indicates where each component of Condition 2.20 (including Conditions 2.20A and 2.20B) is addressed within the CHEMP. A systematic approach has been adopted to make certain that all aspects of Condition 2.20 of Project Approval (06_0009) are met by the CHEMP.

Table 1
Condition 2.20, Schedule 2 of Project Approval (06_0009)

Project Approval (06_0009) Condition 2.20, Schedule 2	Section Addressed in the Document
The Proponent shall develop and submit for the approval of the Director-General, a Compensatory Habitat and Ecological Monitoring Program to detail how habitat and ecological values lost as a result of the project will be offset, and how ecological monitoring will be undertaken to inform on-going ecological management. The Program shall be developed in consultation with the NSW Office of Environment and Heritage (OEH), and shall include, but not necessarily be limited to:	The CHEMP
a) ecological surveys, following detailed design of the project, to identify and quantify the extent and types of habitat that would be lost or degraded as a result of the project;	Section 2
b) provision for establishment of compensatory habitat for each relevant component of the project as follows, unless otherwise agreed by the Director-General: <ul style="list-style-type: none"> i) for <i>Litoria aurea</i> habitat lost as a result of the project, establishment of 75 hectares of compensatory habitat in a location agreed by the Director-General, in consultation with OEH. The compensatory habitat shall include viable and sustainable populations of <i>Litoria aurea</i> within a mosaic of wetland, terrestrial and breeding habitat, which includes foraging, sheltering, and wintering habitat attributes and movement corridors, in order to maximise the potential reproductive output of the <i>Litoria aurea</i> population. This amount of compensatory habitat may be reduced if the Proponent can determine, using scientific methodology agreed to the Department, in consultation with OEH, that the population of <i>Litoria aurea</i> impacted by the project is less than 37.5 hectares. The reduced amount shall be agreed to by the Department, in consultation with the OEH, by 30 June 2015; ii) for migratory shore bird habitat (including endangered ecological communities) lost as a result of the Project, including filling in of parts of Deep Pond and Swan Pond from the construction of rail and associated infrastructure, the establishment of 8 hectares of compensatory habitat in a location agreed by the Director-General, in consultation with the OEH. The commencement of compensatory habitat works shall occur within 6 months of the commencement of construction of the High Capacity Optional Inlet Rail Spur and Rail Sidings, or as otherwise agreed by the Director-General; 	Section 5 Section 2 Section 6
c) provision for on-going ecological studies and migratory bird monitoring in and around Deep Pond and Swan Pond, to investigate bird behaviour and to inform the design process for components of the project affecting these ponds;	Section 7
d) provision for the funding of works required under this condition, to be managed by a mechanism that provides a sound and legally enforceable means of allocating resources for ongoing adaptive management and review of the performance of compensatory habitat works for the life of the project;	Section 3
e) provision for research into <i>Litoria aurea</i> in and around Kooragang Island and the Hunter Estuary, as may be identified by the Proponent in consultation with relevant ecological and research groups;	Section 4
f) provision for ameliorative works on land surrounding the project Site, as may be negotiated by the Proponent with the relevant adjacent land owners, to improve or restore natural hydrology and ecosystems, remove mangrove communities where relevant and restore locally-endemic Endangered Ecological Communities;	Section 8

Table 1 (Continued)
Condition 2.20, Schedule 2 of Project Approval (06_0009)

Project Approval (06_0009) Condition 2.20, Schedule 2	Section Addressed in the Document
g) consideration of coordinating compensatory and ameliorative works with similar requirements for other developments, including with respect to the development the subject of development consent DA-134-3-2003-i (dredging and remediation of the South Arm of the Hunter River);	Section 9
h) monitoring requirements for compensatory habitat works and other ecological amelioration proposed under the Program; and	Sections 5.7 and 6.6
i) timing and responsibilities for the implementation of the provisions of the Program. The Proponent shall provide the following commitments in the Program, or as otherwise agreed by the Director-General: <ul style="list-style-type: none"> i. before 31 December 2013, the Proponent shall secure compensatory habitat locations required under condition 2.20b); ii. before 31 December 2014, the Proponent shall have completed the migratory shorebird compensatory habitat works required under condition 2.20b)ii); iii. before 31 December 2016, the Proponent shall have completed the <i>Litoria aurea</i> compensatory habitat works required under condition 2.20b)i). If a viable breeding population* of <i>Litoria aurea</i> has not been established as part of the implemented compensatory habitat works then the Proponent is required to purchase an equivalent area of land that is known to contain the species and manage this land for the enduring conservation of the species in perpetuity. Any land required to be purchased is required to be completed by 31 December 2019. 	Section 11
2.20A Financial surety of the requirements specified in condition 2.20 will be provided by the Proponent to the Department in the form of a Conservation Bond. Within 3 months of the date of the approval of modification application MP 06_0009 MOD 2, referred to in condition 1.1e), the Proponent shall determine the sum of the Conservation Bond to the satisfaction of the Director-General, in consultation with OEH, based on the following: <ul style="list-style-type: none"> a) calculating the full cost of fulfilling its compensatory habitat obligations outlined in condition 2.20, in perpetuity, (including any land acquisition costs). These costs need to consider research, establishment of habitat, ongoing monitoring and management of the habitat. b) employing a suitably qualified quantity surveyor to verify the calculated costs. <p>The Conservation Bond is required to be lodged with the Department by 30 July 2013, or as otherwise agreed by the Director-General, to ensure that the biodiversity offsets outlined in condition 2.20 are implemented in accordance with the performance and timing commitments provided in the Compensatory Habitat and Ecological Monitoring Program. If the offset is completed in accordance with the performance and timing commitments in the Compensatory Habitat and Ecological Monitoring Program to the satisfaction of the Director-General, in consultation with the OEH, the Director-General will release the bond. If the offset is not completed in accordance with the performance and timing commitments in the Compensatory Habitat and Ecological Monitoring Program, the Director-General may, in consultation with OEH, call in all or part of the Conservation Bond, and arrange for the satisfactory completion of the relevant works.</p> <p>The sum of the Conservation Bond may be reduced subject to the successful performance of the compensatory works. The reduction of the Conservation Bond would be at the agreement of the Director-General, in consultation with the OEH. In relation to <i>Litoria aurea</i>, successful performance works include the identification of a viable breeding population.</p>	Section 10
2.20B In the event that the project is modified such that it results in impacts to biodiversity different to those assessed in the document referred to in condition 1.1b), the Proponent is required to submit for the approval of the Director-General, a revised Compensatory Habitat and Ecological Monitoring Program within three months of any approval.	Section 12

* Definitions:

Viable breeding population (in relation to *Litoria aurea*):

Success in the establishment of both a breeding population and a viable population.

Breeding population (in relation to *Litoria aurea*):

Evidence of natural breeding events occur in two seasons (September to March) and include the presence of eggs, tadpoles and/or metamorphs that were not released from captive breeding stock in at least one pond. The breeding events do not have to be recorded over two consecutive seasons.

Viable population (in relation to *Litoria aurea*):

Evidence of at least five reproductively mature individuals are identified within new aquatic and/or terrestrial habitat in each of the two seasons when breeding events occurred. Such evidence will include presence of calling males with nuptial pads and gravid females.

Other conditions relating to the CHEMA are:

- Condition 1.6 of Project Approval (06_0009), which states that NCIG may only proceed to construct the High Capacity Optional Inlet Rail Spur and Rail Siding upon receipt of the Secretary of DP&E satisfaction that the CHEMA is being implemented according to the timeframes required, or to the extent agreed by the Secretary of DP&E.
- Condition 5.1 of Project Approval (06_0009), which provides the Compliance Tracking Program which involves periodic review of the NCIG CET's compliance status against the requirements of Project Approval (06_0009).
- Condition 6.4 of Project Approval (06_0009), which requires the CHEMA to be made available on the NCIG website.
- Condition 8.1 of Project Approval (06_0009), which requires any incident with actual or potential significant off-site impacts on people or the biophysical environment to be reported to the Secretary of DP&E as soon as practicable after the occurrence of the incident.

The CHEMA has been prepared to assist NCIG in the implementation of appropriate environmental management measures during the construction and operation of the NCIG CET. Where there is any conflict between the provisions in the CHEMA and any statutory requirements (i.e. licences, permits, Project Approval conditions and relevant laws), the statutory requirements are to take precedence.

The CHEMA structure is outlined below:

Section 2	Provides results of the ecological surveys and identifies and quantifies the extent and types of habitat that will be lost or degraded as a result of the NCIG CET.
Section 3	Describes the role of the NCIG Consultative Board in guiding the development of the compensatory works program.
Section 4	Describes how NCIG will provide for research into the Green and Golden Bell Frog in and around Kooragang Island and the Hunter Estuary.
Section 5	Describes how NCIG will provide for the establishment of compensatory habitat for the Green and Golden Bell Frog habitat lost as a result of the NCIG CET.
Section 6	Describes how NCIG will provide for the establishment of compensatory habitat for migratory shorebird habitat lost as a result of the NCIG CET.
Section 7	Provides for a migratory shorebird monitoring program and ecological studies in and around Deep Pond and Swan Pond.
Section 8	Describes how NCIG will provide for ameliorative works on land surrounding the Project to remove mangrove communities and provide habitat for locally-endemic Endangered Ecological Communities (EECs).
Section 9	Discusses how compensatory and ameliorative works for the NCIG CET will be co-ordinated with similar requirements for other developments.
Section 10	Describes the process for providing a Conservation Bond.
Section 11	Provides the timing and responsibilities for the CHEMA and details of the assessment and annual works program process.
Section 12	Provides the reporting and review requirements for the CHEMA.
Section 13	Lists the references cited in the CHEMA.

Supporting attachments to the CHEMA are as follows:

Attachment 1	Director-General's Approval of Qualified Ecologist – Dr Arthur White
Attachment 2	Director-General's Approval of Qualified Ecologist – Professor David Goldney
Attachment 3	Green and Golden Bell Frog Habitat and Conservation - Ash Island
Attachment 4	Ash Island Vegetation Mapping and Survey
Attachment 5	Director-General's Approval of Environmental Representative – Nathan Juchau
Attachment 6	Hygiene Protocol for the Control of Disease in Frogs
Attachment 7	Green and Golden Bell Frog Monitoring Data Recording Sheet

2 PRE-IMPACT ECOLOGICAL SURVEYS

Professor David Goldney (Cenwest Environmental Services) (approved by the Director-General [Attachment 2]) conducted ecological surveys in April and May 2007 to identify the extent and types of habitat that will be lost or degraded as a result of the NCIG CET (prior to the NCIG CET rail flyover modification) in accordance with Condition 2.20(a) of Project Approval (06_0009) (NCIG, 2010). The habitats mapped by Professor David Goldney are shown on Figure 4a. The extent and types of habitat that will be lost or degraded as a result of the NCIG CET rail flyover modification components are identified in the *Newcastle Coal Infrastructure Group Coal Export Terminal Rail Flyover Modification Environmental Assessment* (NCIG, 2012a), based on ecological surveys undertaken by Umwelt (Australia) Pty Limited (2012). The habitats in the NCIG CET rail flyover modification are shown on Figure 4b.

Condition 2.20(b)(i) of Project Approval (06_0009) quantifies the area of Green and Golden Bell Frog compensatory habitat that NCIG is required to establish (i.e. 75 hectares [ha]). This amount of compensatory habitat may be reduced if NCIG can determine, using scientific methodology agreed to by the DP&E, in consultation with OEH that the population of Green and Golden Bell Frog impacted by the NCIG CET is less than 37.5 ha¹. The reduced amount shall be agreed to by the DP&E, in consultation with the OEH, by 30 June 2015. The Green and Golden Bell Frog compensatory habitat program is described in Section 5.

As a result of the environmental assessments, Condition 2.20(b)(ii) of Project Approval (06_0009) quantifies the area of shorebird compensatory habitat that NCIG is required to establish (i.e. 8 ha), based on approximately 4 ha of shorebird habitat to be lost or degraded (NCIG, 2010, 2012a). The shorebird compensatory habitat program is described in Section 6.

¹ The Director-General's assessment report states the following regarding the NCIG CET (noting that the areas quoted do not include the NCIG CET rail flyover modification components):

The Department notes that there has been a difference of opinion since the project was approved in relation to the required amount of compensatory habitat for this species. NCIG has consistently stated that its project will directly impact on 8.4 hectares of GGBF habitat and therefore that it is required to provide 16.8 hectares of compensatory habitat (at the ratio of 2:1) in accordance with condition 2.20. However, the OEH maintains that the area of direct impact is in fact 34 hectares, made up of 17 hectares of wetland (breeding) habitat and 17 hectares of terrestrial (foraging) habitat and therefore that the amount of compensatory habitat required should be 68 hectares.

In relation to biodiversity, the Department has clarified the amount of compensatory habitat offsets that are required for the project and included specific milestones for their implementation in order to ensure positive biodiversity outcomes are realised.



LEGEND

Habitat Types

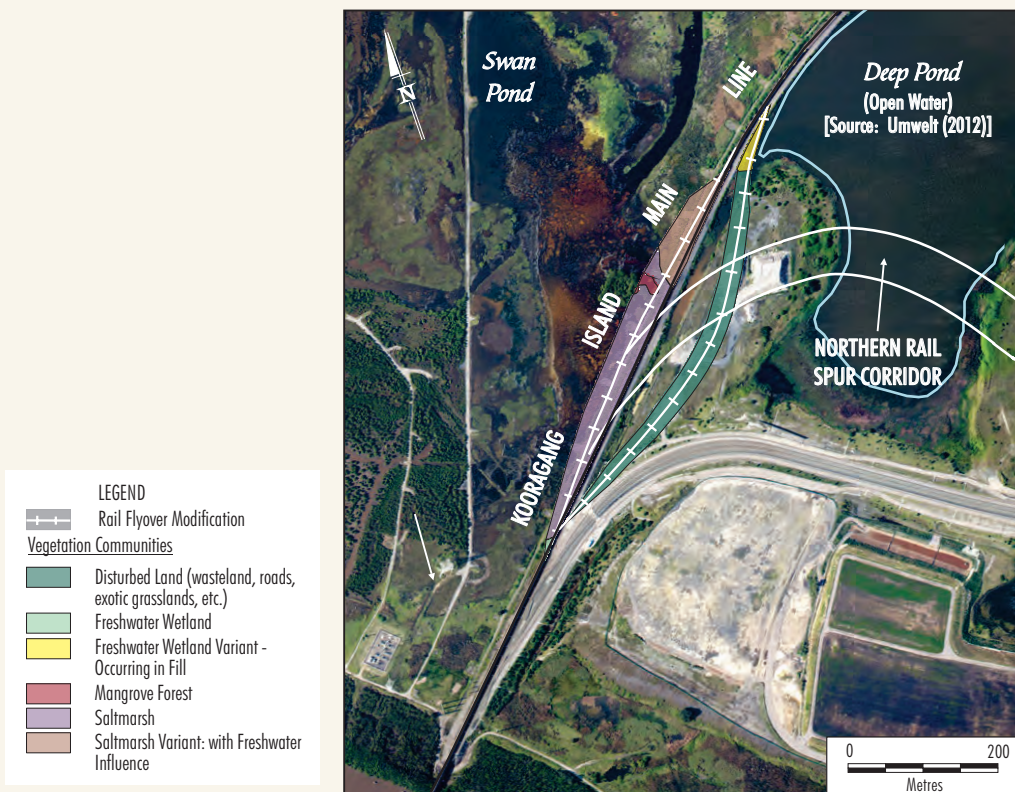
1	Artificial Wetland - Predominantly Inundated	6	Pasture with Occasional Scattered Low Trees	— Approximate Extent of Approved NCIG CET Key Components (Prior to Rail Flyover Modification) - - High Capacity Optional Inlet Spur and Rail Sidings
2	Artificial Wetland - Predominantly Ephemeral	7	Pasture with Emergent Rushes	
3	Artificial Drainage Line - Predominantly Inundated	8	Scattered Low Trees	
4	Saltmarsh	9	Mixed - Pasture, Terrestrial Rushland, Scattered Low Trees	
5	Open Water	10	Bare Ground	

Source: *Habitat Mapping* by Professor David Goldney (April, 2007)

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM

FIGURE 4a
Habitat Types within the
NCIG CET Site

Newcastle Coal
INFRASTRUCTURE GROUP



Source: Aerial Photo NCIG (February 2012) (Not Orthorectified) and Umwelt (2012)

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM

FIGURE 4b

Habitat Types within the NCIG CET Site - Rail Flyover Modification

3 PROGRAM CO-ORDINATION – CONSULTATIVE BOARD

Condition 2.20(d) of Project Approval (06_0009) requires that NCIG provide for the funding of works required under Condition 2.20 of Project Approval (06_0009) to be managed by a mechanism that provides a sound and legally enforceable means of allocating resources for establishment, ongoing adaptive management and review of the performance of compensatory habitat works for the life of the NCIG CET. A Consultative Board has been formed by NCIG to guide the ongoing development of the activities/works required to satisfy Condition 2.20(d) of Project Approval (06_0009). The Consultative Board provides advice to NCIG management on:

- the effective allocation of resources for ongoing adaptive management;
- review the outcomes of the research programs; and
- review the performance of compensatory habitat works for the life of the NCIG CET.

The NCIG Consultative Board includes representatives from:

- DP&E;
- OEH;
- Hunter Local Land Services;
- University of Newcastle;
- Approved Ecologist (Dr Arthur White [Biosphere Environmental Consultants Pty Ltd]) (approved by the Director-General [Attachment 1]); and
- NCIG.

The NCIG Consultative Board is responsible for reviewing the proposed program of works on an annual basis and recommending any changes to ensure that the NCIG obligations continue to be met. These recommendations will be made considering the program objectives, schedule of works, and the performance of the compensatory habitat. Terms of Reference for the NCIG Consultative Board which outline the responsibility of the overall Board and individual members of the Board have been established.

Recommendations for the compensatory habitat works (consistent with the CHEMA) required for the upcoming year will be provided by a qualified ecologist (as approved by the Secretary of DP&E [Attachments 1 and 2]) as informed by ongoing monitoring and research undertaken. The recommendations will be used by NCIG to prepare an annual works program including estimated costs and details of any contractor engagements. This works program will then be presented to the NCIG Consultative Board for discussion and comment. Appropriate changes to the recommended annual works program could then be adopted based on the advice received.

Subject to the feedback of the NCIG Consultative Board on the composition of tasks within the annual research and works program, NCIG will undertake or arrange for activities to be undertaken in accordance with the program. All of the tasks that constitute the annual research and works program will be directly funded by NCIG for the life of the NCIG CET.

A summary of the annual research and works program will be included in the Annual Environmental Management Report (AEMR) which will be distributed to relevant government agencies and stakeholders, including the Secretary of DP&E and OEH (Section 12).

4 GREEN AND GOLDEN BELL FROG RESEARCH PROGRAM

In accordance with Condition 2.20(e) of Project Approval (06_0009), NCIG is providing funding to the University of Newcastle to further research the Green and Golden Bell Frog (Plates 1 and 2) in and around Kooragang Island and the Hunter Estuary.

The research program has been discussed with and agreed to by the NCIG Consultative Board.

4.1 CONSTRUCTION OF RESEARCH PONDS

NCIG has had ongoing consultation with the NPWS (who are the landholders of much of Kooragang Island/Ash Island [Figure 5]), DP&E, the University of Newcastle and Kooragang Wetland Rehabilitation Project (KWRP) regarding the planning, construction and management of the Research Ponds. A forum was held on 1 March 2012 to identify constraints and issues in design and location of the Research Ponds. Members from NPWS and University of Newcastle were present, as well as Dr Arthur White (Biosphere Environmental Consultants Pty Ltd), NCIG and its consultants. KWRP members were unable to attend. Aspects discussed included design of ponds to capture existing water resources on Ash Island (groundwater and surface water), acid sulphate soils, security, site access and existing services.

Since 2011, NCIG has been working with the University of Newcastle (Professor Michael Mahony) to design the Green and Golden Bell Frog Research Ponds on Ash Island. The research enclosure was constructed in 2012 and covers an area of approximately 10,000 square metres (approximately 80 metres [m] wide and 140 m in length) (Figures 5 and 6). NCIG currently has a licence with the NPWS covering the majority of land (totalling approximately 20 ha) between Cabbage Tree Road, Schoolhouse Road and Scotts Point Way.

The Research Ponds have been designed to investigate habitat preferences of the Green and Golden Bell Frog. The ponds have been constructed such that the physical characteristics of all ponds are similar, except in depth.

A total of 16 ponds approximately 18 m x 10.5 m in size were constructed and enclosed in a frog enclosure fence (Plate 3). These ponds consist of eight deep and eight shallow ponds. The deep ponds are approximately 1.5 m deep to access groundwater and therefore maintain permanent water habitat for the frogs (Figures 7a-c). The shallow ponds are approximately 0.5 m deep in order to provide ephemeral habitat for the frogs.

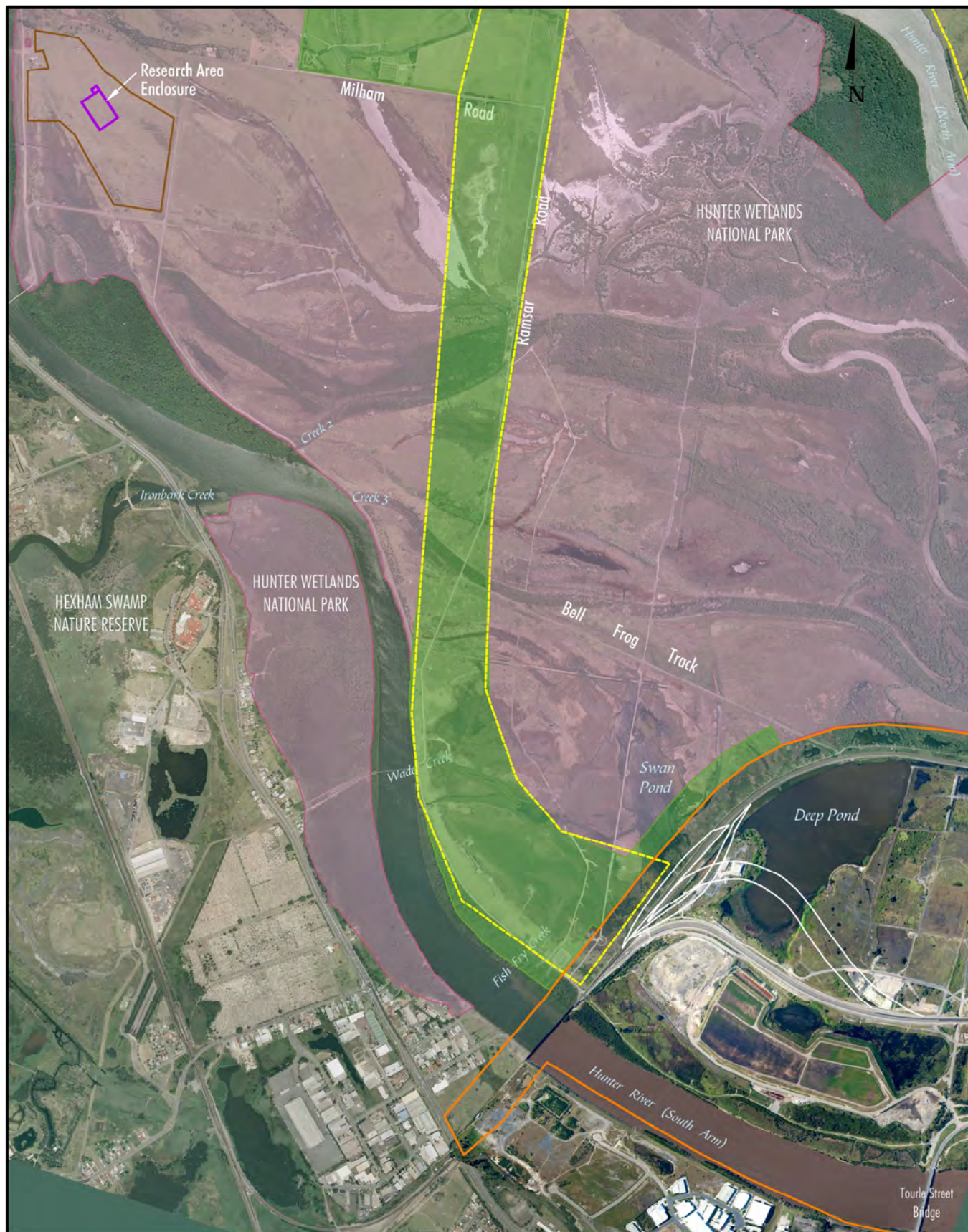
Pond wall slopes are generally at a gradient of 3.5:1 based on geotechnical assessment of soil stability. The ponds include rock lined walls on one side to maintain the stability and structural integrity of the pond and to exclude dense fringing vegetation on the southern margins (basking area) thereby creating areas of open water. Boulders and rocks have been placed in and around the ponds to provide increased basking and shelter habitat for the frogs. Plantings of *Carex* spp. and *Juncus usitatus* and emergent vegetation such as *Schoenoplectus* spp. and *Bolboschoenus* spp. and *Eleocharis* spp. have been established around the margins of the ponds to create strategic diurnal shelter and foraging areas. Water Ribbons (*Triglochin procera*) have been planted to provide submerged aquatic vegetation.



Plate 1: Adult Green and Golden Bell Frog (*Litoria aurea*)
Source: A. White



Plate 2: Tadpole Green and Golden Bell Frog (*Litoria aurea*)
Source: A. White



LEGEND

- National Park
- National Park Managed Land (Part II)
- SEPP (Major Development) 2005 - Tamaga Industrial Site
- SEPP (Major Development) 2005 - Newcastle Port Site
- Northern Rail Spur Flyover (including Rail Flyover Modification Components)
- NCIG Licence Area

0 200 400
Metres

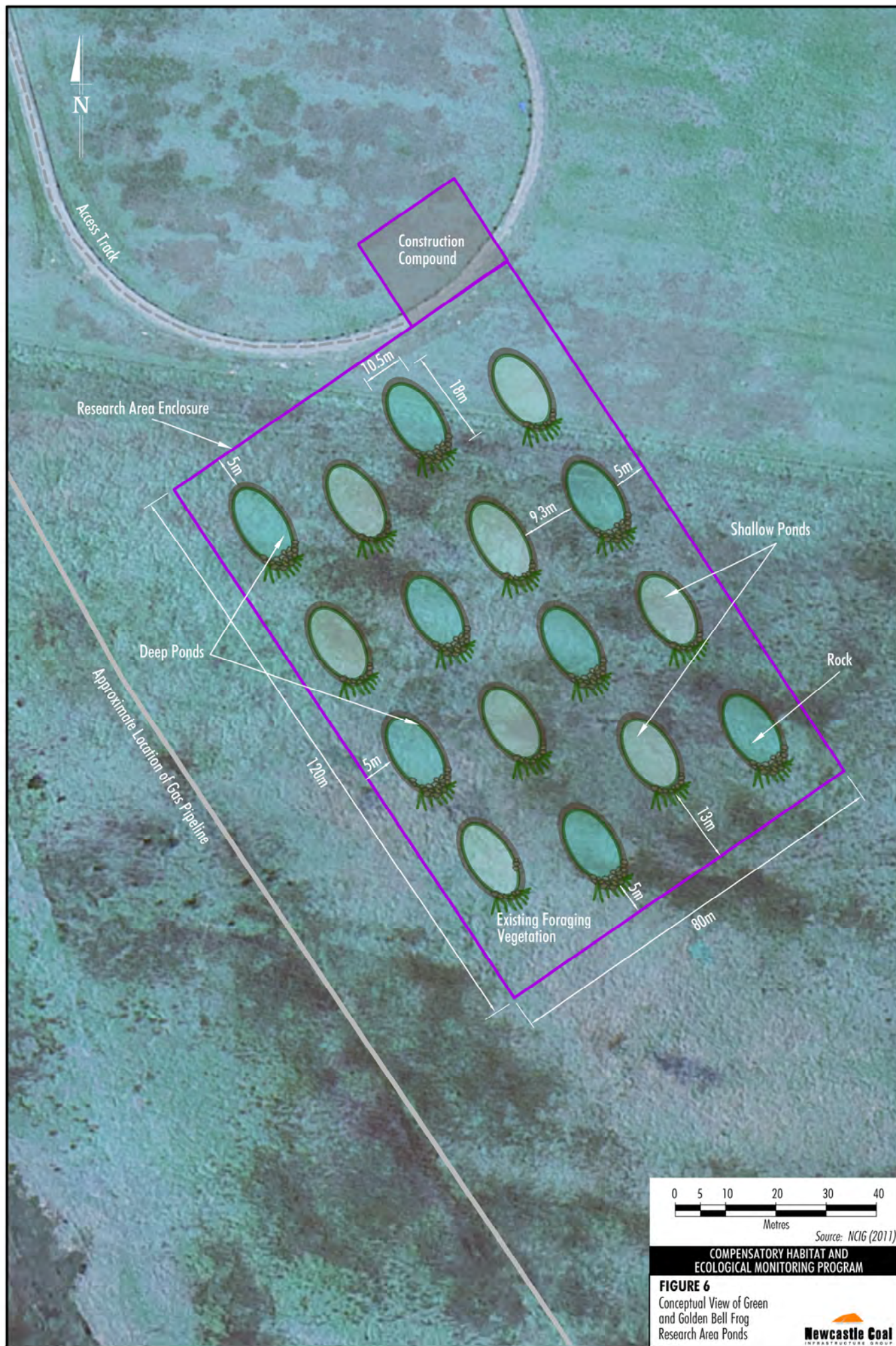
Source: RPS (2010); NPWS (2012); KWRP (2007) and NCIG (2012)

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM

FIGURE 5

Location of the Research Area Enclosure

Newcastle Coal
INDUSTRIAL GROUP



0 5 10 20 30 40
Metres
Source: NCIG (2011)
COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 6
Conceptual View of Green
and Golden Bell Frog
Research Area Ponds





Tadpoles Released in Completed Frog Research Pond



Completed Frog Research Ponds (Aerial View)



Frog Enclosure Fence



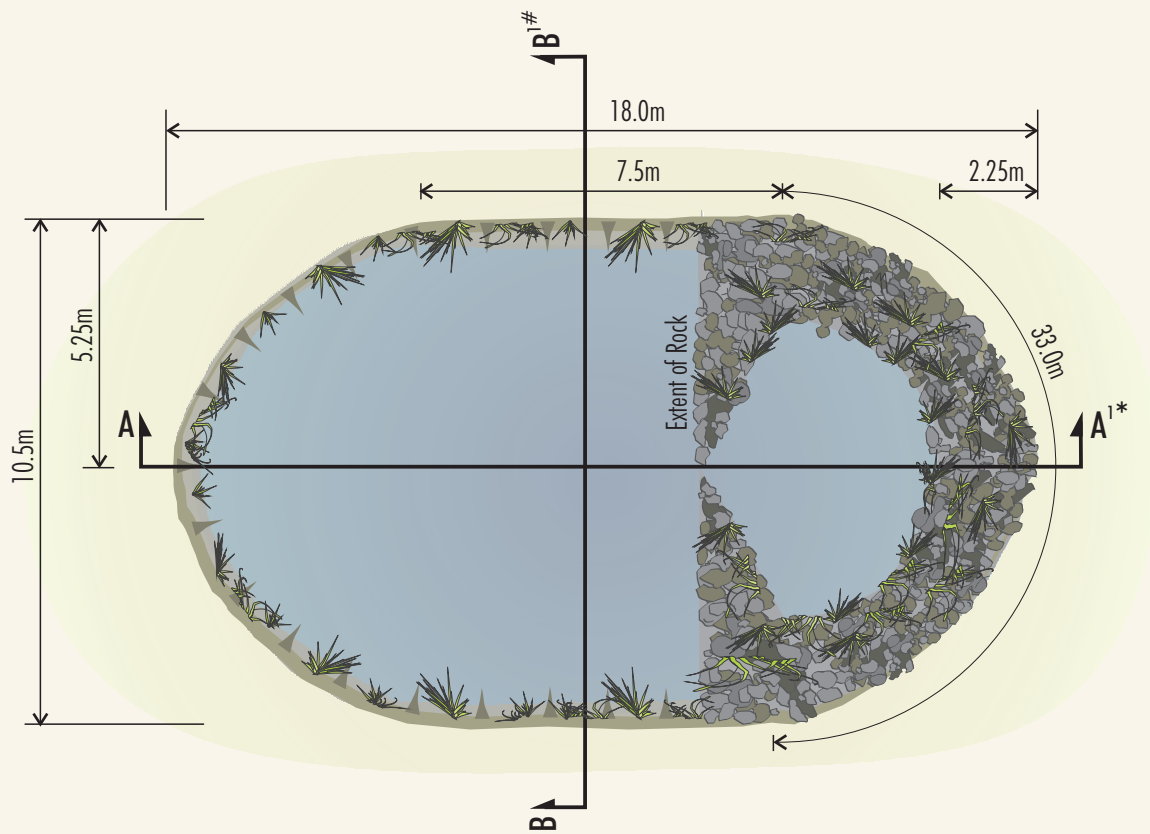
Completed Frog Research Ponds (including Rock Liner)

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

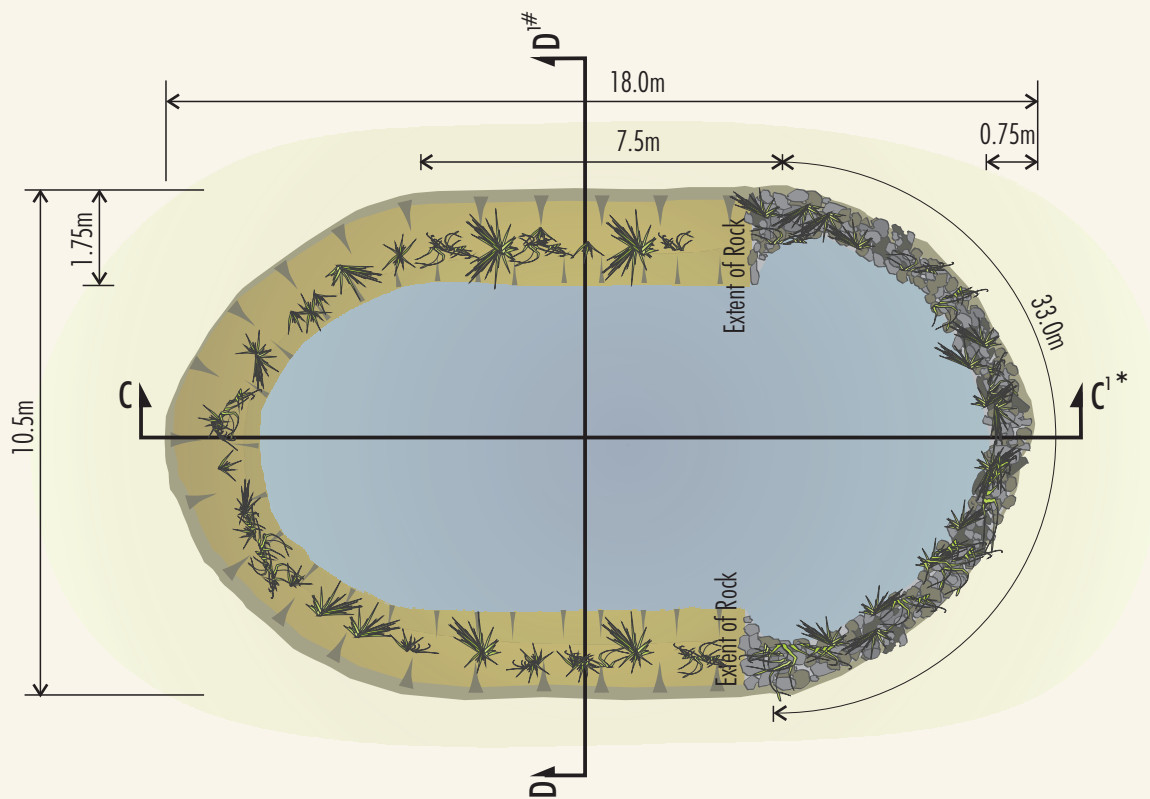
PLATE 3

NCIG Green and Golden Bell
Frog Research Ponds (photos
dated January/February 2013)





CONCEPTUAL PLAN VIEW - DEEP POND



CONCEPTUAL PLAN VIEW - SHALLOW POND

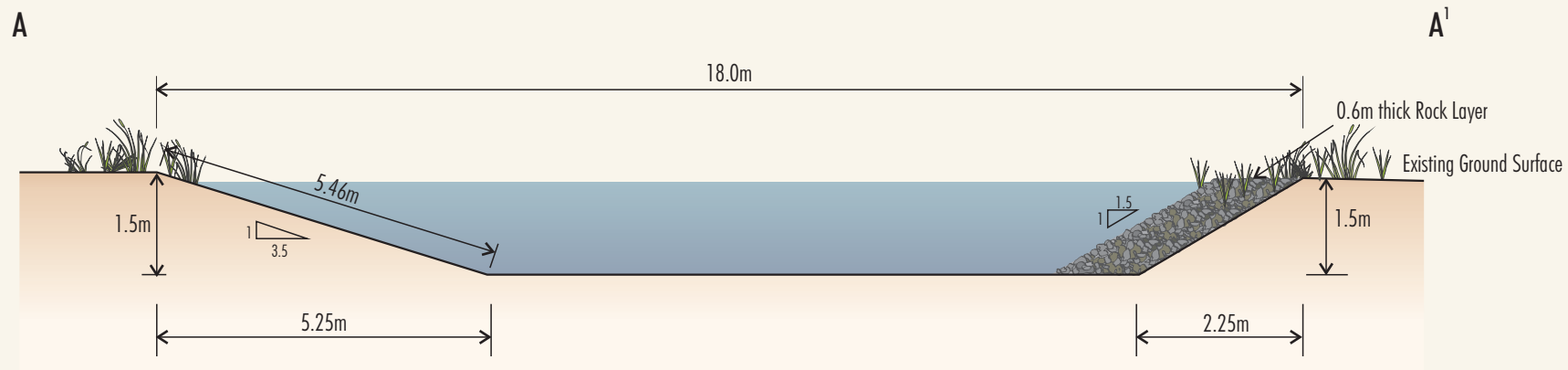
Not to Scale

**COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM**

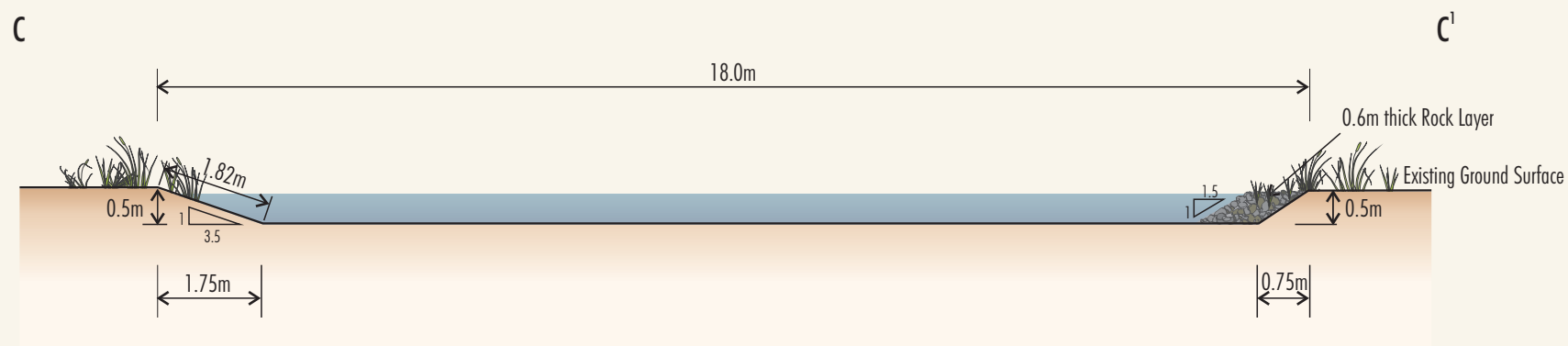
FIGURE 7a
Conceptual Plan Views of Green
and Golden Bell Frog Ponds

Newcastle Coal
INFRASTRUCTURE GROUP

* Refer to Figure 7b
Refer to Figure 7c



CONCEPTUAL LONG SECTION - DEEP POND



CONCEPTUAL LONG SECTION - SHALLOW POND

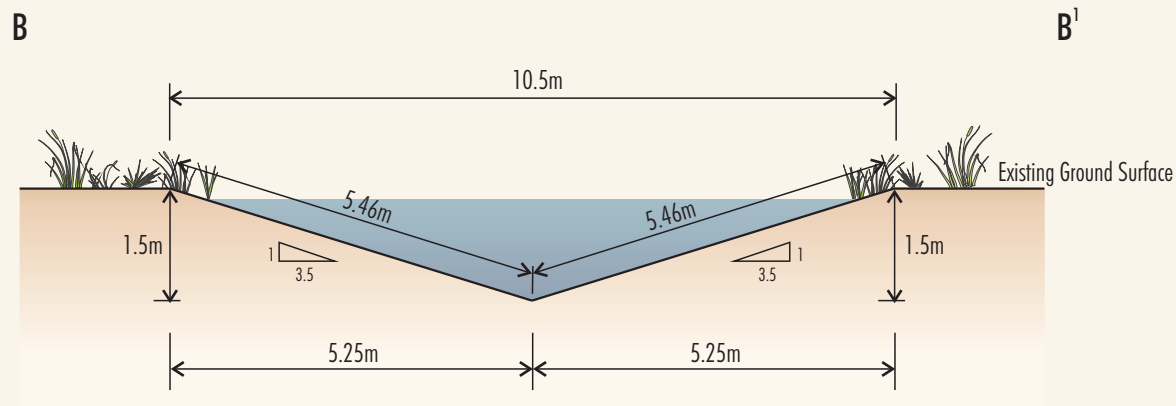
Not to Scale

**COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM**

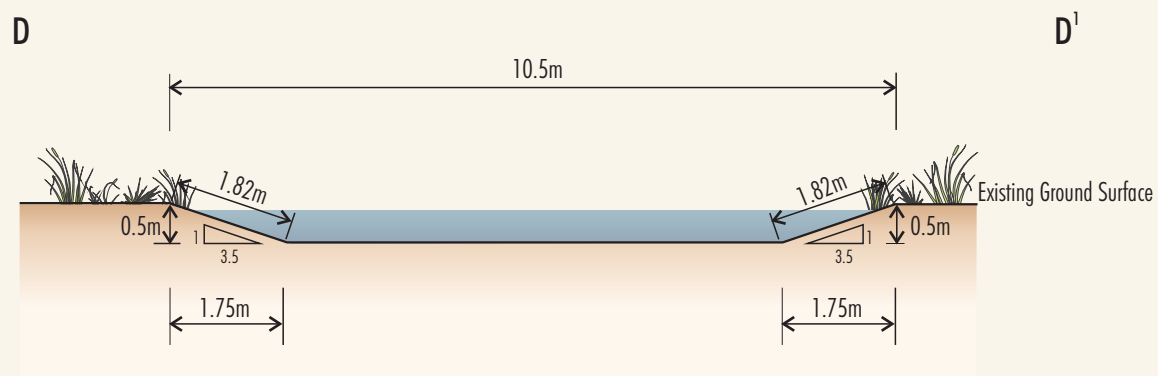
FIGURE 7b

Conceptual Long-sections of Green
and Golden Bell Frog Ponds

Newcastle Coal
INFRASTRUCTURE GROUP



CONCEPTUAL CROSS SECTION - DEEP POND



CONCEPTUAL CROSS SECTION - SHALLOW POND

Not to Scale
 COMPENSATORY HABITAT AND
 ECOLOGICAL MONITORING PROGRAM

FIGURE 7c
 Conceptual Cross-sections of Green
 and Golden Bell Frog Ponds



4.2 TRANSLOCATION OF GREEN AND GOLDEN BELL FROGS INTO THE RESEARCH ENCLOSURE

To facilitate the introduction of captive-bred frogs into habitat, a translocation application has been completed and approved by the NPWS – Licensing Division. The Research Ponds were populated with Green and Golden Bell Frog tadpoles that were captive-bred at the University of Newcastle. The University of Newcastle's breeding program consists of ten adult breeding pairs, which the University of Newcastle obtained from Kooragang Island/Ash Island.

A total of 7,500 were introduced into the Research Ponds as tadpoles and metamorphs. The introduction of tadpoles was undertaken in a staged approach to improve success of the introduction. This included introduction of a subset of the captive-bred population under controlled conditions to gauge any potential negative impacts on tadpoles/metamorphs. There were no identified negative impacts and the full population was introduced shortly thereafter and distributed throughout the habitat.

At the end of the research period an evaluation will be made as to whether to retain the facility for further research or to remove the fence around the research facility to open the ponds to the environment. If the fence is to be removed then a translocation application will be completed and submitted to the NPWS – Licensing Division, if required.

4.3 RESEARCH PROJECTS

Two research projects will be undertaken by the University of Newcastle as detailed below. The details of research projects may change at the discretion of the University of Newcastle in consultation with NCIG. Research projects will run typically for a period of up to three years each.

This research will be guided by NCIG and the supervisory staff at the University of Newcastle in order to achieve the required outcomes. Primary supervision of the research will be provided by the University of Newcastle with secondary supervision from a qualified ecologist commissioned by NCIG. In this way, the research projects will maintain a focus on the Green and Golden Bell Frog populations in the Hunter Estuary and provide beneficial outcomes in relation to the NCIG CET.

Issues such as intellectual privacy and future publication of results will be determined in consultation with the University of Newcastle before the research projects commence. NCIG will require that those undertaking the research projects provide NCIG with progress updates on a regular basis (e.g. quarterly).

4.3.1 Behavioural Ecology Research

NCIG has committed to a behavioural based research program. This program aims to investigate the process of how Green and Golden Bell Frogs select habitat. The primary objective is to understand the process of habitat choice and to determine important drivers of this process. The following research questions will be a focus for the research:

- | | |
|------------|--|
| Question 1 | Are Green and Golden Bell Frogs attracted to areas occupied by conspecifics ² ? |
| Question 2 | Do Green and Golden Bell Frogs use the presence of conspecifics to determine habitat suitability? |
| Question 3 | Are Green and Golden Bell Frogs able to discriminate between infected/diseased and healthy conspecifics? |

² Individuals belonging to the same species.

Answers to these research questions may provide a novel approach to attract individuals to certain waterbodies, and will assist in manipulating the local distribution and increase the local abundance of the Green and Golden Bell Frog.

The first step was to conduct laboratory behavioural observations and to establish a lab colony of adult Green and Golden Bell Frogs (males and females). These frogs were collected from the wild or equivalent sources. A colony size of approximately 25 males and 25 females was established, which resulted in enough statistical power in order to determine patterns and trends with confidence.

Testing frogs of both sexes allows a determination if the observed behaviour is sex dependent. Such behavioural trials are conducted in the laboratory, because the University of Newcastle is able to control other variables that may affect the behavioural responses (e.g. ambient temperature and time of day). This approach also allows for the testing of multiple animals at the same time under exactly the same conditions, which further reduced potential variance in the data.

Work generally began on a small scale as a pilot study, with a relatively small sample size, and then progressed to a larger scale once the initial findings had been made. The initial pilot studies employed the method of choice trials, where individuals chose between at least two options as determined by the University of Newcastle. The choice process is monitored using a video recording system (CCTV) and the outcome for each tested individual is recorded. These trials will allow distinction between given options and whether a preference for one of the options exists.

Once the pilot studies have allowed some initial insight, a full-size experiment with a larger sample size, applying the same technique of choice trials will be designed by the University of Newcastle and conducted in the laboratory. In these full-size experiments, the University of Newcastle will test the lab colony (males and females) in a replicated experimental design.

In addition to the laboratory experiments, field observations and recording frog behaviour in natural conditions will be conducted as determined by the University of Newcastle. This mainly relates to answering research question 1, but may also give some indication in relation to research question 2, thereby allowing further refinement of the detailed design of the respective laboratory experiments.

4.3.2 Population Modelling Research

Research has been initiated in relation to the population dynamics of the Green and Golden Bell Frog. Population modelling will be undertaken utilising appropriate ecological software. The manner in which a process of modelling will be used to achieve the desired outcomes has been discussed with both Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) and the University of Newcastle.

This research will comprise the following fundamental components:

- a literature survey of all published information;
- collation of relevant existing data;
- a gap analysis of data to guide research priorities;
- definition of proposed monitoring and modelling methodologies;
- outline proposed hypothesis;
- set structure and priorities for research program;
- undertake detailed data collection (monitoring);
- statistical analysis of collected information (modelling);
- ongoing reporting; and
- test research question posed to either prove or disprove stipulated hypothesis.

Due to the perception of amphibians being a bio-indicator species and their associated sensitivity to localised and global environmental factors, ecological modelling research on this group of animals is a growing field. A number of research programs have therefore been undertaken for a variety of species, both within Australia and overseas, which will provide context for the initiation of the proposed research. This research field has the principle aim of defining threat processes and the impact of habitat and environmental variables on population dynamics.

The University of Newcastle describe that the specific outcomes of their research will include:

- Growth rate and survival probability comparisons of animals in Research Ponds with known values for wild populations to infer habitat suitability.
- Identification of how habitat utilisation and the availability of particular habitat attributes affect growth and survival. Such models may identify that some frogs spend more time in warmer sections of the habitat and also have higher growth and survival rates so future habitat creation should consider temperature that may be achieved by managing water depth.
- Identify habitat preferences/selection of Green and Golden Bell Frog via utilisation verse availability type analysis. This is important because Green and Golden Bell Frogs do not always select apparently suitable habitat.
- Population viability modelling allows projections of population size and persistence/extinction under different habitat creation and threatening process scenarios.

5 GREEN AND GOLDEN BELL FROG COMPENSATORY HABITAT PROGRAM

5.1 INTRODUCTION

The previous CHEMA (Revision 01) (NCIG, 2010) presented a program for creating compensatory habitat for the Green and Golden Bell Frog in accordance with Condition 2.20(b)(i) of Project Approval (06_0009). The compensatory habitat program provided for staged creation of breeding, sheltering, foraging, overwintering and movement habitat for the frog (Stages 1 to 3) (Figure 8).

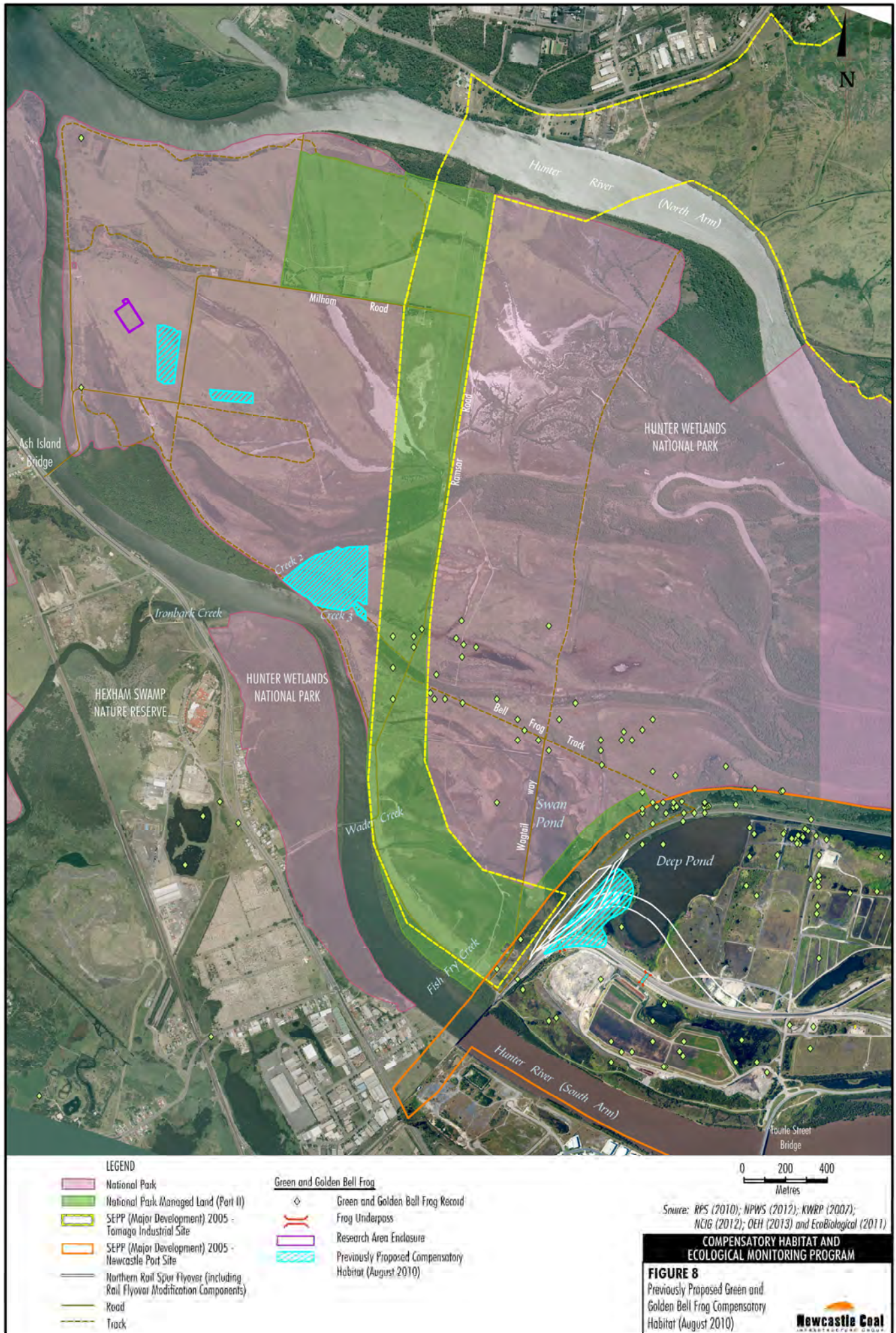
Since the approval of the CHEMA (Revision 01) (NCIG, 2010), NCIG has undertaken consultation with various stakeholders (including NPWS, University of Newcastle and other members on the NCIG Consultative Board), and has commissioned various specialist studies (biological [Attachments 3 and 4], hydrology and soil characterisation [RCA Australia, 2012]). A revised Green and Golden Bell Frog compensatory habitat program is outlined below based on the new information from the work completed to date.

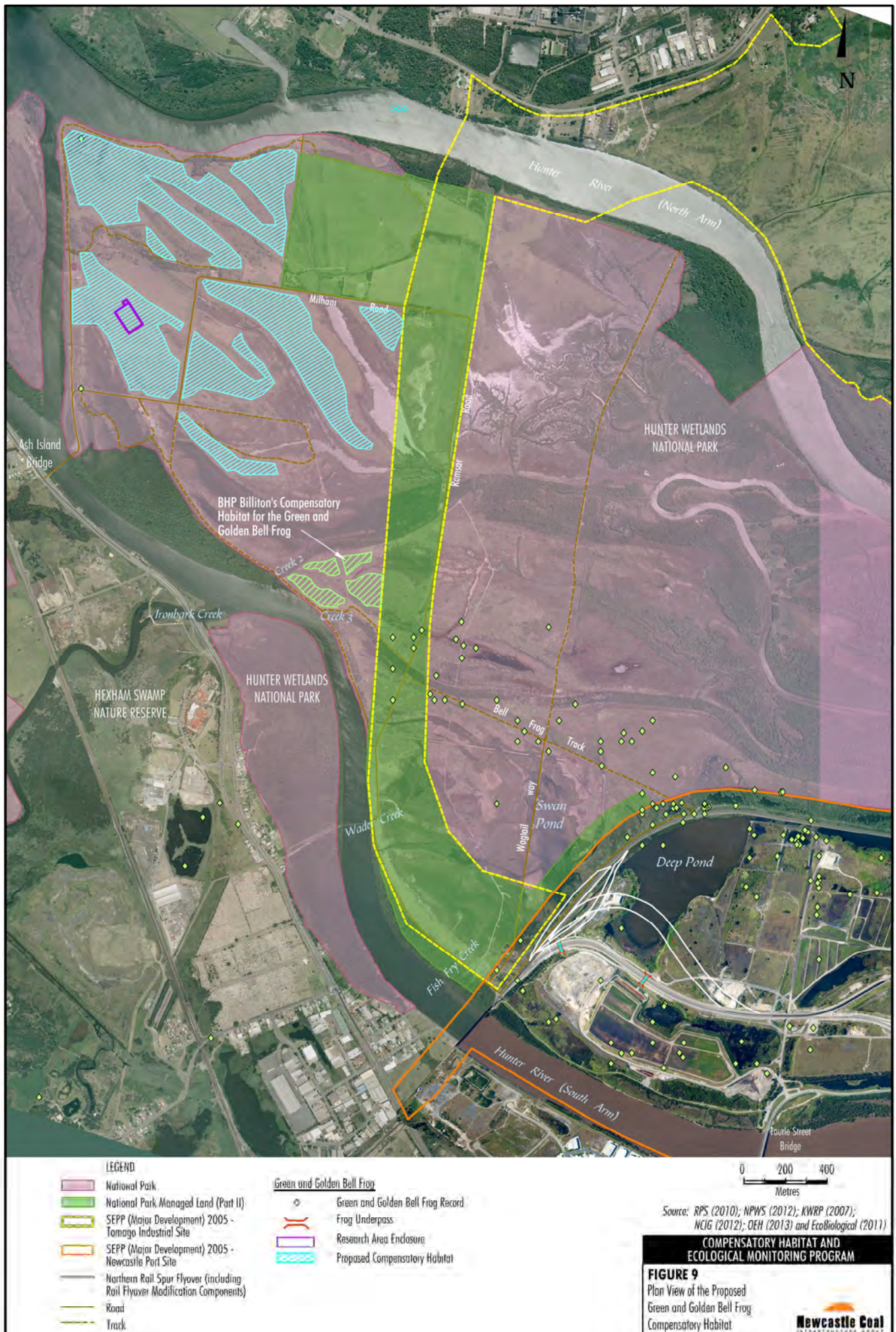
NCIG commenced compensatory habitat works on 21 January 2009 with the creation of habitat at the approach to the frog underpasses associated with the NCIG rail infrastructure (Figure 9). Subsequent stages of proposed habitat creation as outlined in the previous CHEMA (Revision 01) (NCIG, 2010) have not commenced because NCIG has not been permitted access to the land previously identified for Stage 1 and the land for Stage 2 is no longer available due to competing interests (Figure 8).

The proposed Stage 1 compensatory habitat was previously proposed to be located within the Kooragang Island Waste Emplacement Facility (KIWEF) between the Kooragang Island Mainline and the NCIG Rail Spur and Rail Sidings (NCIG, 2010) (Figure 8). However, the Newcastle Port Corporation (NPC) (State Property Authority) has not provided approval for NCIG to use the land for compensatory habitat. Notwithstanding, since this Stage 1 area was within the KIWEF (an industrial area), it was not an ideal location for Green and Golden Bell Frog compensatory habitat due to conflicting land uses. The revised Green and Golden Bell Frog compensatory habitat program described below, proposes habitat creation on Ash Island within the Hunter Wetlands National Park in accordance with a Memorandum of Understanding between NPC and NPWS (Figure 9). More recent communications between NPWS (the landholders) and NCIG (February 2013) confirms the availability of this land for habitat creation. This will provide for a more suitable and sustainable outcome in line with the existing land use planning.

NCIG previously identified a proposed location for compensatory habitat on Ash Island within the Hunter Wetlands National Park (i.e. Stage 2 compensatory habitat) (NCIG, 2010) (Figure 8). After NCIG had received approval for the CHEMA (Revision 01) (NCIG, 2010), BHP Billiton obtained approval from the Secretary of DP&E to use the same target area as compensatory habitat for their development. This required NCIG to select a different target area (Figure 9).

The proposed location for the Stage 3 compensatory habitat identified in the previous CHEMA (Revision 01) (NCIG, 2010) on Ash Island (Figure 8) still remains a viable location for the compensatory habitat. A revised Green and Golden Bell Frog compensatory habitat program is outlined below re-focusing the program and expanding on this previously identified area (Figure 9). The Green and Golden Bell Frog compensatory habitat program will provide outcomes consistent with the previous CHEMA (Revision 01) (NCIG, 2010) (i.e. a mosaic of wetland, terrestrial and breeding habitat, which includes foraging, sheltering and wintering habitat attributes and movement corridors).





It is noted that the Research Area ponds are located within proposed areas of Green and Golden Bell Frog compensatory habitat. While the current use of this area is exclusively for research purposes, the intention is that exclusion fences will be removed from around the ponds at the completion of research, and that ponds will be allowed to become part of the natural landscape. These ponds will be incorporated into NCIG's final compensatory area. For this reason, it is considered that development of the Research Area is a significant contribution to the commencement of compensatory works.

The Green and Golden Bell Frog compensatory habitat program has been prepared in consideration of the *Kooragang Island Threatened Species Offset Framework* (NSW Department of Environment and Climate Change [DECC], 2008a), *Principles for the Use of Biodiversity Offsets in NSW* (OEH, 2011a), *Best Practice Guidelines: Green and Golden Bell Frog Habitat* (DECC, 2008b) and *Protecting and Restoring Green and Golden Bell Frog Habitat* (DECC, 2008c).

5.2 GREEN AND GOLDEN BELL FROG OCCURRENCE ON KOORAGANG ISLAND/ASH ISLAND

An overview of the Green and Golden Bell Frog distribution, habitat and population size on Kooragang Island/Ash Island (in relation to this Green and Golden Bell Frog compensatory habitat program) is provided below.

5.2.1 Distribution

The Green and Golden Bell Frogs on Kooragang Island/Ash Island have been surveyed and monitored on multiple occasions over the past 12 years by multiple different ecological consultants and researchers (Table 2).

Table 2
Green and Golden Bell Frog Studies on Kooragang Island/Ash Island – 2000 to 2012

Document	Period/Year	Reference
Monitoring that provides individual sightings over the monitoring period	2006, 2007, 2008, 2009, 2010, 2011 and 2012	Biosphere Environmental Consultants (Dr Arthur White) (2006-2012)
Various consultant records and database records that provide individual/multiple sightings	July to October 2001, December 2002 and January 2003	Environmental Resources Management (ERM) (2003a)
	December 2002 to January 2003	ERM (2003b)
	2003	ERM (2004)
	2006	Connell Hatch (2006)
	2010 and 2011	Umwelt (Australia) Pty Limited (2012)
	2011	EcoBiological (2011)
Research (mainly undertaken through the University of Newcastle)	September 1999 to April 2000	Lane <i>et al.</i> (2007)
	September 2000 to April 2001	Hamer and Mahony (2010)
	September 2001 to April 2002	Hamer and Mahony (2007)
	September 2001 to April 2002	Hamer <i>et al.</i> (2008)

The Green and Golden Bell Frogs on Kooragang Island are widely dispersed and are often difficult to locate, however, after optimal climatic conditions, they can occur in large numbers. The core population of the Green and Golden Bell Frog is located in habitat located along Bell Frog Track (Figure 9). The majority of the Green and Golden Bell Frogs known extent on Kooragang Island in this part of the island was gazetted as part of the Hunter Wetlands National Park in early 2011 (Figure 9).

There have been few records of the Green and Golden Bell Frog on Ash Island (Figure 9) (e.g. EcoBiological [2011]), and the lower occupancy rates compared with Kooragang Island can most likely be attributed to the lack of high quality breeding habitat (i.e. wetlands are largely ephemeral and lack key habitat characteristics for successful and reliable breeding and recruitment by the species).

5.2.2 Habitat

Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) undertook an investigation into the presence of Green and Golden Bell Frog habitat and its relative importance within the Green and Golden Bell Frog compensatory habitat area (Attachment 3). Key habitat attributes for the Green and Golden Bell Frog (breeding, sheltering, foraging, overwintering and movement) are defined in Table 3 and Attachment 3.

Table 3
Green and Golden Bell Frog Habitat Types and Key Features

Habitat Type	Habitat Features
Breeding	<ul style="list-style-type: none"> • Permanent or near-permanent fresh waterbodies with substantial, open water areas.* • Ponds need to have high exposure to direct sunlight. • Ponds need some protection from prevailing winds. • Ponds should be fluctuating. • Ponds should not contain predatory fish (or fish to be in low numbers, or there to be significant shelter areas in the ponds created by emergent vegetation).
Sheltering	<ul style="list-style-type: none"> • Fallen trees or logs. • Emergent vegetation in ponds; fringing vegetation around ponds. • Industrial or domestic solid refuse items.
Foraging	<ul style="list-style-type: none"> • Areas of low, ground vegetation (such as exotic and native pastureland, herb fields) where crickets and grasshoppers proliferate. • Margins of ponds where there is a well developed margin of fringing, low vegetation. • Disturbed, open sites (where cockroaches may be found).
Overwintering	<ul style="list-style-type: none"> • Fallen trees or logs. • Tall, emergent vegetation in ponds. • Rock piles. • Industrial or domestic solid refuse items.
Movement	<ul style="list-style-type: none"> • Areas of low, ground vegetation (such as exotic and native pastureland, herb fields, edges or roads, tracks or drains). • May include saline areas (provided there is a freshwater source nearby).

Source: After Attachment 3.

* Green and Golden Bell Frogs opportunistically use ephemeral waterbodies for breeding/sheltering and foraging when they are filled after heavy rain (Hamer *et al.*, 2008).

5.2.3 Population

A single population of the Green and Golden Bell Frog occurs on Kooragang Island (NSW Department of Environment and Conservation [DEC], 2005). It is recognised as an important population and is estimated to be large with more than 1,000 adults (Commonwealth Department of the Environment, Water, Heritage and the Arts [DEWHA], 2009; Hamer *et al.*, 2002).

Dr Arthur White (Biosphere Environmental Consultants Pty Ltd), has undertaken annual monitoring of the Green and Golden Bell Frog on Kooragang Island since 2006 in accordance with the *Newcastle Coal Infrastructure Group Coal Export Terminal Green and Golden Bell Frog Management Plan* (NCIG, 2007) (Biosphere Environmental Consultants, 2006-2012). This monitoring involved collection of frog presence data (through standard frog survey methods) to monitor the Green and Golden Bell Frog within habitat areas adjacent to the NCIG CET site within the KIWEF and any other locations where frogs captured at the NCIG CET were relocated (NCIG, 2007)³. The monitoring locations are shown on Figure 10.

Green and Golden Bell Frogs are not evenly dispersed across Kooragang Island. The detection rates vary from 0 to 70.8% with Green and Golden Bell Frogs only being recorded more than 33.3% of visits at three sites (i.e. the frogs are detected one time or more for every three visits) (Table 4). Only at Site 3 on Kooragang Island are the frogs detected at more than 50% detection rate (Table 4).

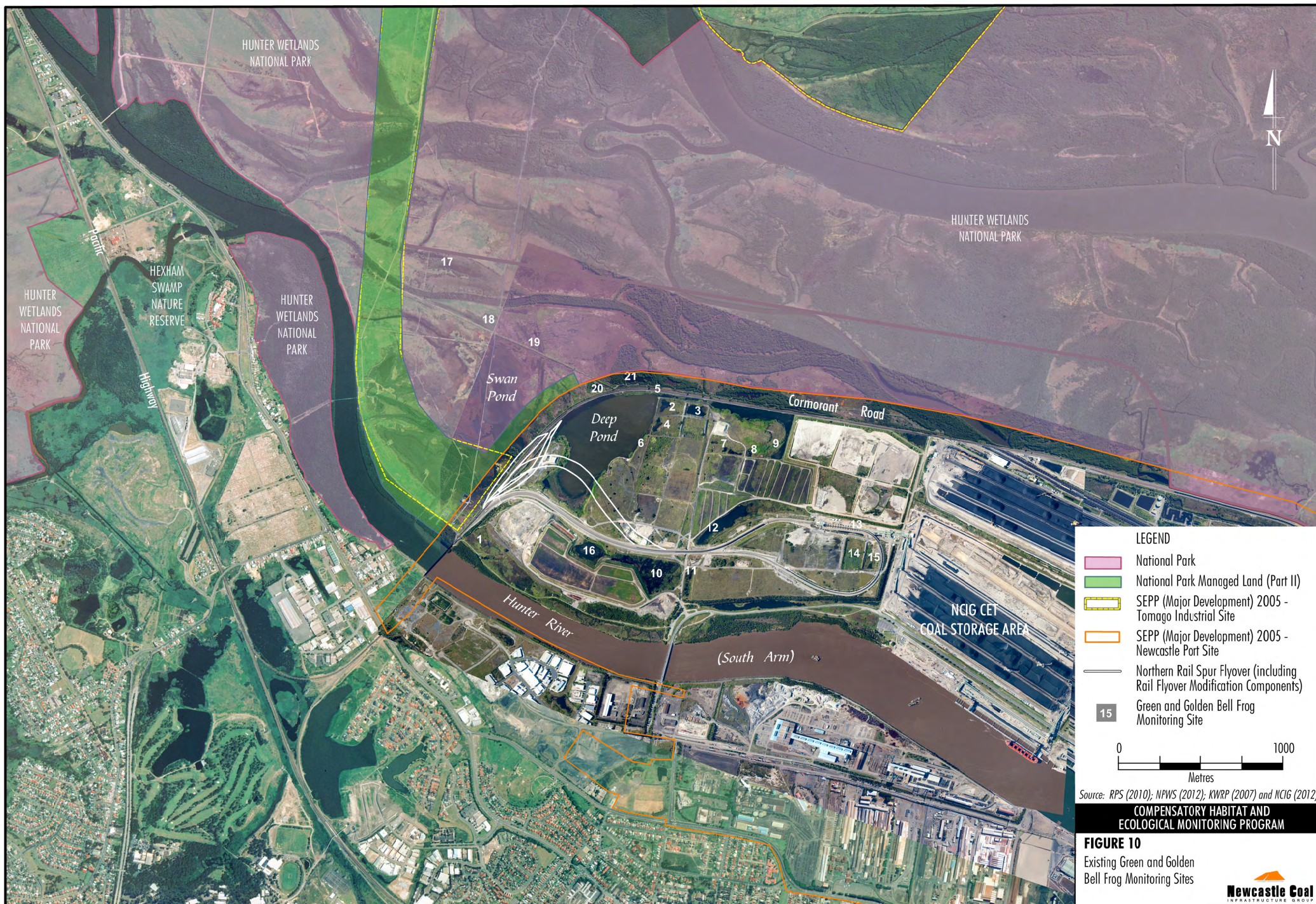
Table 4
Green and Golden Bell Frog Detection Rates at Kooragang Island – 2009 to 2011

Site	No. of Survey Visits	No. of Times Green and Golden Bell Frogs were Detected	% Detection Rate
1	24	1	4.2
2	24	4	16.7
3	24	17	70.8
4	24	3	12.5
5	24	4	16.7
6	24	3	12.5
7	24	1	4.2
8	24	3	12.5
9	24	5	20.8
10	24	1	4.2
12	24	0	0
13	24	1	4.2
14	24	2	8.3
15	24	1	4.2
16	24	9	37.5
17	9	1	11.1
18	9	1	11.1
19	9	1	11.1
20	9	2	22.2
21	9	4	44.4

Evidence of successful breeding (either by the presence of tadpoles or recently emerged metamorph frogs) has been detected infrequently (twice at Site 3, once at Site 2 and once at Site 6).

Prior to the construction of the NCIG CET, research on the population of Green and Golden Bell Frog on Kooragang Island was undertaken by Hamer and Mahony (2007), Hamer *et al.* (2008) and Hamer and Mahony (2010). 'Mark-capture' techniques were undertaken at 32 waterbodies on Kooragang Island to investigate the population age structure, as well as growth and survival rates of individuals (Hamer and Mahony, 2007). These data have also been used to investigate the species' movement and habitat use of the Green and Golden Bell Frog (Hamer *et al.*, 2008) and to model site-occupancy and population turnover (Hamer and Mahony, 2010).

³ The requirement to relocate Green and Golden Bell Frogs from disturbance areas is described in the Green and Golden Bell Frog Management Plan (NCIG, 2007).



5.2.4 Other Compensatory Habitat Programs on Kooragang Island

It is noted that BHP Billiton are also undertaking Green and Golden Bell Frog compensatory habitat on Kooragang Island. The location of BHP Billiton's proposed compensatory habitat is shown on Figure 9.

5.3 CONSULTATION RELATING TO THE COMPENSATORY HABITAT PROGRAM

NCIG has undertaken consultation with various stakeholders regarding the compensatory Green and Golden Bell Frog habitat program since 2008:

- In July 2008, a workshop was held between the two qualified ecologists (Professor David Goldney [Cenwest Environmental Services] and Dr Arthur White [Biosphere Environmental Consultants Pty Ltd]) and the NCIG Environmental Representative (Nathan Juchau) (approved by the Director-General [Attachment 5]). The workshop involved inspections of successful Green and Golden Bell Frog compensatory habitat areas designed by Dr Arthur White in Woonona and Homebush, NSW, and an inspection of potential Green and Golden Bell Frog compensatory habitat areas for the NCIG CET.
- In July 2008, following the workshop, a meeting was held with the workshop participants and representatives of the KWRP, to discuss the suitability of the proposed Green and Golden Bell Frog compensatory habitat areas and design principles relevant to the compensatory habitat works.
- On 22 August 2008, the NSW Department of Environment, Climate Change and Water (DECCW) (now OEH) presented their compensatory habitat framework to NCIG and BHP Billiton. DECCW (now OEH) later formalised the compensatory habitat framework through provision of their threatened species offset framework on 29 September 2008. Following receipt of DECCW's (now OEH) threatened species offset framework, the Director-General approved the deferral of compensatory habitat commencement until no later than 1 March 2009.
- December 2010 – Meeting with NPWS Local Manager to define land on Ash Island available for compensatory works.
- January 2011 – On-site assessment with NPWS of opportunities and constraints of available Ash Island land.
- July 2011 – Consultative Board meeting.
- November 2011 – Consultative Board meeting.
- March 2012 – Forum conducted involving NCIG, NPWS and University of Newcastle and approved ecologist to define Research Area pond design and overall habitat layout.
- May 2012 – Consultative Board meeting.
- September 2012 – Forum involving NCIG, DP&E, NPWS, OEH, NSW Environment Protection Authority, BHP Billiton, NPC and Port Waratah Coal Services (PWCS). OEH provided a figure showing land available on Kooragang/Ash Island for compensatory habitat (OEH, 2012).
- December 2012 – Consultative Board meeting.
- February 2013 – land was allocated by NPWS for the NCIG compensatory habitat works.

5.4 DESCRIPTION OF THE GREEN AND GOLDEN BELL FROG COMPENSATORY HABITAT

5.4.1 Objective

The objective of the compensatory habitat is to establish habitat that has all essential habitat elements (as described in Section 5.2.2) that are required to support a viable breeding population of the Green and Golden Bell Frog. Project Approval (06_0009) defines a viable breeding population (in relation to *Litoria aurea*) as success in the establishment of both a breeding population and a viable population. A breeding population (in relation to *Litoria aurea*) is evidence that natural breeding events occur in two seasons (September to March) and include the presence of eggs, tadpoles and/or metamorphs that were not released from captive breeding stock in at least one pond. A viable population (in relation to *Litoria aurea*) is defined as evidence of at least five reproductively mature individuals within the new aquatic and/or terrestrial habitat in each of the two seasons when breeding events occurred.

5.4.2 Location

The location of the Green and Golden Bell Frog compensatory habitat is shown on Figure 9. The most substantial component of Green and Golden Bell Frog compensatory habitat will be located on Ash Island, within the Hunter Wetlands National Park. The other compensatory habitat (which was completed in 2009 – Section 5.5) is located either end of the underpasses at the NCIG CET (Figure 9).

The location of the Green and Golden Bell Frog compensatory habitat was chosen based on land made available by NPWS, who are the landholders of much of Ash Island. The *Statement of Interim Management Intent (revised 2011) for Ash Island (Hunter Wetlands National Park)* (OEH, 2011b) and Memorandum of Understanding between NPC and NPWS recognises the commitments for provision of sites for NCIG's habitat offset projects. In February 2013, NPWS allocated land for the NCIG Green and Golden Bell Frog compensatory habitat works as shown on Figure 9.

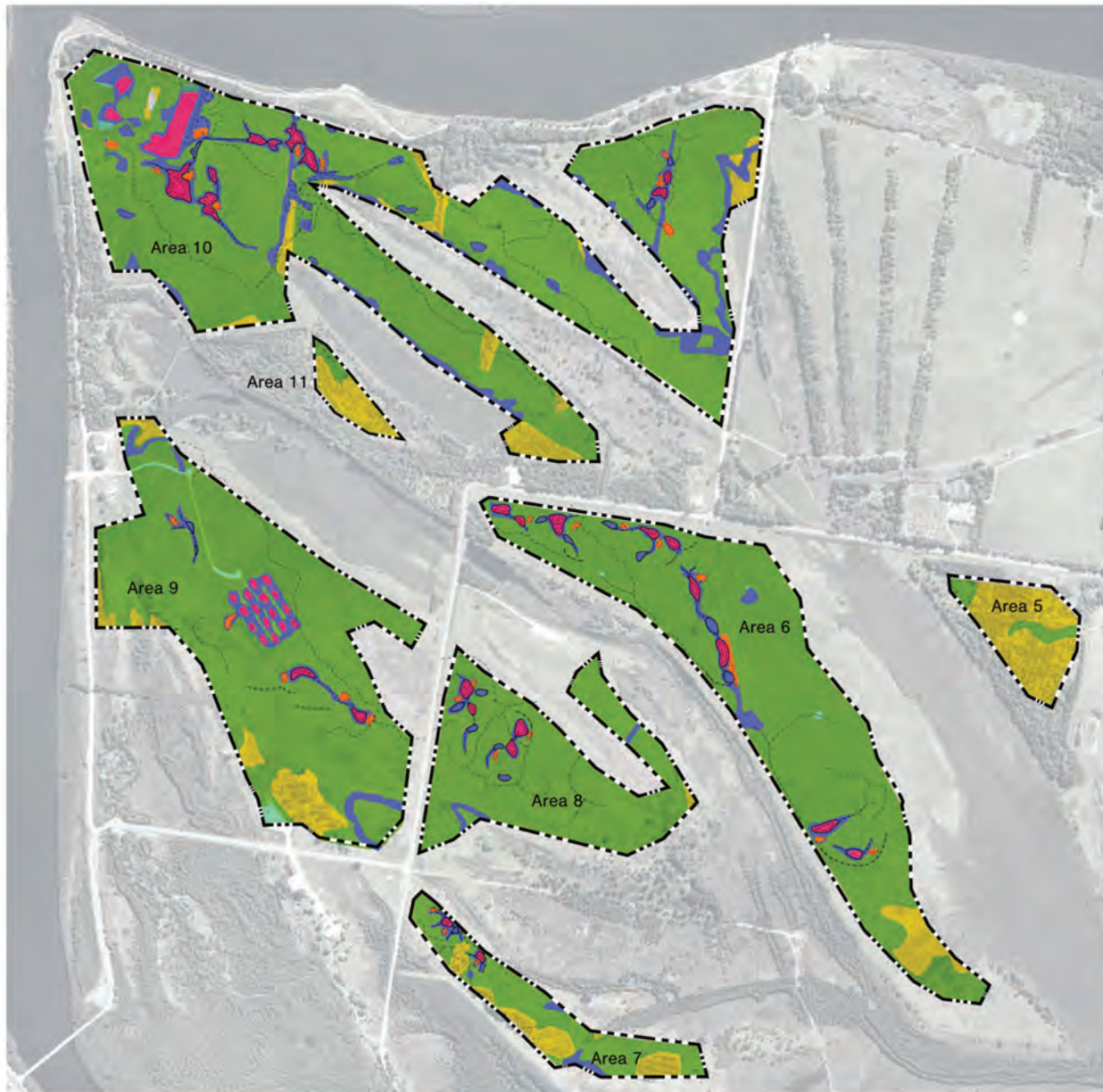
5.4.3 Quantification (Size)

Condition 2.20(b)(i) of Project Approval (06_0009) quantifies the area of Green and Golden Bell Frog compensatory habitat that NCIG is required to establish (i.e. 75 ha). This amount of compensatory habitat may be reduced if NCIG can determine, using scientific methodology agreed to by the DP&E, in consultation with OEH that the population of Green and Golden Bell Frog impacted by the NCIG CET is less than 37.5 ha. The reduced amount shall be agreed to by the DP&E, in consultation with the OEH, by 30 June 2015.

The delivery of the habitat elements illustrated by Figure 11 represents the implementation of NCIG's 75 ha compensatory habitat obligation. The extent of compensatory habitat shown on Figure 11 (including the research area ponds) covers an area of 78 ha in total (i.e. 3 ha more than the 75 ha required to be established in accordance with Condition 2.20[b][i] of Project Approval [06_0009]).

5.4.4 Compensatory Habitat Principles and Design

Terras Landscape Architects were commissioned by NCIG to undertake a conceptual design of the Green and Golden Bell Frog compensatory habitat, in consultation with Dr Arthur White (Biosphere Environmental Consultants Pty Ltd). An analysis of the topography and surface water movement (Figure 12), vegetation mapping by FloraSearch (Figure 13) and Green and Golden Bell Frog habitat requirements (Table 5) identified opportunities and constraints for the Green and Golden Bell Frog compensatory habitat within the existing landscape on Ash Island. The resulting designs are shown on Figures 11 to 30. The design has the primary focus of supporting a sustaining Green and Golden Bell Frog population.



Legend

- Breeding Habitat
- Shelter Habitat
- Over-Winter Habitat
- Foraging Habitat
- Potential Movement Area
- Combined Foraging Habitat and Potential Movement Area
- Green and Golden Bell Frog Compensatory Habitat

Note:
Area numbers shown on this drawing align with those nominated on the NFWS Land Allocation Plan.



FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

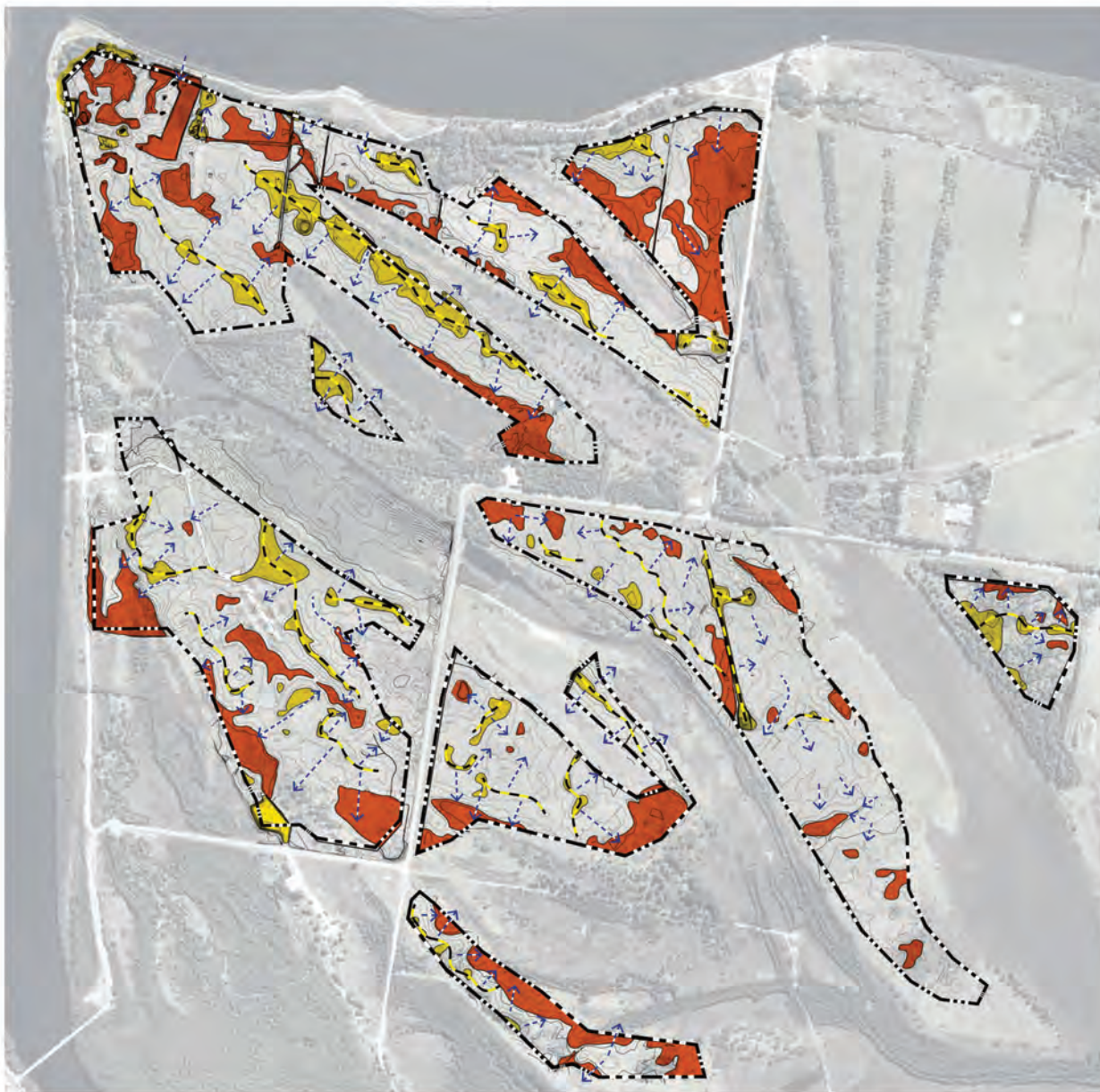


Terras Landscape Architects
Drawing Ref: 9793.5 - 08






scale	1:7,500
drawn	TA
checked	SR
REVIEW	

**COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM**
FIGURE 11
Proposed Green and Golden Bell Frog Habitat

date	10-05-2013	
drawing	HW03-05-C-22907	rev
		1



Legend

-  High point relative to surrounding terrain
 - dry areas
 - vantage point over surrounding terrain
 - refuge from floods
-  Low point relative to surrounding terrain
 - water collection areas for surface runoff
-  Ridgelines
-  Surface water flow direction
-  Green and Golden Bell Frog habitat



FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

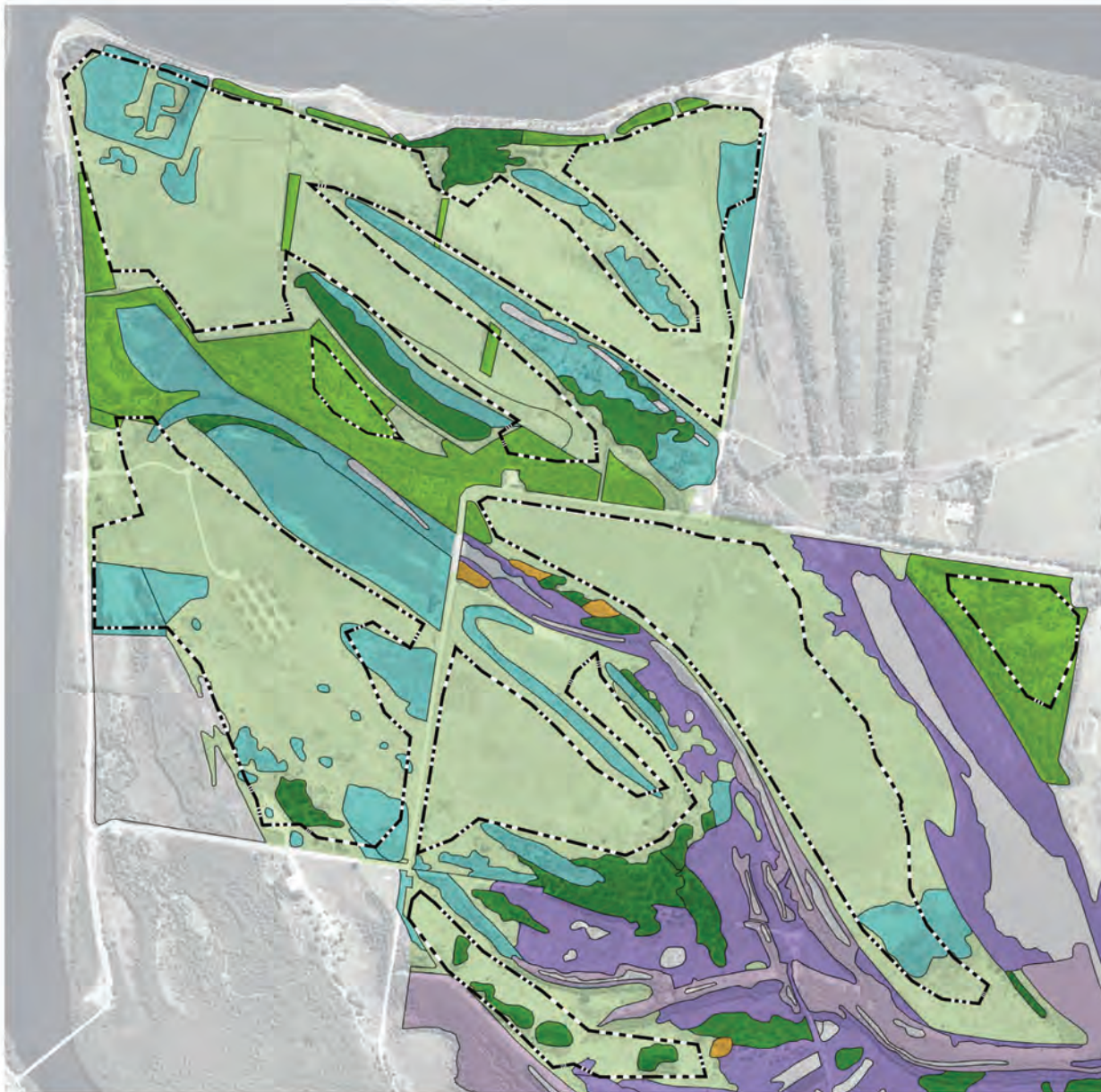


Terras Landscape Architects
Drawing Ref: 9793.5 - 01

scale	1:7,500
drawn	TA
checked	SR
REVIEW	

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 12
Topographical Analysis

date	10-05-2013	rev	
drawing	HW03-05-C-22924	rev	1



Legend

- Freshwater Wetlands on Coastal Floodplain
 - bird and predator habitat
 - competitive frog species
 - fresh water availability
- Swamp Oak Floodplain Forest
 - trees
 - predator vantage point
- Melaleuca Thicket
- Plantings and Forested area
 - trees
 - predator vantage point
- Exotic Rank Grassland
 - high value foraging area with insect activity
 - open areas with vulnerability to predation
- Coastal Saltmarsh
 - high salinity
 - low foraging value
 - possible barrier to Bell Frog movement
- Green and Golden Bell Frog habitat



rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 02

scale	1:7,500
drawn	TA
checked	SR
	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 13
Vegetation Analysis

FINAL ISSUE		
date	10-05-2013	
drawing	HW03-05-C-22925	rev
		1

Table 5
Reconciliation of the Compensatory Habitat Program
Against the Principles for Creating Habitat for the Green and Golden Bell Frog

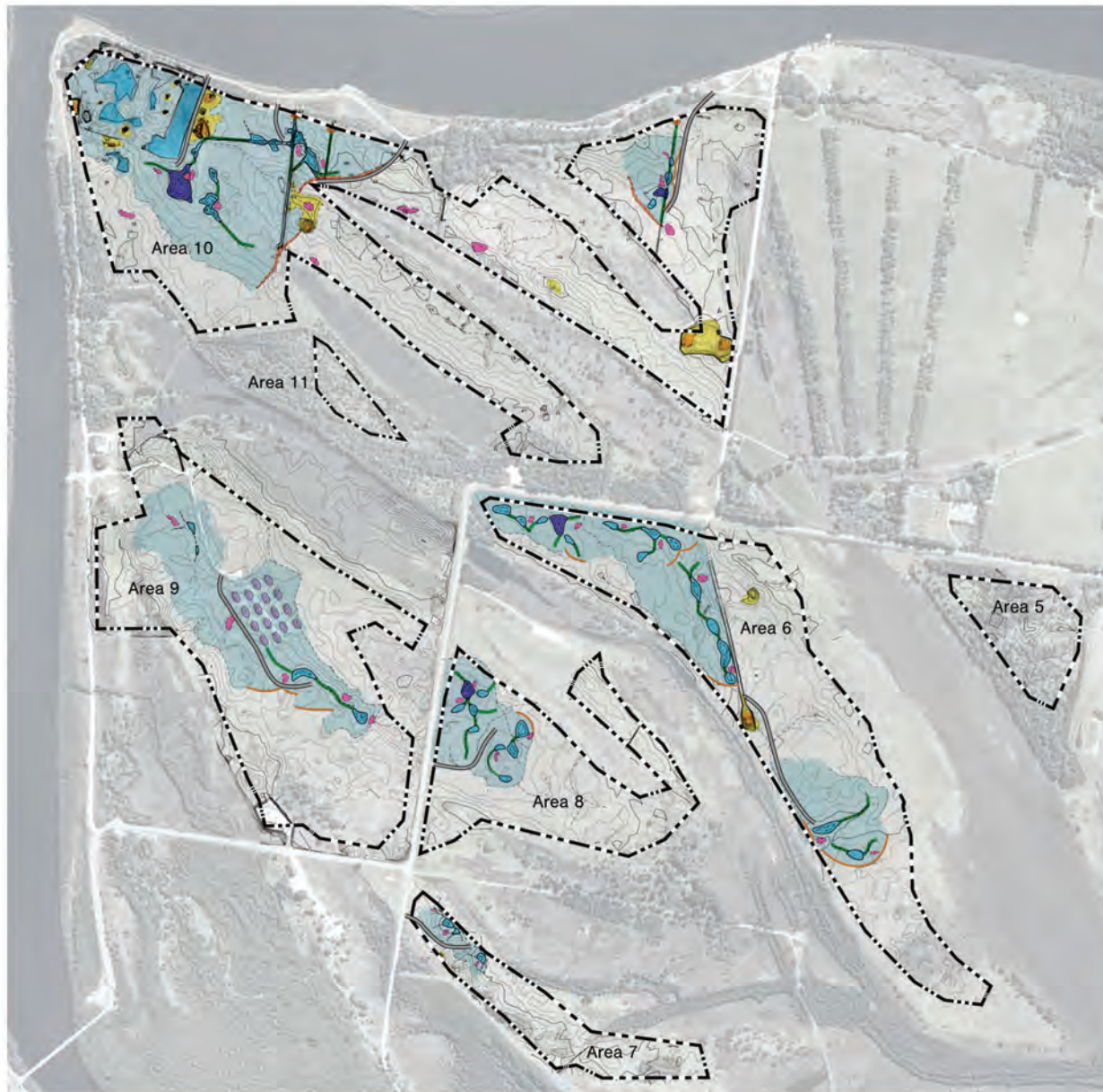
Principles (White, pers. comm., 2008 in NCIG, 2010)	Application of the Principles
Green and Golden Bell Frog habitat areas should be developed around areas of existing habitat (existing habitat areas should not be adversely affected by the presence of the new habitat areas).	The compensatory habitat aims to provide additional habitat for Green and Golden Bell Frogs on Ash Island by converting disturbed areas containing exotic vegetation (i.e. pasture) to more useful habitat for the Green and Golden Bell Frog and managing areas of surrounding potential habitat.
Green and Golden Bell Frog habitat areas should provide the four main habitat requirements, namely: <ul style="list-style-type: none"> • breeding habitat; • shelter habitat; • foraging habitat; and • overwintering habitat. 	The compensatory habitat program will provide breeding, sheltering, foraging and overwintering habitat for the Green and Golden Bell Frog (Figure 11). Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) undertook an investigation into the presence of Green and Golden Bell Frog habitat and its relative importance on Ash Island (Attachment 3). Habitat types and key features are defined in Attachment 3 and Table 3.
The quantity of each habitat type that is to be created should be determined to best compliment the availability and location of these habitat types already present at Kooragang Island and Ash Island.	The compensatory habitat (e.g. construction of waterbodies) will compliment habitat types already present on Ash Island (e.g. foraging, movement and overwintering habitat).
Green and Golden Bell Frog movement corridors should be established to link outlying habitat areas.	Green and Golden Bell Frog movement habitat is mapped on Figure 11. The ponds will be positioned to maximise the capture of surface water and be generally elongated to mimic existing waterbodies (Figure 14).
Green and Golden Bell Frog habitat areas should not be created in sites that may adversely affect other threatened or rare species (e.g. Grass Owls) on Kooragang Island and Ash Island.	No other species will be significantly impacted by converting disturbed areas containing exotic vegetation (i.e. pasture). Some other wetland species will also benefit from the habitat creation works. No Grass Owls have been recorded in the area.
Where possible, compensatory habitat should be developed on sites that are not currently used or less important to other native species. For example, Ash Island contains areas of exotic pasture or weed dominated areas that could be converted to useful Green and Golden Bell Frog habitat.	The objective of the compensatory habitat is to provide additional habitat for Green and Golden Bell Frogs on Ash Island by converting disturbed areas containing exotic vegetation (i.e. pasture) to more useful habitat for the Green and Golden Bell Frog and managing areas of surrounding potential habitat.

General Design of the Green and Golden Bell Frog Compensatory Habitat











The Green and Golden Bell Frog compensatory habitat is shown in Figures 11 to 30. Perennial and ephemeral ponds will be constructed. Both types of ponds will be designed such that:

- A variety of ponds will be constructed with differing shapes and sizes.
- Perennial ponds will be excavated (approximately 2 m deep).
- Perennial ponds may be clay-lined to isolate the pond water from the more saline groundwater depending on the results of further investigations⁴.
- Ephemeral ponds will be excavated to approximately 0.4 to 1.5 m deep.

⁴ A Review of Environmental Factors was submitted to NPWS in April 2013 for a soil, surface water and groundwater investigation program within the Green and Golden Bell Frog compensatory habitat area.



Legend

-  Green and Golden Bell Frog research area enclosure
-  Proposed ephemeral ponds for Green and Golden Bell Frog habitat
-  Proposed permanent, deep ponds for Green and Golden Bell Frog habitat
-  Shallow waterways and depressions to serve as seasonal habitat areas and connections between ponds
-  Refuge and wintering areas containing rocks, logs and fringe vegetation
-  Water catchment area for ponds
-  Constructed berms to create pond basin and catchment
-  Existing high points to serve as refuge areas in flooding conditions
-  Proposed vehicular track alignment
-  Green and Golden Bell Frog Compensatory Habitat

Note:
Area numbers shown on this drawing align with those nominated on the NFWs Land Allocation Plan.



rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 06

scale	1:7,500
drawn	TA
checked	SR
REVIEW	

**COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM**
FIGURE 14
Conceptual Green and Golden Bell Frog
Compensatory Habitat Design

FINAL ISSUE

date	10-05-2013	
drawing	HW03-05-C-22905	rev 1

The illustrations on this page begin to describe how the different pond types may be constructed. The shallow ponds and swales will be carved out of the ground and lined partially with rocks and plants. The deep ponds will also be lined with clay in order to hold fresh water for longer periods.

The following pages provide detail designs of the pond and habitat in each area of the Green and Golden Bell Frog habitat area.

Ephemeral water bodies

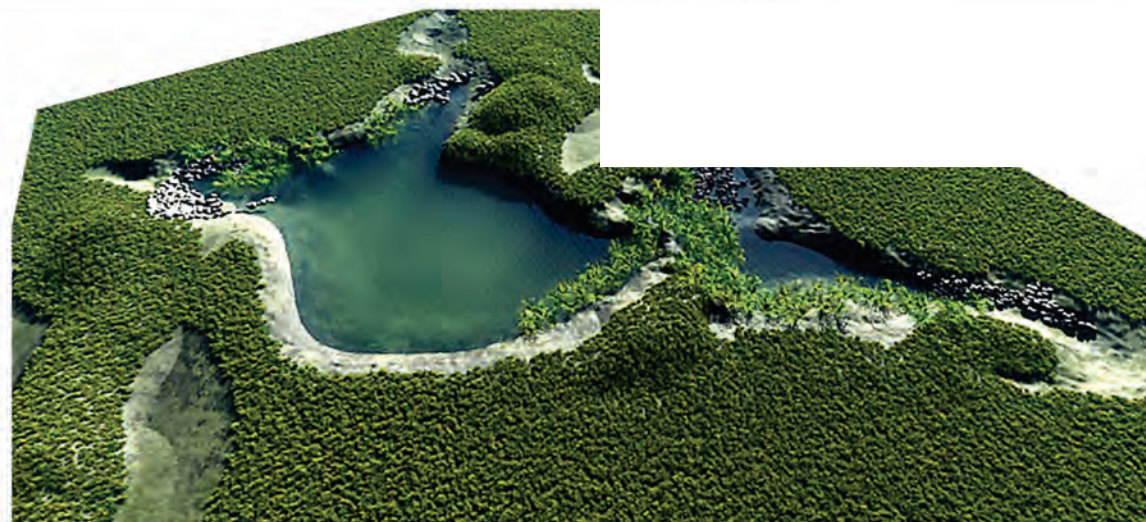
Raised areas to channel water to swales.
These areas may also provide shelter and over-winter habitat

Large pond with open water area

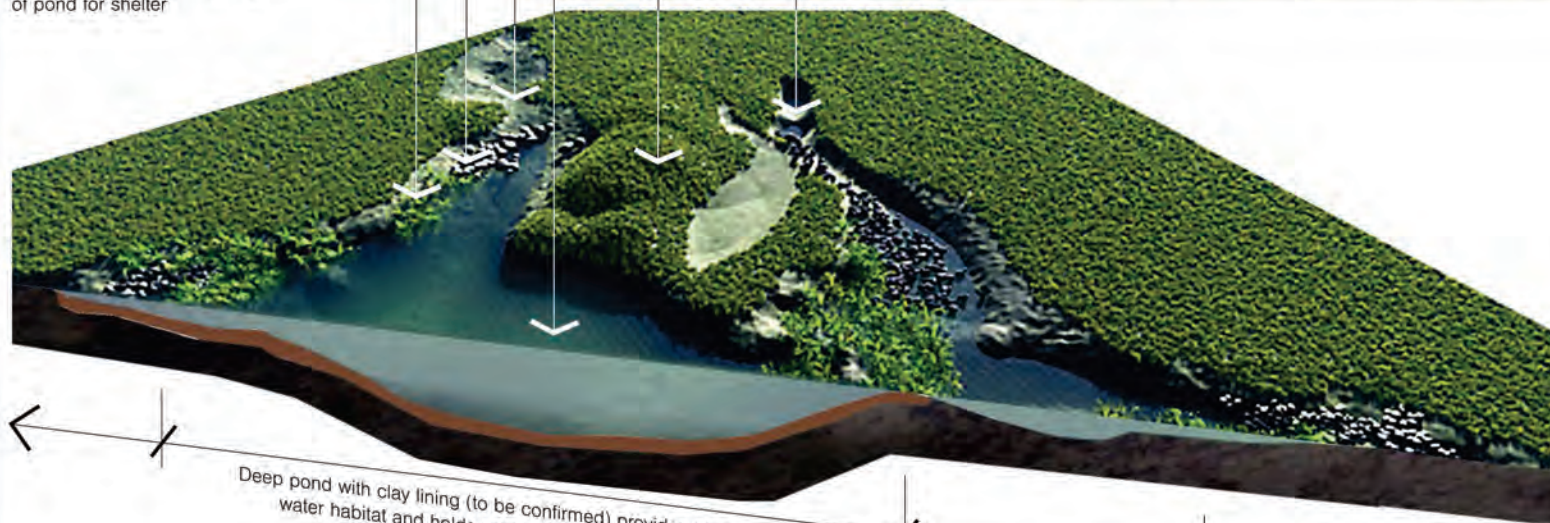
Swale depression to channel water to larger pond

Rock edges to provide shelter

Emergent planting along edge of pond for shelter



Artist's rendering of a typical pond



Deep pond with clay lining (to be confirmed) provides open water habitat and holds water through dry season

Shallow ponds with seasonal water provides varied habitat throughout the year

Swale areas collect runoff and remain moist to provide shelter and movement corridors

Cross Section of a typical pond

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final Issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

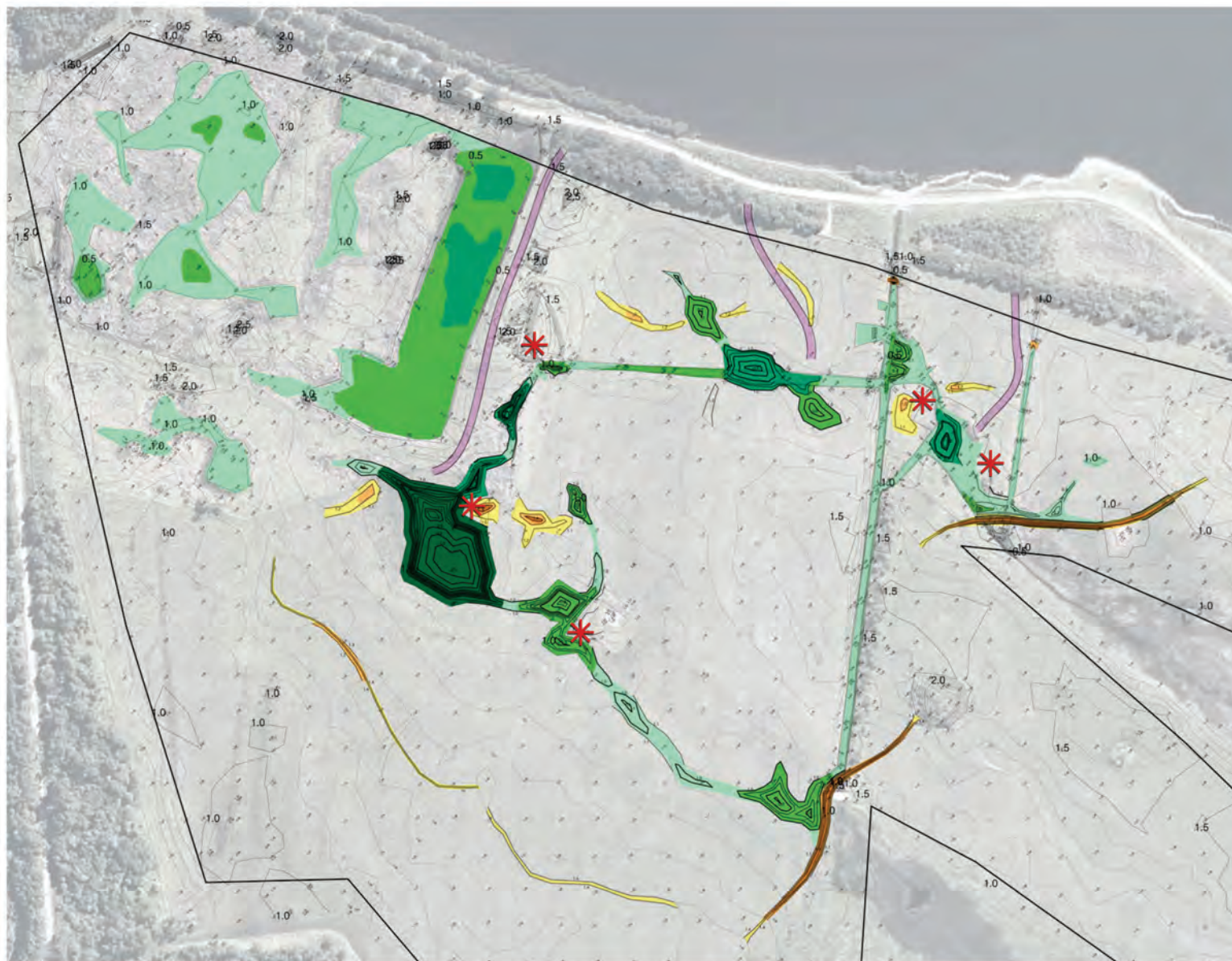


Terras Landscape Architects
Drawing Ref: 9793.5 - 09

drawn	SR
checked	SR
scale	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 15
Typical Pond Design

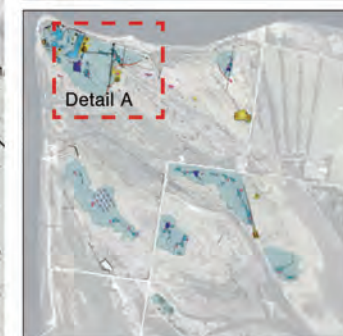
date	10-05-2013	rev	1
drawing	HW03-05-C-22908		



Legend

- Deep Pond (2m deep)**
 - clay lined (to be confirmed)
 - planting around edge
 - rock along 40% of edge
- Shallow Pond (1 - 1.5m deep)**
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)**
 - planting around 50% of edge
 - rock along 20% of edge
- Swale**
- Low mound / bund (up to 0.1m)**
soil from pond excavation
- Medium mounding (0.1 - 0.3m)**
soil from pond excavation
- Berm (up to 1m)**
soil from pond excavation
- Vehicular access track (3m wide)**
- Refuge Area**

Key Plan



Pond Detail A

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 10

scale	1:1750
drawn	TA
checked	SR
REVIEW	

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 16
Habitat Design (Detail A)

date	10-05-2013	rev	
drawing	HW03-05-C-22909	rev	1



FINAL ISSUE

rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 11

scale	
drawn	
checked	SR
	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 17
Artist's Impression (Detail A)

date	10-05-2013	
drawing	HW03-05-C-22910	rev 0



FINAL ISSUE

rev	description	day	mo	yr
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

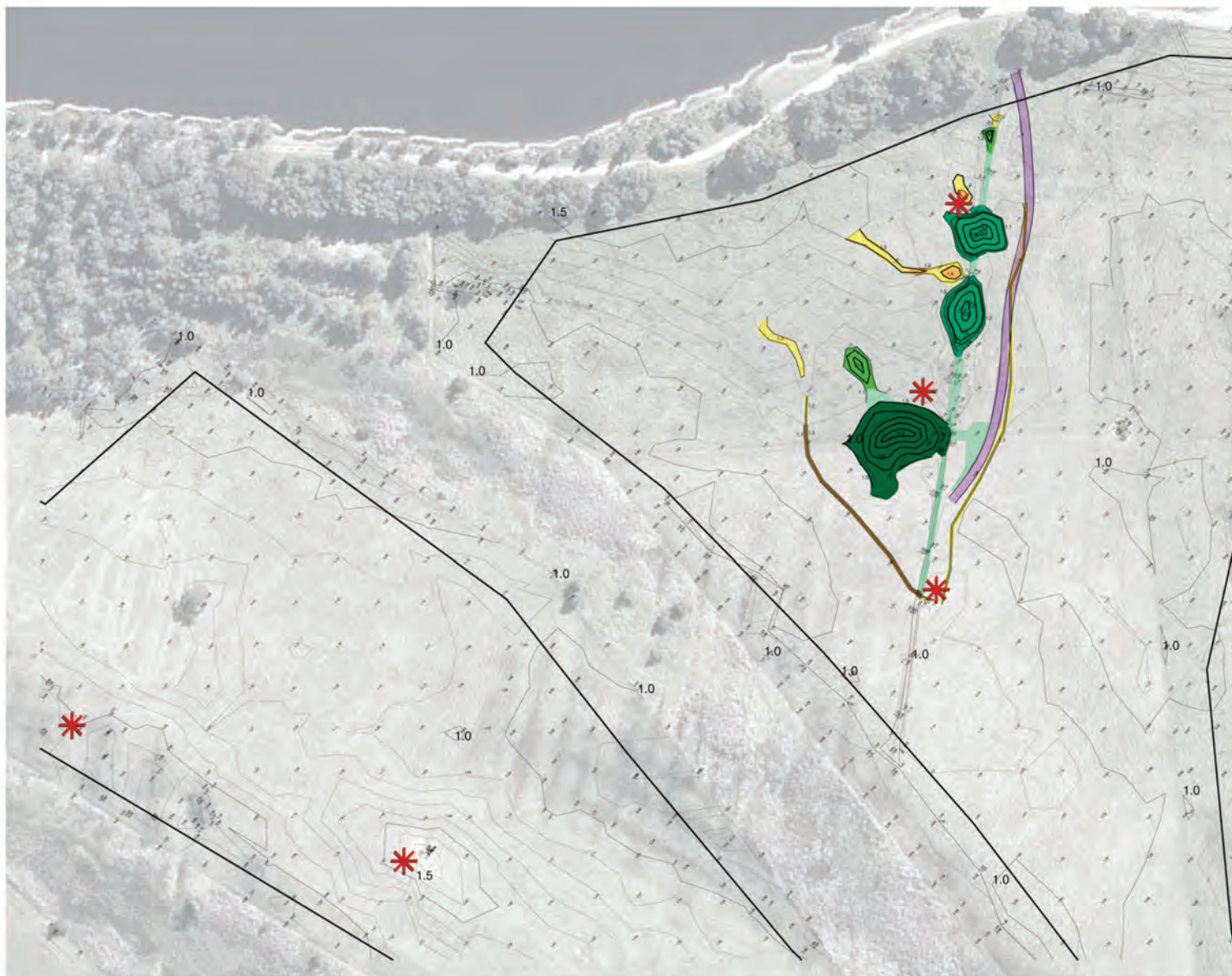


Terras Landscape Architects
Drawing Ref: 9793.5 - 12

scale	
drawn	
checked	SR
REVIEW	

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 18
Artist's Impression (Detail A Enlargement)

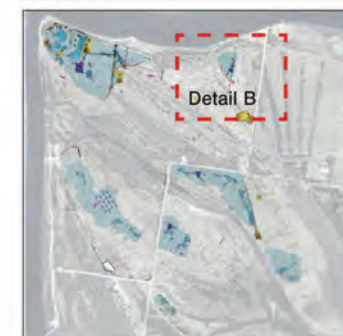
date	10-05-2013	
drawing	HW03-05-C-22911	rev
		0



Legend

- Deep Pond (2m deep)
 - clay lined (to be confirmed)
 - planting around edge
 - rock along 40% of edge
- Shallow Pond (1 - 1.5m deep)
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)
 - planting around 50% of edge
 - rock along 20% of edge
- Swale
- Low mound / bund (up to 0.1m) soil from pond excavation
- Medium mounding (0.1 - 0.3m) soil from pond excavation
- Berm (up to 1m) soil from pond excavation
- Vehicular access track (3m wide)
- ✱ Refuge area

Key Plan



Pond Detail B

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 13

scale	1:1500
drawn	TA
checked	SR
	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 19
Habitat Design (Detail B)

date	10-05-2013	
drawing	HW03-05-C-22912	rev 1



NCE-07-02 CHEMP R03_020A

rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

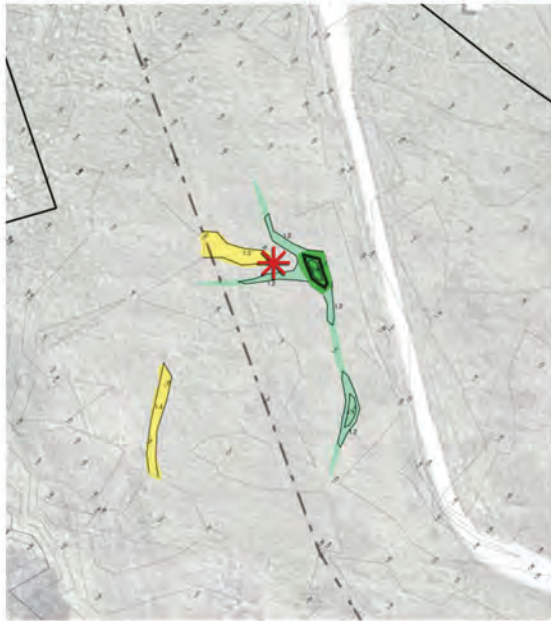


Terras Landscape Architects
Drawing Ref: 9793.5 - 14

scale	
drawn	
checked SR	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 20
Artist's Impression (Detail B)

FINAL ISSUE		
date	10-05-2013	
drawing	HW03-05-C-22913	rev 0



Pond Detail C

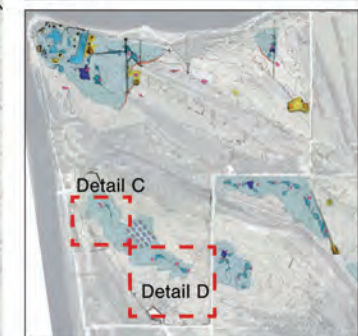


Pond Detail D

Legend

- Deep Pond (2m deep)
 - clay lined (to be confirmed)
 - planting around edge
 - rock along 40% of edge
- Shallow Pond (1 - 1.5m deep)
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)
 - planting around 50% of edge
 - rock along 20% of edge
- Swale
- Low mound / bund (up to 0.1m) soil from pond excavation
- Medium mounding (0.1 - 0.3m) soil from pond excavation
- Berm (up to 1m) soil from pond excavation
- Vehicular access track (3m wide)
- * Refuge area
- - - Jemena gas main alignment

Key Plan



FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 15

scale	1:1500
drawn	TA
checked	SR
REVIEW	

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 21
Habitat Design (Detail C and D)

date	10-05-2013	
drawing	HW03-05-C-22914	rev
		1



NCE-07-02 CHEMP R03_002A

rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

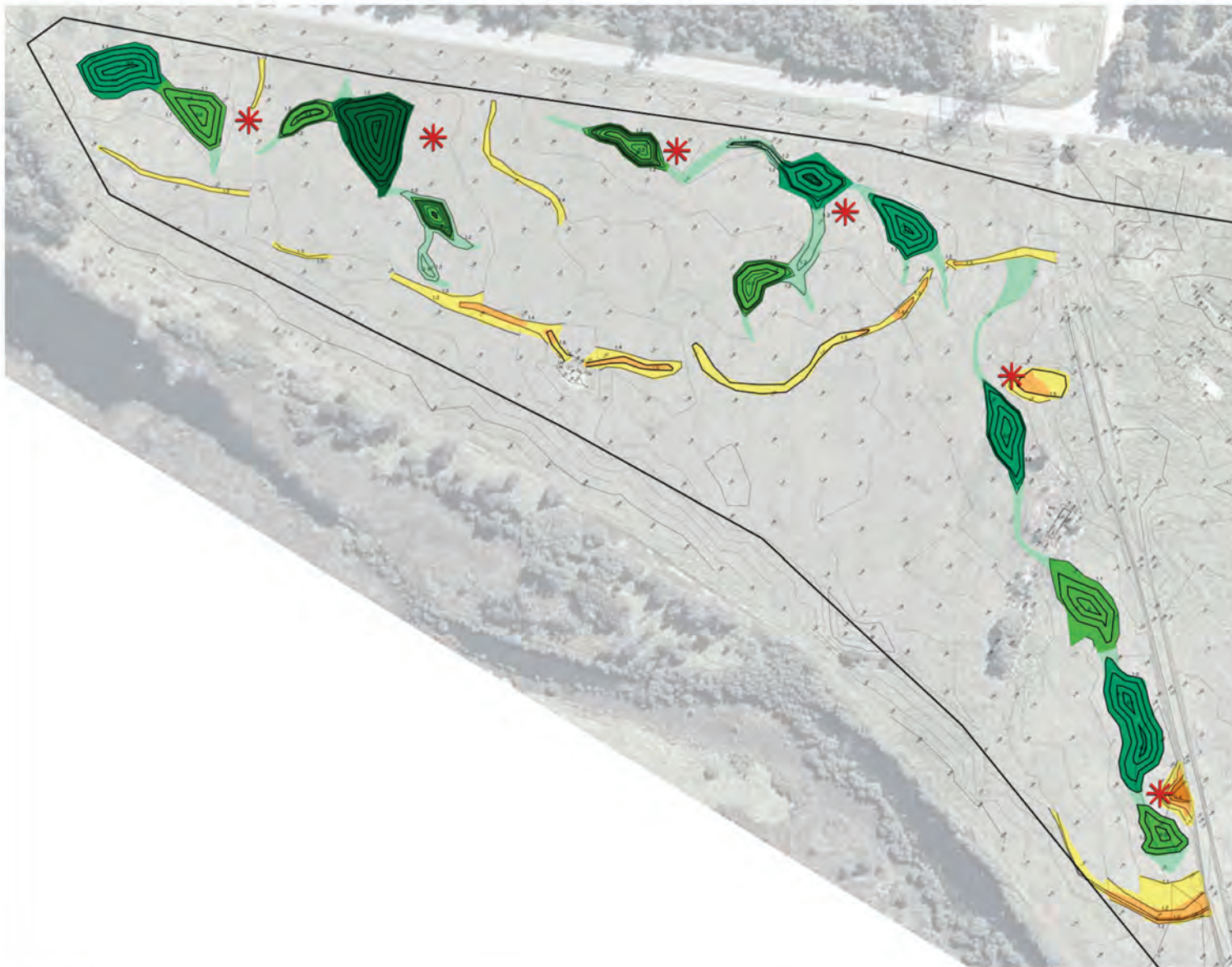


Terras Landscape Architects
Drawing Ref: 9793.5 - 16

scale	
drawn	
checked SR	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 22
Artist's Impression (Detail C and D)

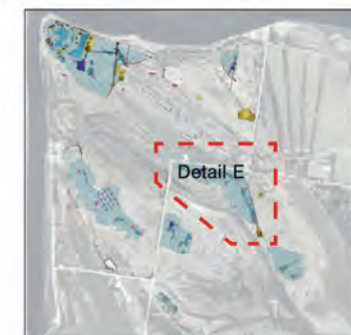
FINAL ISSUE		
date	10-05-2013	
drawing	HW03-05-C-22915	rev 0



Legend

- Deep Pond (2m deep)
 - clay lined (to be confirmed)
 - planting around edge
 - rock along 40% of edge
- Shallow Pond (1 - 1.5m deep)
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)
 - planting around 50% of edge
 - rock along 20% of edge
- Swale
- Low mound / bund (up to 0.1m) soil from pond excavation
- Medium mounding (0.1 - 0.3m) soil from pond excavation
- Berm (up to 1m) soil from pond excavation
- Vehicular access track (3m wide)
- * Refuge area

Key Plan



Pond Detail E

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 17

scale	1:1500
drawn	TA
checked	SR
	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 23
Habitat Design (Detail E)

date	10-05-2013	
drawing	HW03-05-C-22916	rev
		1



rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

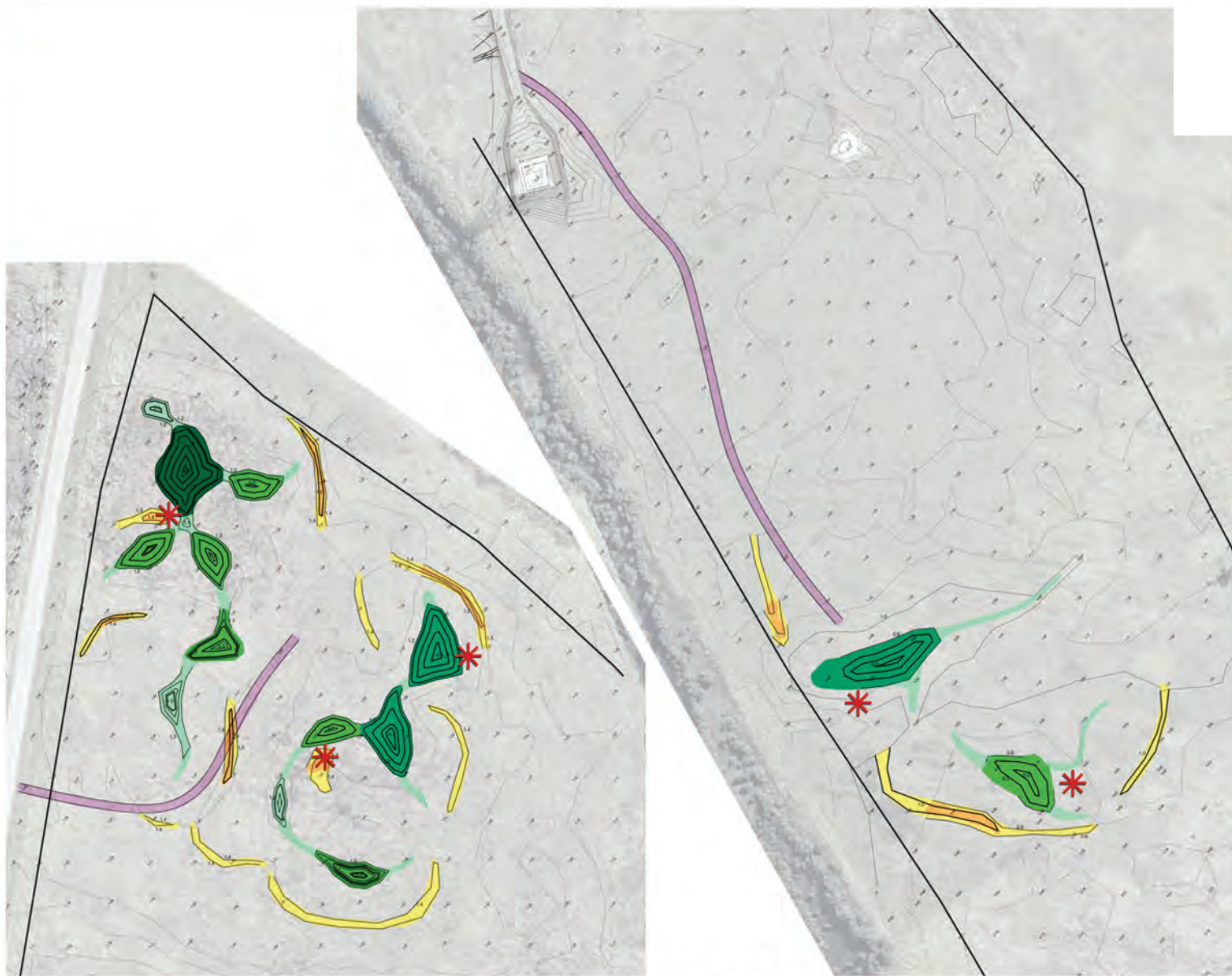


Terras Landscape Architects
Drawing Ref: 9793.5 - 18

scale	
drawn	
checked	
SR	REVIEW

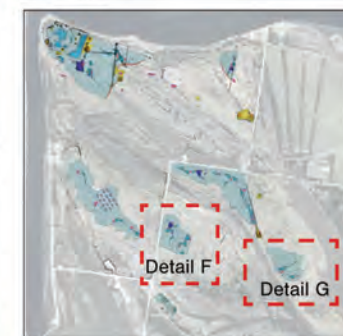
COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 24
Artist's Impression (Detail E)

FINAL ISSUE		
date	10-05-2013	
drawing	HW03-05-C-22917	rev 0



- Shallow Pond (1 - 1.5m deep)
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)
 - planting around 50% of edge
 - rock along 20% of edge
- Swale
- Low mound / bund (up to 0.1m) soil from pond excavation
- Medium mounding (0.1 - 0.3m) soil from pond excavation
- Berm (up to 1m) soil from pond excavation
- Vehicular access track (3m wide)
- * Refuge area

Key Plan



Pond Detail F

Pond Detail G

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 19

scale	1:1500
drawn	TA
checked	SR
	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 25
Habitat Design (Detail F and G)

date	10-05-2013	rev	
drawing	HW03-05-C-22918		1



NCE-07-02 CHEMP R03_0264

rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

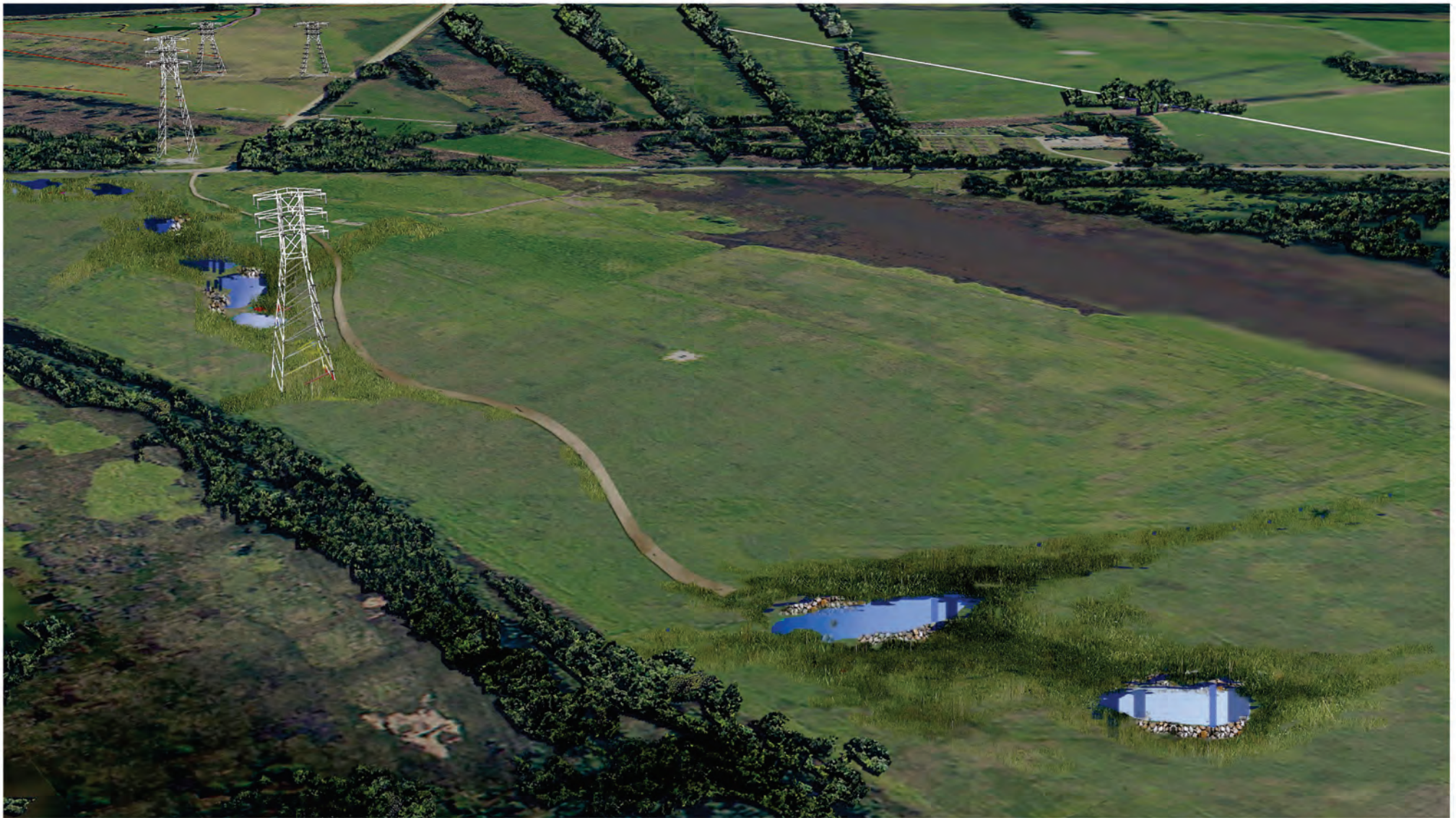


Terras Landscape Architects
Drawing Ref: 9793.5 - 20

scale	
drawn	
checked	SR
REVIEW	

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 26
Artist's Impression (Detail F)

FINAL ISSUE	
date	10-05-2013
drawing	HW03-05-C-22919
rev	0



NCEG-07-02 CHEMP R03_027A

rev	description	day	mo.	yr.
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13

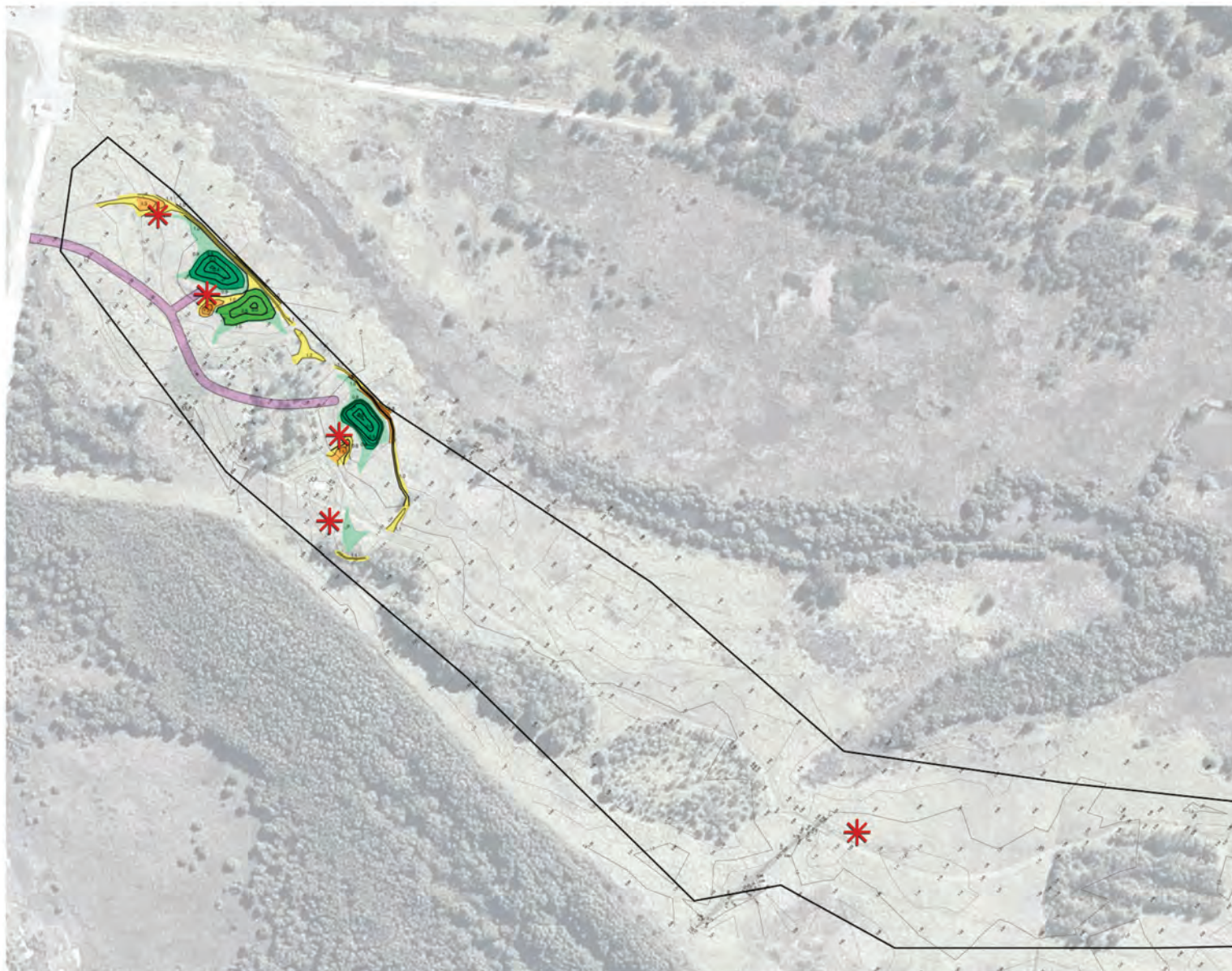


Terras Landscape Architects
Drawing Ref: 9793.5 - 21

scale	
drawn	
checked SR	REVIEW

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM
FIGURE 27 Artist's Impression (Detail G)

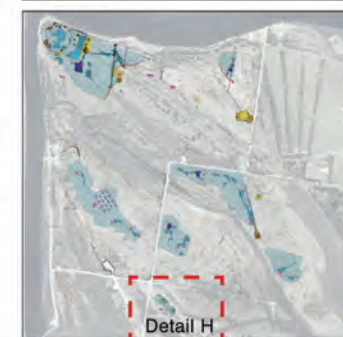
FINAL ISSUE	
date	10-05-2013
drawing	HW03-05-C-22920
rev	0



Legend

- Deep Pond (2m deep)**
 - clay lined (to be confirmed)
 - planting around edge
 - rock along 40% of edge
- Shallow Pond (1 - 1.5m deep)**
 - planting around edge
 - rock along 50% of edge
- Shallow Pond (0.4 - 0.8m deep)**
 - planting around 50% of edge
 - rock along 20% of edge
- Swale**
- Low mound / bund (up to 0.1m)**
soil from pond excavation
- Medium mounding (0.1 - 0.3m)**
soil from pond excavation
- Berm (up to 1m)**
soil from pond excavation
- Vehicular access track (3m wide)**
- * Refuge area**

Key Plan



Pond Detail H

FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



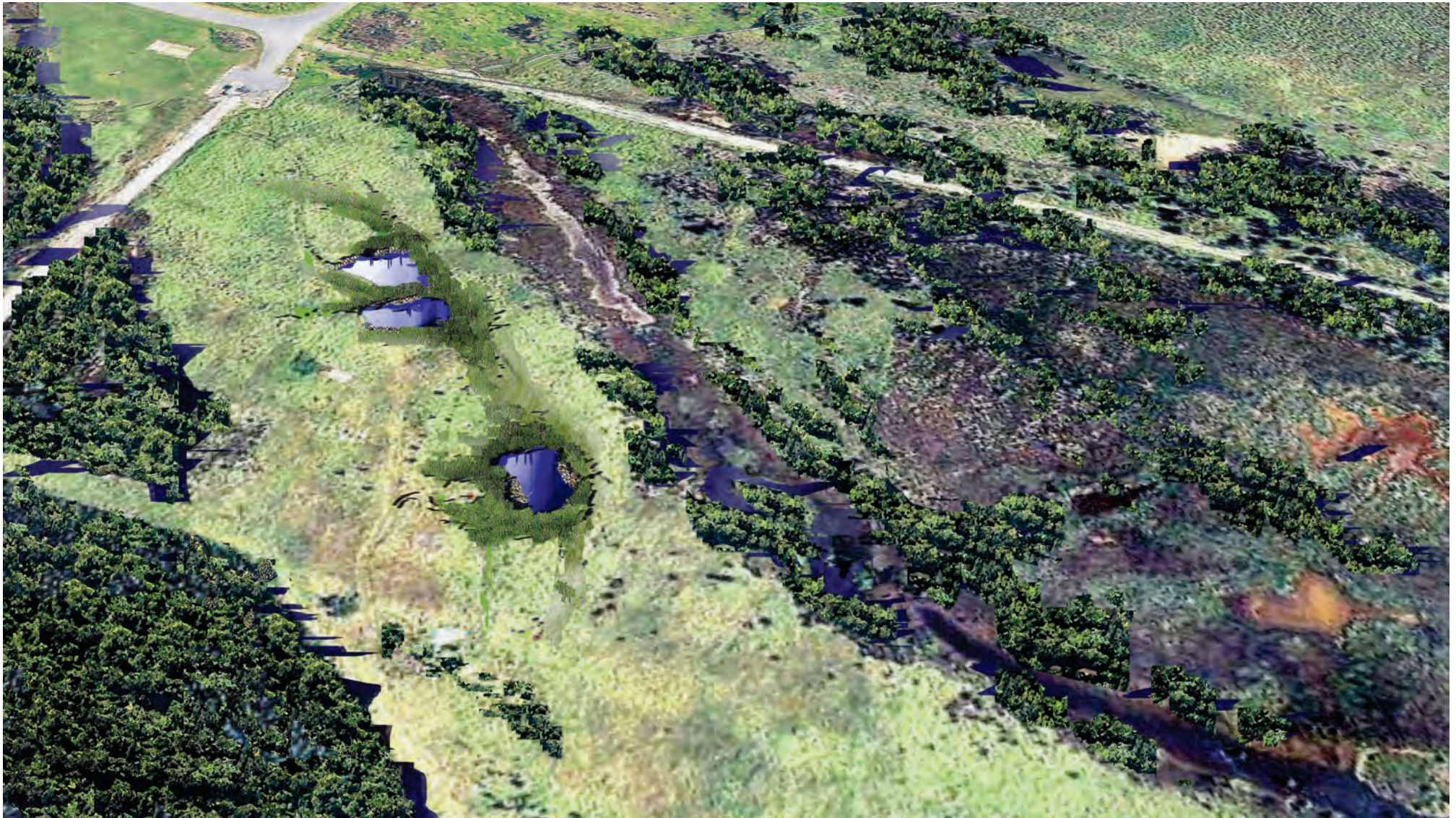
Terras Landscape Architects
Drawing Ref: 9793.5 - 22

drawn
TA
checked
SR
scale
1:1500
REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 28
Habitat Design (Detail H)

date	10-05-2013	rev	1
drawing	HW03-05-C-22921		



NCE-07-02 CHEMP R03_029A

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final Issue	10	05	13
C	Issued for internal review	08	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 23

drawn	checked	scale
SR	SR	REVIEW

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM	
FIGURE 29 Artist's Impression (Detail H)	

FINAL ISSUE	
date	10-05-2013
drawing	HW03-05-C-22922
page	1



FINAL ISSUE

rev	description	day	mo.	yr.
1	Client requested updates	03	06	13
0	Final issue	10	05	13
C	Issued for internal review	09	05	13
B	Issued for internal review	08	05	13
A	Draft	18	04	13



Terras Landscape Architects
Drawing Ref: 9793.5 - 24

scale	
drawn	
checked	
SR	REVIEW

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM
FIGURE 30
Artist's Impression Overall Habitat Area

date	10-05-2013	
drawing	HW03-05-C-22923	rev
		1

- The ponds will be a minimum of approximately 20 m x 10 m in size, but the size of the ponds will be maximised depending on water availability.
- The ponds will have open water areas (free from emergent vegetation).
- The ponds will be positioned to maximise the capture of surface water and be generally elongated to mimic existing waterbodies.
- The slopes of the pond walls will generally be a gradient of approximately 3.5:1 for stability.
- Rock lined walls will be constructed along a length of each pond to enable access, exclude dense fringing vegetation, provide a basking area and maintain an area of open water.
- Boulders, rocks and logs will be placed around the margins of the ponds and pond banks to provide increased basking and shelter habitat for the frogs.
- Plants such as *Carex* spp., *Juncus usitatus*, *Schoenoplectus* spp. and *Bolboschoenus* spp. may be planted around the margins of the ponds to create strategic diurnal shelter and foraging areas.
- Plants such as Water Ribbons (*Triglochin procera*) may be planted to provide submerged aquatic vegetation.

Design of Features Surrounding the Ponds

Features surrounding the ponds will include access tracks, swales/bunds, drains, rock piles and treed wind breaks. Details of these are as follows:

- Access tracks will be constructed to each pond for maintenance and monitoring purposes.
- The length of access tracks will generally be minimised but may be positioned to maximise the capture of surface water to ponds.
- Earth excavated from the ponds will be used as swales/bunds to maximise the capture of surface water and for access road construction.
- Swales/bunds will be vegetated with low, ground covers (e.g. plants that form tussocks).
- Drains may be excavated and lined with rocks to maximise the capture of surface water to ponds, and to provide ephemeral habitat for Green and Golden Bell Frogs.
- Refuge/wintering area (rock piles approximately 3 m x 3 m) will be distributed across the compensatory habitat areas.
- Treed wind breaks (e.g. Swamp Oak) may need to be provided to protect some ponds from prevailing winds.

A reconciliation of this Green and Golden Bell Frog compensatory habitat program against the *Principles for the Use of Biodiversity Offsets in NSW* (OEH, 2011a) is provided in Table 6.

Table 6
Reconciliation of the Compensatory Habitat Program
Against the NSW Offset Principles

Principles (OEH, 2011a)	Description of How the Program Addresses the Principles
<i>Impacts must be avoided first by using prevention and mitigation measures.</i>	Impacts from the NCIG CET were avoided and mitigated where practicable. Impact avoidance measures were outlined in the NCIG CET Environmental Assessment (NCIG, 2006) and NCIG CET rail flyover modification (NCIG, 2012a).
<i>All regulatory requirements must be met.</i>	The aim of the compensatory habitat program is to satisfy existing consent conditions. NCIG will meet regulatory requirements.
<i>Offsets must never reward ongoing poor performance.</i>	The aim of the compensatory habitat program is to satisfy existing consent conditions. The compensatory habitat is not proposed to reward performance.
<i>Offsets will complement other government programs.</i>	The compensatory habitat program will occur within the Hunter Wetlands National Park and will compliment the conservation of Green and Golden Bell Frog within the national park.
<i>Offsets must be underpinned by sound ecological principles.</i>	Dr Arthur White (Biosphere Environmental Consultants Pty Ltd) has provided principles for the provision of compensatory habitat for the Green and Golden Bell Frog (listed in Table 5).
<i>Offsets should aim to result in a net improvement in biodiversity over time.</i>	The objective of the compensatory habitat is to establish a viable breeding population of the Green and Golden Bell Frog as part of the compensatory habitat works.
<i>Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.</i>	NCIG will provide enduring conservation of the compensatory habitat (Section 11.2).
<i>Offsets should be agreed prior to the impact occurring.</i>	The aim of the compensatory habitat program is to satisfy Consent Condition 2.20 (b)(i) of Project Approval (06_0009).
<i>Offsets must be quantifiable. The impacts and benefits must be reliably estimated.</i>	Condition 2.20(b) (i) of Project Approval (06_0009) quantifies the area of Green and Golden Bell Frog compensatory habitat that NCIG is required to establish (i.e. 75 ha). This amount of compensatory habitat may be reduced if NCIG can determine, using scientific methodology agreed to by the DP&E, in consultation with OEH that the population of Green and Golden Bell Frog impacted by the NCIG CET is less than 37.5 ha. The reduced amount shall be agreed to by the DP&E, in consultation with the OEH, by 30 June 2015. The Green and Golden Bell Frog compensatory habitat program is described in this section.
<i>Offsets must be targeted.</i>	The compensatory habitat is targeted to provide additional habitat for Green and Golden Bell Frogs by converting disturbed areas containing exotic vegetation (i.e. pasture) to more useful habitat for the Green and Golden Bell Frog and managing areas of surrounding potential habitat.
<i>Offsets must be located appropriately.</i>	The location of the Green and Golden Bell Frog compensatory habitat is shown on Figure 9.
<i>Offsets must be supplementary.</i>	The Green and Golden Bell Frog compensatory habitat is beyond other requirements and not already funded under another scheme.
<i>Offsets and their actions must be enforceable through development consent conditions, license conditions, conservation agreements or a contract.</i>	The aim of the compensatory habitat program is to satisfy existing consent conditions.

5.4.5 Existing Environment in the Compensatory Habitat Area and Surrounds

A description of the existing environment in and around the Green and Golden Bell Frog compensatory habitat area is provided below.

Flora

A survey of flora within the Green and Golden Bell Frog compensatory habitat area and surrounds was undertaken by FloraSearch in early 2013 (Attachment 4). Exotic rank grassland dominates most of the area for the Green and Golden Bell Frog compensatory habitat area (Plate 4 and Figure 31). It comprises former grazing paddocks sown with Kikuyu (*Pennisetum clandestinum*) for cattle grazing (Figure 31).



Source: Attachment 4.

Plate 4: Exotic Rank Grassland on Ash Island

FloraSearch (Attachment 4) identified four EECs listed under the NSW *Threatened Species Conservation Act, 1999* (TSC Act) in the wider area (Figure 31):

- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC (Coastal Saltmarsh EEC).
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC.
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC (Freshwater Wetlands on Coastal Floodplains EEC).
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions EEC.

One threatened flora species, the Magenta Lilly Pilly (*Syzygium paniculatum*), listed under the TSC Act and Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act), was identified by FloraSearch (Attachment 4). It has been planted by the Kooragang Wetlands Rehabilitation Project in littoral rainforest plantings on the Rainforest Walk. These plantings will not be disturbed by the proposed Compensatory Habitat.

Fauna

Herbert (Hunter Bird Observers Club) (2007) does not identify any significant bird habitat in the proposed location for the Green and Golden Bell Frog compensatory habitat. Recent fauna surveys have been undertaken in the area by EcoBiological (2011) and McConville (2011). No threatened fauna have been found in the compensatory habitat area, with the exception of the Green and Golden Bell Frog, recorded by EcoBiological (2011).



Land Use and Infrastructure

The Green and Golden Bell Frog compensatory habitat area is mostly within the Hunter Wetlands National Park (except for the underpasses at the NCIG CET). The Green and Golden Bell Frog compensatory habitat area will be identified with signs as described in Section 5.5.2. The Green and Golden Bell Frog compensatory habitat area will be protected through identification in the Plan of Management for the Hunter Wetlands National Park.

Geology and Soils

Ash Island was originally in a series of deltaic islands including Dempsey Island and Moschetto Island at the mouth of the Hunter River (RCA Australia, 2006). As Ash Island is in the delta of the Hunter River it has formed over many years from the deposition of sediment (mostly alluvial but some from wind-blown deposition of sand) (Wicks, 1992). The island was part of the ancient sand dune system that makes up the nearby Tomago Sand Beds (Wicks, 1992). The original islands were low-lying mudflats that were susceptible to flooding and subject to tidal influence (RCA Australia, 2006).

Soil sampling was undertaken on Ash Island for the research enclosure in 2012 (RCA Australia, 2012). A Review of Environmental Factors was submitted to NPWS in April 2013 for a soil, surface water and groundwater investigation program within the Green and Golden Bell Frog compensatory habitat area. Soil samples will be taken using a hand auger.

Surface Water

There are existing ephemeral waterbodies located proximal to the Green and Golden Bell Frog compensatory habitat area. The drainage pattern of Ash Island is very changeable due to the low lying land and rainfall and tidal affects (Wicks, 1992). Historical surface water monitoring data from water ribbon swale (provided by KWRP) indicates a pH range of 5 to 7.3, conductivity 380 to 2556 microSiemens per centimetre ($\mu\text{S}/\text{cm}$), a turbidity range of 8 to 246 nephelometric turbidity units (NTU) in the last four years (NCIG, 2012b).

Surface water quality sampling was undertaken on Ash Island for the research enclosure in 2012 (RCA Australia, 2012). Surface water quality in north-west Ash Island is generally neutral to slightly acidic (RCA Australia, 2012). As stated above, a Review of Environmental Factors was submitted to NPWS in April 2013 for a soil, surface water and groundwater investigation program within the Green and Golden Bell Frog compensatory habitat area. Surface water sampling will be undertaken at the areas of free water within the Green and Golden Bell Frog compensatory habitat area using an extendable-handle container.

Groundwater

The groundwater regime of Ash Island consists of a phreatic aquifer overlying an aquitard that makes up a leaky confined aquifer system that extends over the whole of Kooragang Island (Wicks, 1992). The aquifer under Ash Island is also recharged from tidal affects and frequent flooding (Wicks, 1992). The tides cause the groundwater table to fluctuate when the tides rise and fall (Wicks, 1992).

Groundwater sampling was undertaken on Ash Island for the research enclosure in 2012 (RCA Australia, 2012). Groundwater is encountered at depths generally between 0.7 m to 1.0 m below the ground surface (RCA Australia, 2012). Monitoring results show that groundwater quality is generally neutral to slightly acidic (NCIG, 2012b). Salinity levels range from approximately 0.01% to 2% (NCIG, 2012b). As stated above, a Review of Environmental Factors was submitted to NPWS in April 2013 for a soil, surface water and groundwater investigation program within the Green and Golden Bell Frog compensatory habitat area. The program will involve installing temporary groundwater bores (approximately 90 millimetres [mm] in diameter and 2.5 m deep) at the same 19 soil sampling locations within the Green and Golden Bell Frog compensatory habitat area.

5.5 HOW THE COMPENSATORY HABITAT WILL BE SET UP

NCIG commenced compensatory habitat works on 21 January 2009, with the commencement of the creation of Green and Golden Bell Frog habitat areas at the approach to the frog underpasses associated with the NCIG rail infrastructure (Figure 9) (Section 5.5.1). The following additional works will be undertaken as part of Green and Golden Bell Frog compensatory habitat creation on Ash Island and these are described in detail below:

- delineating the area on the ground (Section 5.5.2);
- undertaking pond construction (Section 5.5.3);
- undertaking necessary revegetation works (Section 5.5.4); and
- implementing hygiene protocols to reduce the likelihood of spreading Chytrid fungus (Section 5.5.5).

5.5.1 Compensatory Habitat at NCIG CET Underpasses

Suitable habitat for Green and Golden Bell Frogs was created at the frog underpasses in order to encourage their use (Figure 9). Habitat creation at the frog underpasses included:

- establishment of pond areas at either end of the frog underpasses (Plate 5);
- selective plantings of plant species preferred by the Green and Golden Bell Frog; and
- placing piles of rocks to provide protection from predators in strategic places such as either end of (or within) frog underpasses.

NCIG delineated the initial area of compensatory habitat by way of detailed survey and establishing the area as an Environmental Protection Area. This work was also conducted in accordance with Condition 2.17 of Project Approval (06_0009).



Plate 5: Frog Underpass and Associated Habitat

5.5.2 Delineating the Area on the Ground

Signs will be installed which state *NCIG Green and Golden Bell Frog Compensatory Habitat* and provide contact details of the Environmental Representative.

5.5.3 Compensatory Habitat/Pond Construction

NCIG will obtain all relevant approvals required to construct the Green and Golden Bell Frog compensatory habitat. For example, the program will be undertaken on land reserved under the NSW *National Parks and Wildlife Act, 1974*. Accordingly, NCIG will prepare a Review of Environmental Factors to obtain approval from the NPWS.

Based on the results of soil sampling (RCA Australia, 2012), Potential Acid Sulphate Soils (PASS) may occur below the ground surface up to the depth of the excavations (i.e. up to 1.5 m). To prevent or minimise oxidation of PASS, an Acid Sulphate Soil Management Plan (ASSMP) will be developed which will detail the safeguards and mitigation measures that will be used. The ASSMP will be developed in accordance with the Acid Sulphate Soil Management Advisory Committee's (1998) *Acid Sulphate Soils Planning Guidelines*.

Prior to the commencement of works, a site survey will be undertaken to delineate the exact boundary/perimeter of the disturbance and areas requiring protection from disturbance (e.g. location of EECs – Figure 31). During the construction of compensatory habitat, temporary frog-enclosure fences will be erected to exclude Green and Golden Bell Frogs from earthworks areas. Frog clearance surveys will occur prior to the commencement of earthworks. If a Green and Golden Bell Frog is found during construction, clearance in the area where it was found will halt until a suitability qualified ecologist evaluates whether the area where it was found can be retained (e.g. if the area sustains breeding or overwintering habitat) or disturbed (e.g. if the frog is found along an existing access track). If construction is to continue, then the Green and Golden Bell Frog present will be relocated to the nearest area of Green and Golden Bell Frog habitat.

To avoid contact with any underground utility services, service locators will be used during the site survey and a 'Dial Before You Dig' search will also be completed prior to commencing the works. NCIG has consulted with the Jemena Gas Network regarding the Activity. Jemena's safety procedures are currently being followed, particularly in relation to safety risk assessment of excavation works carried out in the vicinity of the gas pipeline easement.

Soils excavated during the earthworks will be used in creating the pond margin habitat (i.e. used as growth medium for plantings of suitable emergent vegetation for shelter and foraging habitat) and localised landscaping for aesthetic and hydrological outcomes. Silt fences may be installed (where required) to restrict the movement of sediment outside the earthworks area.

5.5.4 Revegetation

Revegetation of disturbed areas (resulting from mobile plant movement) and landscaped areas will occur by replacing the original vegetation (e.g. pastures) to provide uniformity with the surrounding vegetation. Swales/bunds will be vegetated with low, ground covers (e.g. plants that form tussocks).

As previously described, plants such as *Carex* spp., *Juncus usitatus*, *Schoenoplectus* spp. and *Bolboschoenus* spp. may be planted around the margins of the ponds to create strategic diurnal shelter and foraging areas. Plants such as Water Ribbons (*Triglochin procera*) may be planted to provide submerged aquatic vegetation. Treed wind breaks (e.g. Swamp Oak) may need to be provided to protect some ponds from prevailing winds.

5.5.5 Amphibian Chytrid Fungus – Hygiene Protocols

The accidental introduction or spread of pathogens has the potential to adversely affect frog populations. A water-borne fungal pathogen *Batrachochytrium dendrobatidis*, commonly known as the amphibian or frog Chytrid fungus, is responsible for the disease Chytridiomycosis (Berger *et al.*, 1999; NPWS, 2008). In Australia, *Batrachochytrium dendrobatidis* has been found in frogs since 1989 and has been observed in various regions, including rainforests of southern, central and northern Queensland and northern NSW, montane and foothill forests of Victoria, and suburban/semi-rural populated areas of Brisbane, Adelaide and Perth (Berger *et al.*, 1999).

Chytridiomycosis has been detected in over 40 species of native amphibian in Australia (Mahony and Werkman, 2001), including the Genus *Litoria* (Berger *et al.*, 1999). Infection occurs through waterborne zoospores released from an infected amphibian in water (NPWS, 2008) and the fungus infects both frogs and tadpoles (Berger *et al.*, 1999). Typical clinical signs of frogs with Chytridiomycosis include lethargy, inappetence, skin discoloration, presence of excessive sloughed skin, and sitting unprotected during the day with hind legs held loosely to the body (Berger *et al.*, 1999).

To reduce the likelihood of spreading potential infection, all Project employees and contractors involved in activities in the Green and Golden Bell Frog compensatory habitat area will be trained in site hygiene management in accordance with *Threatened Species Management Information Circular No. 6 Hygiene Protocol for the Control of Disease in Frogs* (Hygiene Protocol) (NPWS, 2008) as part of environmental induction training. The Hygiene Protocol is presented in Attachment 6.

Any mobile plant entering the Green and Golden Bell Frog compensatory habitat area during construction will be inspected prior to entry to ensure the plant is free of soil and/or organic matter and to disinfect tyres and wheels of vehicles entering the Green and Golden Bell Frog compensatory habitat area that have been exposed to mud. Inspection and disinfection of mobile plant entering the Green and Golden Bell Frog compensatory habitat area during construction will be undertaken by employees and contractors.

5.6 ONGOING MANAGEMENT

The Green and Golden Bell Frog compensatory habitat will be actively managed for the life of the NCIG CET. Detailed management measures have been developed into a Green and Golden Bell Frog Compensatory Habitat Management Plan, which has been submitted to NPWS as an Addendum to the approved REF for the compensatory habitat. The management plan includes the following factors:

1. Water source.
2. Water quality.
3. Vegetation.
4. Weed control.
5. Control of introduced predators.
6. Predatory fish.
7. Amphibian Chytrid fungus.

These activities are described below in Sections 5.6.1 to 5.6.7.

5.6.1 Water Source

Should monitoring indicate that a deep pond is not retaining permanent water and water falls below a critical level, a deep groundwater bore/well (and pump system) may be installed to gain access to an additional water source to fill the pond. However, prior to the use of the bore/well water, the water will be tested to ensure suitability for frogs and larval development. Alternatively, the pond may be excavated to a lower depth (i.e. up to approximately 2 m to 2.5 m) to allow the collection of additional groundwater into the pond. The artificial frog ponds will also be sited, where practicable, to take advantage of natural drainage flows of the area (and use of excavated material for construction of swales).

NCIG will consult with the University of Newcastle, relevant specialists and the NPWS prior to installing a groundwater bore/well and pump system or conducting any additional excavation works or extracting or draining water from the artificial frog ponds.

5.6.2 Water Quality

Green and Golden Bell Frog habitat pond water quality parameters based on values from occupied habitat on Kooragang Island and Sydney Olympic Park and from some studies of physiological tolerance are provided in Table 7.

Table 7
Water Quality Parameters

Water Quality Variable	Suitable Range for Survival	
	Tadpoles	Frogs
Water Temperature (°C)	16-31	4-35
Salinity (ppt)	< 4 [*]	< 6.4
Ph	4-9	4-10.2
Dissolved Oxygen (mg/L)	4.1-17.1	

°C = degrees Celsius.

ppt = parts per thousand.

mg/L = milligrams per litre.

^{*} In the references provided, tadpole survivorship was not affected up to 4 ppt. However, in one study, tadpole survivorship was reduced at 2 ppt (Christy and Dickman, 2002).

Following pond construction, salinity levels in each pond will be monitored regularly (Section 5.7.2) using a hand-held water quality probe and/or permanently installed data-loggers. Signs of salt stratification within the ponds will also be monitored. Should water quality fall outside of desired levels, additional water may be added to the pond(s) (e.g. sourced from a deep groundwater bore/well) (Section 5.6.1).

5.6.3 Native Vegetation Management

The *Best Practice Guidelines: Green and Golden Bell Frog Habitat* (DECC, 2008b) describe how it may be necessary to remove overgrown native plants from within and surrounding the artificial frog ponds. Vegetation control will be restricted to hand removal, mechanical removal and/or “environmentally friendly” products. A herbicide registered for use in aquatic situations by the National Registration Authority will be used where physical control methods are not suitable.

5.6.4 Weed Control

Similarly to native vegetation management above, weed control will be restricted to hand removal, mechanical removal and/or “environmentally friendly” products. A herbicide registered for use in aquatic situations by the National Registration Authority will be used for the control of weeds where physical control methods are not suitable.

The following noxious weeds have been recorded in the general area: Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Pampas Grass (*Cortaderia selloana*), Lantana (*Lantana camara*), Common Prickly Pear (*Opuntia stricta*) and Blackberry (*Rubus anglocandicans*) (EcoBiological, 2011).

5.6.5 Control of Introduced Predators

The area surrounding the artificial frog ponds will be managed to promote habitat opportunities for the frog. Foxes (*Vulpes vulpes*) and Feral Cats (*Felis catus*) may prey on the Green and Golden Bell Frog (DECC, 2008b). NCIG will seek to co-ordinate feral predator control (Foxes and Feral Cats) with the NPWS. NCIG will consult with NPWS to determine if/when feral predator control is deemed necessary.

5.6.6 Predatory Fish

No predatory fish (e.g. Plague Minnow [*Gambusia holbrooki*]) will be added to the artificial frog ponds. If predatory fish infestations are found in the artificial frog ponds, a management strategy will be developed with the NCIG Consultative Board. Plague Minnow can be controlled by chemical use or draining the pond (Hamer, 1998) or by increasing the complexity of habitat to provide refuge for tadpoles (Pyke and White, 2001; Hamer *et al.*, 2002).

5.6.7 Amphibian Chytrid Fungus

If Chytrid fungus infestations are found in the artificial frog ponds, a management strategy will be developed with the NCIG Consultative Board to aim to reduce the presence of Chytrid fungus. Options will include, but not necessarily be limited to: preventing spread of the infection (Section 5.5.5); amphibian exclusion fencing to prevent frogs moving in and out of the infected area; and/or collecting infected frogs.

5.7 MONITORING

Green and Golden Bell Frog monitoring will continue be undertaken in accordance with the *Newcastle Coal Infrastructure Group Coal Export Terminal Green and Golden Bell Frog Management Plan* (NCIG, 2007) prepared in accordance with Condition 2.16 of Project Approval (06_0009). The objective of Green and Golden Bell Frog monitoring is to monitor the Green and Golden Bell Frog within habitat areas adjacent to the NCIG CET site within the KIWEF and any other locations where captured frogs have been relocated as part of the *Newcastle Coal Infrastructure Group Coal Export Terminal Green and Golden Bell Frog Management Plan* (NCIG, 2007).

Two additional types of monitoring will be undertaken as part of the CHEMA:

1. monitoring the Green and Golden Bell Frog's use of the compensatory habitat; and
2. habitat monitoring – monitoring the compensatory habitat area frequently to detect the need for maintenance (e.g. vegetation control or removal of threats).

Both monitoring components are to enable adaptive management of the compensatory habitat. These monitoring components are described below in Sections 5.7.1 and 5.7.2.

5.7.1 Monitoring Green and Golden Bell Frog Usage of the Habitat

The objective of this monitoring program is to monitor the Green and Golden Bell Frogs use of the additional habitat created by NCIG. The monitoring program is to detect the presence of a viable breeding population of the Green and Golden Bell Frog, namely:

- Evidence of natural breeding events occurring in two seasons⁵ (September to March) and includes the presence of eggs, tadpoles and/or metamorphs that were not released from captive breeding stock in at least one pond.
- Evidence of at least five reproductively mature individuals identified within new aquatic and/or terrestrial habitat in each of the two seasons when breeding events occurred. Such evidence will include presence of calling males with nuptial pads and gravid females.

The monitoring will detect the following in relation to the Green and Golden Bell Frog:

- site occupancy;
- recruitment;
- presence of eggs, tadpoles and/or metamorphs;
- presence of calling males with nuptial pads;
- presence of gravid females;
- survivorship;
- habitat use; and
- movement amongst artificial frog ponds and between artificial frog ponds and existing ponds (note: the study of movement patterns within and between areas of suitable habitat is a research action outlined in the NSW recovery plan [DEC, 2005]).

The monitoring program will commence with the construction of created habitat. Surveys will be conducted annually during favourable seasonal and climatic conditions (e.g. between September and March [spring, summer and autumn] and after heavy rain [after DEHWA, 2010; Hamer *et al.*, 2008]).

Mark and recapture sampling will occur within habitat created by NCIG (when created) as well as adjacent existing habitat. The Green and Golden Bell Frog Monitoring Data Recording Sheet (appended to the Recovery Plan for this species) (DEC, 2005), or similar data collection documentation, will be used to record data (Attachment 7). Sampling techniques will be consistent with contemporary State and Commonwealth survey guidelines (DECC, 2009; DEHWA, 2010), including presence of tadpoles and frog calls. Data on the existing environmental conditions will also be recorded.

Marking frogs will be undertaken using PIT microchip tags. Christy (1996) documented the efficacy of using PIT tags on Green and Golden Bell Frog (194 adults) for mark-recapture studies. The PIT tags (~11 mm) are injected into the skin using a needle and syringe. The frogs can then be scanned by a mini-reader scanner. Once the tags are inserted into the frogs they are permanent. Other mark and recapture studies on the Green and Golden Bell Frog include: Pyke and White (2001); Hamer *et al.* (2008) and Hamer and Mahony (2010).

⁵ The breeding events do not have to be recorded over two consecutive seasons.

The monitoring surveys will be conducted in accordance with relevant OEH permits and the Hygiene Protocol detailed in the *Newcastle Coal Infrastructure Group Coal Export Terminal Green and Golden Bell Frog Management Plan* (NCIG, 2007), which meets contemporary standards. Collection and handling of frogs and inadvertent transport of infected material between frog habitats may also promote the spread of Chytrid fungus. Access to amphibian habitats and the handling of frogs have the potential to introduce or spread the Chytrid fungus.

Personnel conducting amphibian surveys will be required to observe the following hygiene protocols in accordance with the *Hygiene Protocols for the Control of Disease in Frogs* (NPWS, 2008):

- The thorough cleaning and disinfecting of footwear.
- The thorough cleaning and disinfecting of equipment (such as nets, callipers, headlamps and waders).

The data collected will be analysed using appropriate ecological software (e.g. PRESENCE or MARK). The program MARK can be used to model all of the aspects to be studied (i.e. recruitment, number of frogs inhabiting each pond, survivorship, habitat use and movement amongst artificial frog ponds and between artificial frog ponds and existing ponds). The statistical program PRESENCE may be used, consistent with Hamer and Mahony (2010). Other statistical programs may also be used where appropriate.

5.7.2 Monitoring Habitat for the Green and Golden Bell Frog

Compensatory habitat monitoring will be undertaken to measure and record the development and condition of compensatory habitat. NCIG will undertake a process of ongoing adaptive management and review of the performance of Green and Golden Bell Frog compensatory habitat. Parameters that will be monitored at each pond site include:

- Water quality parameters:
 - water depth;
 - water temperature;
 - turbidity;
 - dissolved oxygen;
 - salinity;
 - pH; and
 - area of open water.
- Vegetation condition.
- Extent of emergent plant cover.
- Extent of foraging habitat.
- Predatory fish (e.g. Plague Minnow).

Habitat monitoring will be carried out monthly for the first year following completion of compensatory habitat works and then quarterly.

5.8 ADAPTIVE MANAGEMENT

NCIG will undertake a process of ongoing adaptive management and review of the performance of the compensatory habitat through the construction and monitoring of habitat. As described in Section 3, the NCIG Consultative Board provides a sound and legally enforceable means of allocating resources for ongoing adaptive management and review of the performance of compensatory habitat works.

5.8.1 Translocation of Green and Golden Bell Frogs

In the event that Green and Golden Bell Frogs do not colonise the compensatory habitat, consideration will be given to translocating Green and Golden Bell Frogs into the area. If this is considered a viable option, a Translocation Application will be completed and submitted to the NPWS – Licensing Division. Consideration will be given to using frogs from within the Research Ponds once the research work has ceased (Section 4.2).

5.8.2 Additional Linkages to the Core Population

In the event that Green and Golden Bell Frogs do not colonise the compensatory habitat, the practicality and benefits of providing better linkages between the compensatory habitat and the core population along Bell Frog Track or BHP Billiton's proposed compensatory habitat (pending its success) may be evaluated.

6 SHOREBIRD COMPENSATORY HABITAT PROGRAM

6.1 INTRODUCTION

In accordance with Condition 2.20(b)(ii) of Project Approval (06_0009) and recommendations from DECC (now OEH) in 2008 (refer “Threatened Species Offset Framework”), NCIG propose to reinstate saltmarsh/mudflat habitat for shorebirds through removing mangroves from a substantial area on Kooragang Island (Figures 32 to 34). Mangrove removal has proven to be beneficial in the restoration of saltmarsh communities as habitat for shorebirds (Hunter Bird Observers Club, 2010).

The shorebird compensatory habitat program is expected to benefit shorebirds because encroachment of mangrove vegetation into saltmarsh/mudflat habitat is a recognised issue for shorebird habitation (Harding *et al.*, 2007) and the area selected to be enhanced was once saltmarsh/mudflat habitat used by shorebirds. Historic aerial photos of Kooragang Island shows that the Fish Fry Flats area was once saltmarsh/mudflat (Figure 35). The Hunter Central Rivers Catchment Management Authority (CMA) (2011) describes:

Prior to 1995 tidal flow via Fish Fry Creek was restricted and the area contained more saltmarsh and exposed mudflat areas which favour shorebird usage. Mangroves that were present were scattered and stunted. In 1995 tidal flushing was restored to Fish Fry Creek with the removal of the small culverts and obstruction to flows. As a result, the area received greater tidal influence and mangrove tree health improved and they have since expanded, particularly within the Fish Fry compartment at the expense of saltmarsh and mudflat habitat.

Herbert (Hunter Bird Observers Club) (2007) recalls that:

Fish Fry Flats was an extensive area of saltmarsh, mudflats and open water before mangroves over-ran the area.

...

Fish Fry Flats used to be important habitat, but it has been overgrown by mangroves during the last 10 years.

NCIG was required to prepare a Review of Environmental Factors (REF) under Part 5 of the EP&A Act. NCIG received approval of the *Shorebird Compensatory Habitat Review of Environmental Factors* (NCIG, 2014) on the 28 June 2015. The outcomes of the *Shorebird Compensatory Habitat Review of Environmental Factors* have been integrated into Section 6. ‘The Activity’ is herein used to refer to the works covered by this REF.

6.2 CONSULTATION RELATING TO THE COMPENSATORY HABITAT PROGRAM

The shorebird compensatory habitat program has been prepared in consultation with Phil Straw (Avifauna Research & Services Pty Ltd), who specialises in wetland habitat design, restoration and management for waterbirds and migratory species. Phil Straw is a member (Vice Chairman) of the Australasian Wader Studies Group.

NCIG has undertaken consultation with various stakeholders regarding the Area E shorebird compensatory habitat:

2008 – The DECC (now OEH) identified Fish Fry Flats as a priority site for shorebird compensatory habitat.

2009 – NCIG undertook extensive discussions with the Hunter-Central Rivers CMA, DECC and NPWS on the benefits of installing a specifically-designed culvert and valve system for the re-establishment of shorebird habitat at Fish Fry Flats.





NCE-07-02 CHEMP R03_033A

rev	description	day	mo.	yr.
2	Client requested updates	03	06	13
1	Revised sheet number	15	05	13
0	Final issue	10	05	13
A	Draft	09	05	13



Terras Landscape Architects
Drawing Ref: 9793.5.2 - 01

drawn	TA
checked	SR

scale

COMPENSATORY HABITAT AND ECOLOGICAL MONITORING PROGRAM

FIGURE 33

Artist's Impression: Area E Existing Habitat

FINAL ISSUE

date
09-05-2013

drawing
HW03-05-C-22927

rev
2



FINAL ISSUE

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 34

Artist's Impression: Area E Proposed Habitat

date
09-05-2013

drawing
HW03-05-C-22928

rev
2

rev	description	day	mo.	yr.
2	Client requested updates	03	06	13
1	Revised sheet number	15	05	13
0	Final issue	10	05	13
A	Draft	09	05	13



Terras Landscape Architects
Drawing Ref: 9793.5.2 - 02

drawn
TA
checked
SR

scale



Fish Fry Flats

1954



Fish Fry Flats

1975



Fish Fry Flats

1993



Fish Fry Flats

2001

Source: Department of Lands (2006) and MCG (2006)

COMPENSATORY HABITAT AND
ECOLOGICAL MONITORING PROGRAM

FIGURE 35

Historical Aerial Photographs
of Kooragang Island

- 2009 – NCIG funded and installed a specifically-designed culvert and valve system at the entrance to Fish Fry Creek, which can be used to improve the hydrological regime in Fish Fry Flats.
- 2011 – NCIG and the Hunter-Central Rivers CMA met to have a conceptual discussion on the proposed Area E shorebird compensatory habitat.
- 2012 – Conceptual discussions with NPWS in relation to the Area E shorebird compensatory habitat and in particular its location relative to the Hunter Wetlands National Park boundary (which was extended in early 2011) and discussed means of securing the land in perpetuity.
- 2012 – (September) NCIG undertook consultation with the Hunter-Central Rivers CMA regarding the management of Fish Fry Flats.
- 2012 – Hunter-Central Rivers CMA received approval for a REF which described the proposed use of the NCIG specifically-designed culvert on Fish Fry Creek and blocking/controlling flow in Wader Creek (Hunter-Central Rivers CMA, 2011).
- 2013 – (December) NCIG met with OEH, NPWS and the DP&E to discuss potential mechanisms of obtaining land security.
- 2014 – NPWS identified the removal of mangroves and re-establishment of shorebird habitat in Fish Fry Flats in their Statement of Interim Management Intent (SIMI) and draft Plan of Management.
- 2014 – (June) NCIG presented findings of site visit and investigation of large scale mangrove removal projects undertaken in New Zealand to NPWS, including assessment of various removal techniques.
- 2014 – (August) NCIG met with Hunter Bird Observers Club to outline the conceptual plan for the Area E shorebird compensatory habitat and discussed what will be appropriate monitoring.
- 2014 – (September) NCIG met with NPWS and Hunter Local Land Services (formerly Hunter-Central Rivers CMA) to discuss how concurrent projects in Fish Fry Flats will work.
- 2014 – (November) NCIG met with NPWS, the OEH, Hunter Bird Observers Club and Hunter Local Land Services to outline the detail of the proposed activity.
- 2015 – (February) NCIG provided details to the Department of Primary Industries (Fishing and Aquaculture) outlining the scope, evolution and intended benefits of the Area E shorebird compensatory habitat.

Consultation was undertaken to identify the location for the compensatory works, identify benefits of re-establishment of shorebird habitat, investigate the most effective method of re-establishing shorebird habitat and confirm the mechanism of land security.

6.3 DESCRIPTION OF THE SHOREBIRD COMPENSATORY HABITAT

6.3.1 Objective

The objective of the shorebird compensatory habitat is to provide additional habitat for migratory shorebirds in accordance with Project Approval (06_0009) and the subsequent *Shorebird Compensatory Habitat Review of Environmental Factors* (NCIG, 2014). NCIG is required to establish shorebird compensatory habitat for 4 ha of shorebird habitat clearance associated with the northern rail spur and rail flyover modification.

6.3.2 Location

The Area E shorebird compensatory habitat is approximately 400 m west of the NCIG CET (Figure 32). Given its proximity to the NCIG CET, it has the potential to benefit birds potentially impacted by the NCIG CET. The shorebird compensatory habitat is adjoining and outside the southern boundary of the Hunter Wetlands National Park (Figure 32) and outside the Hunter Estuary Ramsar Wetland (further north). It is located within crown land managed by the NPWS.

The Area E shorebird compensatory habitat is located within a State Environmental Planning Policy (SEPP) (Major Development) 2005 area, but it does not cover the entire width of the SEPP (Major Development) 2005 area (i.e. there is still land available [over 100 m width] for linear infrastructure [e.g. roads and power corridors] to the south of the shorebird compensatory habitat area).

6.3.3 Quantification (Size)

As shown on Figure 32, the Activity area is larger than the Area E shorebird compensatory habitat in order to remove a greater area of mangroves and assist NPWS with their continued management of the surrounding area.

Condition 2.20(b)(ii) of Project Approval (06_0009) quantifies the area of shorebird compensatory habitat that NCIG is required to establish (i.e. 8 ha) (for the northern rail spur and rail flyover modification). In addition, as described in Section 8, consistent with the CEMP (Revision 01) (NCIG, 2010), NCIG will fund the removal of up to 6 ha of mangroves from coastal saltmarsh habitat between Fish Fry Creek and Wader Creek on Kooragang Island. The overall size of the Area E shorebird compensatory habitat shown on Figure 32 is 18 ha, and this includes 14 ha of mangroves (that will be removed) and 4 ha of existing saltmarsh/mudflat/ shallow water.

The overall size of the Activity area shown on Figure 32 is 32.6 ha. Approximately 17 ha of mangroves will be removed from the Activity area resulting in an additional 3 ha of mangroves being removed as part of this CEMP.

6.3.4 Potential Benefits from the Compensatory Habitat

The NPWS has no existing program to remove the mangroves within the shorebird compensatory habitat so in the absence of the NCIG shorebird compensatory habitat program, the shorebird habitat will not exist. Since the Area E shorebird compensatory habitat area was previously saltmarsh/ mudflat/shallow water, it provides greater certainty about the suitability of the location (e.g. landform and hydrology) to once again support these habitats.

Without the establishment of the culvert in Fish Fry Creek this area of shorebird habitat, including Wader Pond and Swan Pond, will continue to come under pressure from mangrove propagation. Without direct intervention to control mangroves in this area, continued degradation of the ecological values of this area will occur. Potential benefits from the Area E shorebird compensatory habitat include:

- An area of saltmarsh/mudflat habitat known to be previously used by shorebirds as roosting and feeding habitat will be restored.
- Mangroves removed will be replaced with mudflat (feeding habitat) and saltmarsh (roosting habitat). Coastal Saltmarsh is an EEC listed under the TSC Act⁶.

⁶ Condition 2.20(b)(ii) of Project Approval (06_0009) requires compensatory habitat for areas of EECs lost as part of the NCIG CET. In addition to the shorebird compensatory habitat providing Coastal Saltmarsh, the Green and Golden Bell Frog compensatory habitat program (described in Section 5) will provide freshwater wetlands. Freshwater Wetlands on Coastal Floodplains EEC is listed under the TSC Act.

- Reinstating and managing saltmarsh adjacent to the Hunter Wetlands National Park may lessen mangrove encroachment into the national park and Swan Pond.

Table 8 provides a list of birds that were recorded in Fish Fry Flats before it was over-run by mangroves.

Table 8
Records of Birds that Previously Used Fish Fry Flats

Species	Source	Species	Source
Little Pied Cormorant	A, B, C	Marsh Sandpiper	A, C
Little Black Cormorant	B, C	Black-tailed Godwit	A
White-faced Heron	A, B, C	Sharp-tailed Sandpiper	A, B, C
White-necked Heron	B, C	Red-necked Stint	A
Cattle Egret	A, B	Black-winged Stilt	B, C
Eastern Great Egret	B, C	Curlew Sandpiper	A
Intermediate Egret	B, C	Silver Gull	A
Little Egret	B, C	Gull-billed Tern	A
Straw-necked Ibis	B, C	Caspian Tern	A, C
Australian White Ibis	A, B, C	Australian Pelican	B, C
Royal Spoonbill	A, B, C	Black-fronted Dotterel	B, C
Black Swan	A, C	Red-kneed Dotterel	B, C
Pacific Black Duck	A, B	Australasian Grebe	B
Grey Teal	A	Australian Spotted Crake	B
Chestnut Teal	A, B, C	Black-shouldered Kite	B
Masked Lapwing	A, B, C	Buff-banded Rail	B, C
Red-capped Plover	A	Swamp Harrier	B,
Red-necked Avocet	A, B, C	Whistling Kite	B,
Eastern Curlew	A, B, C	White-bellied Sea-Eagle	B,
Common Greenshank	A, B, C	White-fronted Chat	B,

A Kingsford and Ferster Levy (1995)

B Birds Australia data (supplied by Mick Roderick)

C Hunter Bird Observers Club (1999-2003)

6.3.5 Compensatory Habitat Principles

A reconciliation of the shorebird compensatory habitat program against the *Principles for the Use of Biodiversity Offsets in NSW* (OEH, 2011a) is provided in Table 9.

Table 9
Reconciliation of the Shorebird Compensatory Habitat Program
Against the NSW Offset Principles

Principles (OEH, 2011a)	Description of how the Program Addresses the Principles
Impacts must be avoided first by using prevention and mitigation measures.	Impacts were avoided and mitigated where practicable (NCIG, 2006; NCIG, 2012a).
All regulatory requirements must be met.	NCIG will meet regulatory requirements.
Offsets must never reward ongoing poor performance.	The compensatory habitat is not proposed to reward poor performance. The aim of the shorebird compensatory habitat program is to satisfy existing Project Approval conditions.
Offsets will complement other government programs.	The Area E shorebird compensatory habitat will complement the protection of shorebird habitat in the Hunter Wetlands National Park.
Offsets must be underpinned by sound ecological principles.	The Area E shorebird compensatory habitat will include managing existing threats (such as mangrove encroachment) to provide migratory shorebird habitat. The compensatory habitat expands an area of existing shorebird habitat. NCIG will provide enduring shorebird habitat in the compensatory habitat area.
Offsets should aim to result in a net improvement in biodiversity over time.	The Area E shorebird compensatory habitat will provide for a gain in migratory shorebird habitat in the region (i.e. a net increase in 8 ha of compensatory habitat and an addition 6 ha of mangrove removal [Section 6.3.3]).
Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	NCIG will provide enduring conservation of the compensatory habitat (Section 11.2).
Offsets should be agreed prior to the impact occurring.	The aim of the shorebird compensatory habitat program is to satisfy Condition 2.20(b)(ii) of Project Approval (06_0009).
Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	The shorebird compensatory habitat has been quantified in Section 6.3.3.
Offsets must be targeted.	The Area E shorebird compensatory habitat is targeted towards an area that is known to have previously been habitat for shorebirds on Kooragang Island but due to a trend of mangrove encroachment, this habitat was lost.
Offsets must be located appropriately.	The Area E shorebird compensatory habitat is suitably located on Kooragang Island. Given its proximity to the NCIG CET, it has the potential to benefit birds which also use Deep Pond.
Offsets must be supplementary.	The Area E shorebird compensatory habitat is beyond existing requirements and not already funded under another scheme. The compensatory habitat will provide for a gain in migratory shorebird habitat in the region (i.e. a net increase in 8 ha of compensatory habitat and an addition 6 ha of mangrove removal [Section 6.3.3]).
Offsets and their actions must be enforceable through development consent conditions, license conditions, conservation agreements or a contract.	The aim of the shorebird compensatory habitat program is to satisfy Condition 2.20(d) of Project Approval (06_0009).

6.4 HOW THE SHOREBIRD COMPENSATORY HABITAT WILL BE SET UP

Pre-requisites to Setting up the Area E Shorebird Compensatory Habitat

Prior to commencing the establishment of Area E shorebird compensatory habitat the following will be undertaken:

- A Construction and Environmental Management Plan (CEMP) will be submitted to the NPWS Lower Hunter Area Manager for approval at least one month prior to the commencement of the Activity in accordance with the REF Determination Conditions 17 and 20.
- An Incident Management Plan will be submitted to the NPWS Lower Hunter Area Manager for approval prior to the commencement of the Activity in accordance with the REF Determination Condition 18.

- The Acid Sulphate Soils Management Plan will be prepared prior to undertaking the Activity and submitted to OEH/NPWS for consultation.
- A list of tradespersons, contractors and volunteers that will be involved in undertaking the Activity will be submitted to the NPWS Lower Hunter Area Manager for approval prior to commencement of the Activity in accordance with the REF Determination Condition 10.
- At least two weeks before the Activity commences, NCIG will erect a sign at the Hunter Local Land Services Kooragang Wetland Rehabilitation Project office on Ash Island (via Hexham, Hunter Wetland National Park) and in the immediate vicinity of the Activity site that is visible, clearly marked and lists:
 - a. a description of the Activity, reasons for undertaking the Activity and a works schedule;
 - b. the hours of operation; and
 - c. a contact telephone number for public inquiries.
- Monitoring will commence prior to the commencement of the Activity (Section 6.7).

In accordance with the REF Determination Condition 25, mangrove removal works will commence after 30 April, and will be completed prior to 1 November of any year to minimise any potential disturbance or harm to migratory birds that utilise the habitat areas to the north of the Activity Area (i.e. Swan and Wader Ponds).

Setting up the Area E Shorebird Compensatory Habitat

The Area E shorebird compensatory habitat will be created by undertaking the following activities:

1. installation of infrastructure;
2. removal of mangroves;
3. management of waste material;
4. revegetation of saltmarsh;
5. power line management;
6. management of potential diesel/petrol spill risks;
7. management of potential acid sulphate soils;
8. weed control; and
9. environmental induction training.

These measures are described below in Sections 6.4.1 to 6.4.9.

In accordance with REF Determination Condition 16, NCIG will notify the NPWS Lower Hunter Area Manager in writing at least 24 hours prior to commencing each step of the Activity (steps identified in Section 3.5 of the REF [NCIG, 2014]). Prior to the commencement of each step, NCIG (including any employees, contractors, sub- contractors, agents and invitees involved in undertaking the Activity) will also hold an on-site meeting with the NPWS Lower Hunter Area Manager (or their delegate) in accordance with REF Determination Condition 13.

6.4.1 Infrastructure

In accordance with REF Determination Conditions 14 and 15, prior to the commencement of infrastructure works (for example, installation of SmartGates), NCIG will ensure that the proposed works are certified to comply with the Building Code of Australia (BCA) or relevant Australian Standards, if required by the OEH (previously DECCW) Construction Assessment Procedure. Evidence of compliance with the BCA or Australian Standards must be submitted to the satisfaction of the NPWS Lower Hunter Area Manager. For those proposed works that do not require certification under the OEH Construction Assessment Procedure, NCIG will still ensure that the Activity is undertaken in accordance with any relevant requirements of the BCA or Australian Standards, and is safe and fit for the intended purpose.

Fish Fry Creek ‘Smart Gate’

Hydrological controls for the Area E shorebird compensatory habitat have been determined in consultation with Dr William Glamore (University of NSW – Water Research Laboratory). A SmartGate Environmental Control System (or SmartGate) (University of NSW, 2014) will be installed at the entrance of Fish Fry Creek in order to facilitate normal tidal flow and block highest tides. The SmartGate is an electronic automated system that controls the amount of water entering an area based on real time data measurements (University of NSW, 2014). It will be either retrofitted in the existing culvert structure or installed within an adjacent new structure as determined by detailed design.

Dr William Glamore (University of NSW-Water Research Laboratory) designed the SmartGate and it is currently being used to restore tidal flushing and create a wetland in the Kooragang Nature Reserve (University of NSW, 2014) at Tomago. The SmartGate will be designed to facilitate fish passage in accordance with NSW Fisheries (2013).

In accordance with REF Determination Condition 24, the SmartGate will maintain and not increase existing levels of tidal flow.

If timber is used for drop boards, the timber will be sourced in accordance with REF Determination Condition 50 and 51.

Fish Fry Creek – Floating Boom/Silt Curtain

Tidal flows from Fish Fry Creek will act as a source of mangrove propagules into the Area E shorebird compensatory habitat area (without control measures in place). Controls to limit mangrove propagules entering the Area E shorebird compensatory habitat have been determined in consultation with Dr William Glamore (University of NSW – Water Research Laboratory).

Floating boom(s) will be installed on Fish Fry Creek either retrofitted in the existing culvert structure installed within a new structure. The floating boom(s) will be designed to facilitate fish passage in accordance with NSW Fisheries (2013) and will likely to be only installed during the period when risk of propagule entry is highest (August to December).

Access Tracks

Machinery will access the Activity area primarily via existing tracks. Vehicle access within the Hunter Wetlands National Park will also be undertaken with regard to the OEH's *Vehicle Access – General Policy* (DECCW, 2010). Temporary access to mangrove removal areas will be created by directly driving over fallen mangroves. The fallen mangroves will be used to stabilise the sediment thereby minimising ground disturbance. The fallen mangrove tracks or track mats will be removed after completion of mangrove removal.

If required, additional sediment control measures will be used along access tracks. For example, track mats may be installed in particular areas (e.g. where improved access is required or heavily traffic areas).

Temporary Site Compound

A temporary site compound will be constructed on rank grassland during the mangrove removal period, and removed following completion of the Activity.

6.4.2 Removal of Mangroves

During late 2013 and 2014, NCIG undertook an investigation into more efficient and effective methods for removing mangroves. This investigation involved:

- site visits to various large-scale mangrove removal projects in New Zealand (namely, the Mangawhai Harbour Restoration Project, Pahurehure Inlet No 2 and Tauranga Harbour);
- consultation with a shorebird specialist (Phil Straw [Avifauna Research & Services Pty Ltd]);
- consultation with an engineer (Dr William Glamore [University of NSW-Water Research Laboratory]);
- consultation with a hydrogeologist (Jose Rodriguez [University of Newcastle]); and
- consultation with NPWS and other stakeholders.

As a result of the investigation, NCIG propose to use a variety of techniques in order apply the most appropriate methodology in different situations.

In accordance with REF Determination Condition 26, mangrove removal is to occur from south to north towards the existing bird habitat, thereby maintaining a treed buffer during the majority of the works.

Mangrove removal within Fish Fry Flats will involve the following:

- Exclusion/hand removal zones are proposed around Coastal Saltmarsh EEC without mangroves (i.e. areas mapped as 'D' on Figure 36) (Figure 37). Mangrove removal activities within 50 m of these exclusion/hand removal zones will only commence after a temporary fence (e.g. high visibility barrier tape) is erected between the feature and the proposed mangrove removal area. The temporary fence will be removed after the mangrove removal activities in that location are complete. In the exclusion/hand removal zones (Figure 37), any mangroves will be removed via hand removal techniques to minimise impacts on the Coastal Saltmarsh EEC.
- The culvert on Fish Fry Creek (near the Hunter River) (Figure 37) will be utilised to hold the water levels in Fish Fry Flats at low water tide level for a period of up to one month (30 days) to enable greater access to clear mangroves in the tidal zone. This will be achieved by temporarily reinforcing the current culvert system to ensure water integrity.
- The culvert under Wagtail Way that is between Fish Fry Flats and Swan Pond (Figure 37) will be temporarily blocked up to one month (30 days) during initial mangrove removal activities in Fish Fry Flats to limit potential for sedimentation in Swan Pond. In accordance with REF Determination Condition 24, the temporary blocking of the culvert under Wagtail Way will maintain and not increase existing levels of tidal flow.
- Access tracks will be established to facilitate removal of mangroves (Section 6.4.1; Figure 37).

- The mangrove removal will be completed in two passes. The first to remove the bulk of vegetation (mature trees) using an excavator with hydraulic shears or grapple with the vegetation moved (via a small tracked [Marooka] dump truck) outside the tidal area and mulched and placed within the Activity Area. The second will be to clear pneumatophores, propagules and stumps using a wide tracked excavator with a mulcher head or a positrack fitted with a mulcher.

The channel associated with Wader Creek is typically narrow and steep sided so mangroves are able to be reached at all tides with a terrestrial excavator. Mangrove removal along Wader Creek will involve the following:

- A temporary fence (e.g. high visibility barrier tape) will be used to protect the Coastal Saltmarsh EEC (i.e. areas mapped as 'D' on Figure 36) as described above.
- Silt curtains will be installed at the Wader Creek culverts to Swan Pond and the open channels/pipe culverts to Wader Pond to restrict the movement of sediment outside the earthworks area.
- Existing tidal flows will be maintained in Wader Creek to ensure no impact on the hydrology of Wader Pond or Swan Pond.
- Access tracks will be established to facilitate removal of mangroves (Section 6.4.1; Figure 37).
- The mangrove removal will be completed in two passes as described above for Fish Fry Flats.

The mangrove removal procedure above minimises the potential for adverse impacts on Swan Pond (and associated saltmarsh and mudflat areas) which is recognised as important bird habitat. Regular daily inspections (monitoring) of Swan Pond (downstream of sediment control structures) will occur during construction to confirm that the sediment control structures are effective and no adverse impacts occur. Water quality monitoring will be undertaken during mangrove removal activities.

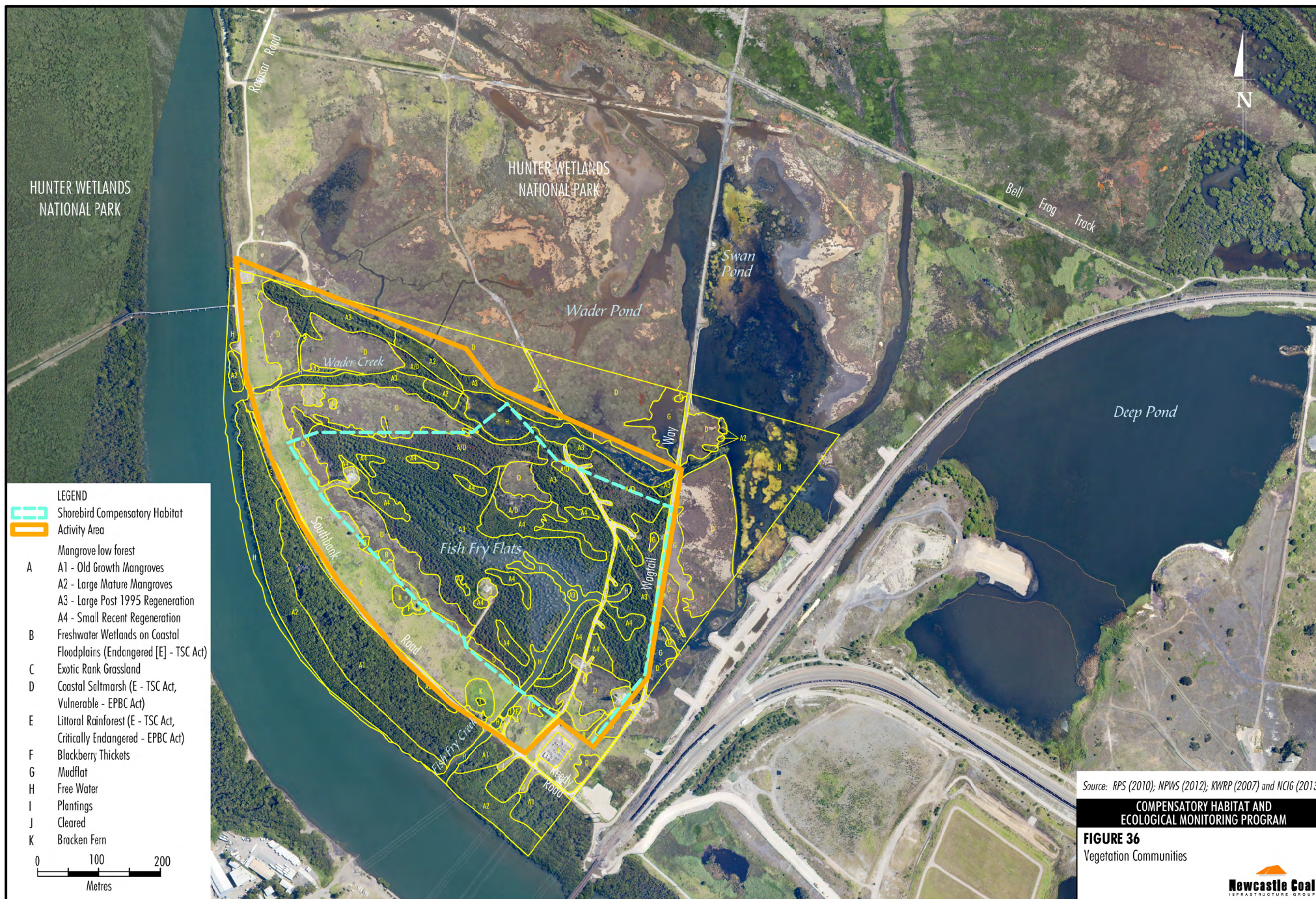
The removal of the mangroves is estimated to take approximately two months. Mangrove removal works will occur during daylight hours (between the hours of 7.00 am and 6.00 pm).

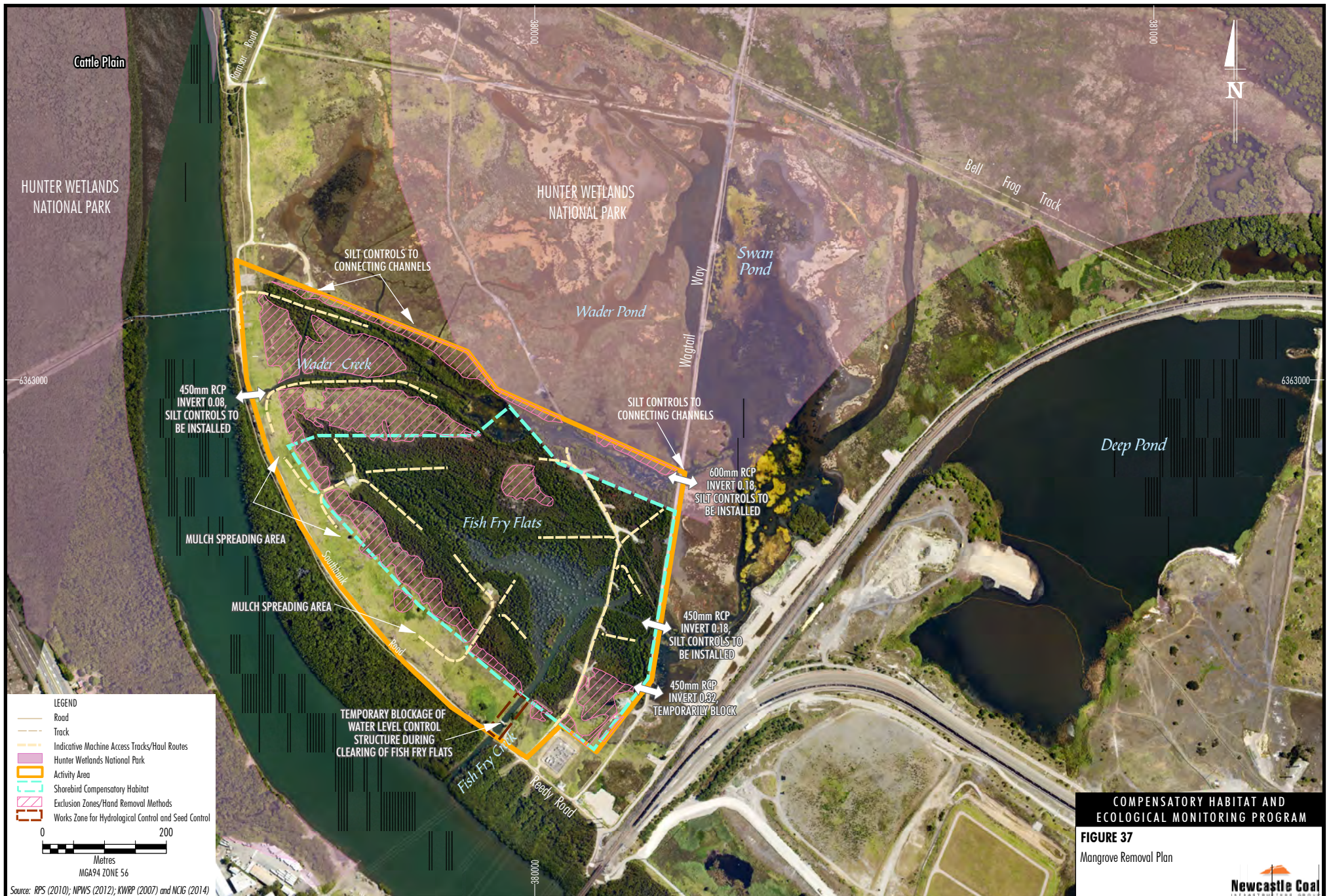
Mangrove removal will be supervised by NCIG environmental personnel. An inspection of the proposed clearance areas will be undertaken by a suitably qualified and licensed ecologist prior to and during the vegetation clearance to identify fauna present that may be affected by the clearance activities (including fauna within hollow-bearing trees).

In the event that fauna (including hollow-dwelling birds or bats) are present in the area proposed to be cleared, the ecologist will recommend clearance methods to reduce impacts on the animals such as, encouraging the animal to leave the area during clearance activities or capture and relocation of the animal immediately outside of the area proposed to be cleared. Threatened species will be managed in accordance with REF Determination Condition 29.

Mangrove removal will be undertaken progressively from south to north towards the existing bird habitat areas (Swan Pond and Wader Pond), thereby maintaining a treed buffer during the majority of mangrove removal activities.

NCIG Vegetation Clearance Protocol will be utilised prior to any vegetation being disturbed.





6.4.3 Management of Waste Materials

Waste will be managed in accordance with the CEMP as required by REF Determination Condition 52.

Mangrove mulch will be stockpiled over the exotic rank grassland in the Activity area between the Area E shorebird compensatory habitat and South Bank Road (Figure 37). No placement of removed material will occur on the western side of Southbank Road (near the narrow strip of Littoral Rainforest EEC [Figure 36]).

Smaller mangroves removed during ongoing management will be left to breakdown within the Area E shorebird compensatory habitat (consistent with Hunter Bird Observers Club, 2010).

Other materials no longer required (e.g. un-used fencing material) will be removed and disposed of appropriately off-site.

6.4.4 Revegetation of Saltmarsh

Once the overstorey of mangrove trees is removed, saltmarsh plants (such as Samphire [*Sarcocornia quinqueflora*] and Saltwater Couch [*Sporobolus virginicus*]) are likely to rapidly colonise the area. Many of these plants are within the mangrove understorey. This is supported by the monitoring undertaken by Laegdsgaard (2014) in Fish Fry Flats. This recolonisation process will be assisted through the manipulation of the tidal regime in the Activity area to be conducive for saltmarsh growth (i.e. by facilitating normal tidal flow via the Fish Fry Creek 'Smart Gate' [Section 6.4.1]).

6.4.5 Power Line Management

Existing power lines occur within the shorebird compensatory habitat (Figure 33). Powerlines do present a risk to migratory birds, particularly lines that cross their flight paths. NCIG will consult with TransGrid and Ausgrid and seek to install visual deterrents (bird flight diverters) on the powerlines within 12 months of mangrove removal.

6.4.6 Diesel/Petrol Spills

To avoid diesel/petrol spills:

- Contractor vehicles and machinery will undergo regular maintenance and daily pre-start inspections, and will be fully road registered or accredited.
- Vehicles and machinery will be parked away from sensitive areas as best as possible to minimise the consequence of material environmental harm in the event of a diesel/oil spill.
- Vehicles and machinery will be refuelled in designated bunded areas.
- Spill kits will be contained in light vehicles at all times and in each work area. Spill kit contents will be administered as soon as oil/diesel leakage is recognised to avoid contact with sensitive ecological areas.

NCIG will work with the civil contractor to implement appropriate refuelling practices and controls including a dedicated bunded refuelling area.

6.4.7 Acid Sulphate Soils

The safeguards/mitigation measures that will be used to limit impacts on land resources from acid-generating soils include:

- NCIG will prepare an Acid Sulfate Soils Management Plan (in accordance with the Acid Sulfate Soils Management Advisory Committee (1998) Acid Sulfate Soils Assessment Guidelines). This will be used to manage any acid sulfate soil management issues.
- The safeguards/mitigation measures that will be used to limit any impacts on land resources from acid-generating soils include:
 - The volume of disturbed soil will be kept to a minimum to avoid the excessive treatment of acid-generating soils.
 - Monitoring of adjacent water bodies to identify any drop in pH that may indicate acid generating soils
 - Development of a Trigger Action Response Plan (TARP) to manage the identification of acid generating soils and any environmental impact.
- The Acid Sulphate Soils Management Plan will be prepared prior to undertaking the Activity and submitted to OEH/NPWS for consultation.

6.4.8 Weed Control

Any mobile plant entering the Area E shorebird compensatory habitat during mangrove removal will be inspected prior to entry to remove soil and/or organic matter and to disinfect tyres and wheels of vehicles entering the Area E shorebird compensatory habitat that have been exposed to mud.

6.4.9 Environmental Induction Training

NCIG employees or contractor staff working within the Area E shorebird compensatory habitat will undertake environmental induction training which will include, but not be limited to, recognition that the works are being undertaken in the Hunter Wetlands National Park, access restrictions, location of EECs, and identification of Coastal Saltmarsh EEC.

To reduce the likelihood of spreading potential Chytridiomycosis infection, all NCIG employees and contractors involved in works for the Activity will be trained in site hygiene management in accordance with *Threatened Species Management Information Circular No.6 Hygiene Protocol for the Control of Disease in Frogs (Hygiene Protocol)* (NPWS, 2008) as part of environmental induction training.

6.5 ONGOING MANAGEMENT

The shorebird compensatory habitat will be actively managed for the life of the NCIG CET. The shorebird compensatory habitat will be managed by:

1. mangrove removal;
2. control of weeds;
3. control of feral predators; and
4. remediation of erosion.

These measures are described in Sections 6.5.1 to 6.5.4.

6.5.1 Mangrove Removal

The mangrove removal methods during the maintenance phase (i.e. after the initial removal of mangroves and during ongoing management of the saltmarsh) will be consistent with the CHEMP (NCIG, 2013) to the extent practicable:

Hand Removal - Mangroves less than 1 m in height will be manually removed (pulled out by hand). If mangrove seedlings are found to be regrowing in the Area E shorebird compensatory habitat Area following an annual inspection, the mangroves will be manually removed.

Depending upon the scale of the maintenance works being undertaken, mechanical removal consistent with the Mangrove Removal Procedure outlined in 6.4.2 may be utilised. It is noted that hand removal is not possible for trimming of exposed mangrove stumps after sediment loss, and such maintenance will require use of machinery. Wide tracked excavator (fitted with mulcher head) or Positrack (mulcher) will not be used in areas of Coastal Saltmarsh EEC.

Care will be taken to minimise trampling of saltmarsh during hand removal of mangroves. It is anticipated that saltmarsh plants are likely to rapidly colonise the area of any minor disturbances.

The techniques for removing mangroves may change over time (e.g. based on new technologies and/or adaptive management).

6.5.2 Weed Control

Weed control methods will be restricted to mechanical removal and/or “environmentally friendly” products. A herbicide registered for use in aquatic situations by the National Registration Authority will be used for the control of weeds where physical control methods are not practical. The introduction of increased tidal waters for defined periods will also be considered to control weed infestation.

Noxious weeds will be controlled in accordance with the NSW *Noxious Weeds Act, 1993*.

6.5.3 Feral Predators

The European Red Fox (*Vulpes vulpes*) has been recorded on Kooragang Island (EcoBiological, 2011) and is known to prey on shorebirds. NCIG will seek to co-ordinate feral predator control with the NPWS.

6.5.4 Remediation of Erosion

Mangroves can stabilise substrate and decrease erosion caused by stream flow. In the event that the stability of creek banks along Fish Fry Creek is problematic, a management strategy will be developed with the NCIG Consultative Board. Possible options for stabilising the creek banks include: revegetation using saltmarsh species or reinforcement of the banks (e.g. rocks or gabion cells). NCIG will seek all relevant approvals in the event that the banks need to be reinforced.

6.6 OTHER FACTORS

Aboriginal and historic heritage will be managed in accordance with REF Determination Conditions 27 and 28.

Equipment and materials will be stored in accordance with REF Determination Conditions 33 to 36.

Fire fighting equipment will be provided on site during periods of declared high fire danger in accordance with REF Determination Conditions 37 to 39.

NPWS will be notified of environmental harm in accordance with REF Determination Conditions 40 to 44.

Acid sulphate soils will be managed in accordance with REF Determination Conditions 47 to 49.

6.7 MONITORING

In accordance with REF Determination Condition 21, as late as practicable but prior to commencing work, initial baseline monitoring (Sections 6.7.1 and 6.7.2) will be undertaken and quantified to allow measurable comparisons with data collected for future long term monitoring. In accordance with REF Determination Condition 22, a baseline report will be compiled to act as a reference for future change as part of the monitoring program. The baseline report will be submitted to the Local Hunter Area Manager.

6.7.1 Monitoring Shorebird Usage of the Habitat

Monitoring will be undertaken to record the usage of the compensatory habitat by shorebirds. Shorebirds (species, abundance and foraging behaviour) will be surveyed by an appropriately qualified specialist each month for the first two years of establishing the compensatory habitat and then quarterly for the life of the NCIG CET (refer to REF Determination Condition 58).

Foraging behaviour will be surveyed during low tide as well as the use of the site as roosting habitat during high tides at the site. Monitoring could be carried out in conjunction with the monitoring described in Section 7.

The data will be collated annually and evaluated for a trend over time by a suitably qualified person.

6.7.2 Monitoring Habitat for Shorebirds

Monitoring will be undertaken to measure and record the development and condition of mudflats and saltmarsh and the compensatory habitat. Habitat monitoring will be carried out monthly for the first two years following completion of compensatory habitat works and then quarterly for the life of the NCIG CET. Monitoring methods are provided in Table 10.

Table 10
Habitat Monitoring Methods

Method	Description
Transects	Saltmarsh cover/growth measurements will be measured along transects.
Visual observations	Visual observations will be made of any mangrove regrowth or new mangrove seedlings.
Photographs	Photographs will be taken at set photo points each month to show the progress.
Vegetation mapping	Mapping of vegetation communities within the compensatory habitat.

Benthic invertebrates provide a food source to shorebirds. Following recommendations from Phil Straw (Avifauna Research & Services Pty Ltd), benthic invertebrates will also be monitored before the mangroves are removed and then every six months after mangrove removal for two years. After two years, benthic invertebrates will also be monitored annually.

A report detailing the Area E shorebird compensatory habitat monitoring results will be prepared annually. The report will include an analysis of the monitoring data over time. The monitoring reports will be provided to OEH and NPWS by 31 December each year.

6.8 ADAPTIVE MANAGEMENT

NCIG will undertake a process of ongoing adaptive management and external review of the performance of the compensatory habitat through the construction and monitoring of habitat. Should monitoring show that ameliorative actions are required at the end of the 2nd year, additional actions will be undertaken in accordance with expert recommendations in order to meet the objectives of the program.

7 MIGRATORY SHOREBIRD MONITORING AND ECOLOGICAL STUDIES

Additional to the monitoring outlined in Section 6.7 for the shorebird compensatory habitat, in accordance with Condition 2.20(c) of Project Approval (06_0009), NCIG will fund migratory bird monitoring in and around Deep Pond and Swan Pond for the life of the NCIG CET. The funding commenced in 2008, whereby the Hunter Bird Observers Club were funded to undertake the monitoring in and around Deep Pond. The monitoring of Deep Pond is conducted on the morning high tide and co-ordinated with other regular monitoring throughout the Hunter River Estuary.

The NCIG CET rail flyover modification, approved by the NSW Planning Assessment Commission as delegate of the Minister for Planning and Infrastructure on 13 May 2013, will impact on Swan Pond. Following completion of construction of the NCIG CET rail flyover modification components, NCIG will fund migratory bird monitoring in and around Swan Pond.

The monitoring data will be analysed for any changes in utilisation patterns/behaviour and may inform the design process for impacts from the NCIG CET on Deep Pond or Swan Pond.

8 AMELIORATIVE WORKS

In accordance with Condition 2.20(f) Schedule 2 of Project Approval (06_0009), NCIG will fund the removal of up to 6 ha of mangroves⁷ from coastal saltmarsh habitat between Fish Fry Creek and Wader Creek on Kooragang Island to improve or restore the natural hydrology and ecosystems (i.e. Area E see Figure 32). These works are proposed in addition to the 8 ha of compensatory habitat required (Section 6.3.3), thereby providing a total 14 ha of potential shorebird habitat. These works are proposed to be managed as part of the Area E shorebird compensatory habitat (Section 6) and are expected to enhance habitat for migratory birds (Section 6.3.4). Further, these works are anticipated to provide habitat for the locally endemic Coastal Saltmarsh EEC.

9 CO-ORDINATION WITH OTHER DEVELOPMENTS

In accordance with Condition 2.20(g) of Project Approval (06_0009), NCIG will continue to consider co-ordinating compensatory and ameliorative works with other development (with similar requirements as detailed in the CHEMP). As mentioned previously in Section 4.2, NCIG has used captive-bred tadpoles to populate the Research Ponds. NCIG is currently sharing costs of a captive breeding facility for Green and Golden Bell Frogs at the University of Newcastle with PWCS. The breeding facility is located at the University of Newcastle and is managed by the amphibian research group.

⁷ This is in addition to the 8 ha of shorebird compensatory habitat (Section 6).

10 CONSERVATION BOND

In accordance with Condition 2.20A of Project Approval (06_0009), a Conservation Bond will be lodged with DP&E by 30 July 2013, or as otherwise agreed by the Secretary of DP&E. Within 3 months of the date of the approval of the NCIG CET rail flyover modification (13 May 2013), NCIG shall determine the sum of the Conservation Bond to the satisfaction of the Secretary of DP&E, in consultation with OEH.

The sum of the Conservation Bond will be based on the following:

- a) Calculating the full cost of fulfilling its compensatory habitat obligations outlined in Condition 2.20 of Project Approval (06_0009), in perpetuity, (including any land acquisition costs). These costs need to consider research, establishment of habitat, ongoing monitoring and management of the habitat.
- b) Employing a suitably qualified quantity surveyor to verify the calculated costs.

In accordance with Condition 2.20A of Project Approval (06_0009), if the offset (compensatory habitat) is completed in accordance with the performance and timing commitments in the CHEMEP to the satisfaction of the Secretary of DP&E, in consultation with the OEH, the Secretary of DP&E will release the bond. If the offset (compensatory habitat) is not completed in accordance with the performance and timing commitments in the CHEMEP, the Secretary of DP&E may, in consultation with OEH, call in all or part of the Conservation Bond, and arrange for the satisfactory completion of the relevant works.

The sum of the Conservation Bond may be reduced, subject to the successful performance of the compensatory works. The reduction of the Conservation Bond will be at the agreement of the Secretary of DP&E, in consultation with the OEH. In relation to the Green and Golden Bell Frog, successful performance works include the identification of a viable breeding population.

The Conservation Bond will be segmented to allow the recovery of portions of the bond subject to the successful completion of major elements and the performance of elements of the compensatory works. The overall bond will comprise separate elements for the delivery of Green and Golden Bell Frog and shorebird elements and be segmented as follows: 50% for completion of capital construction, 25% for completion of establishment and 25% for illustration of success of habitat through occupation. Each successful completion of each of these elements will be verified by an independent certifier and an associated reduction in the overall bond held will be at the agreement of the Secretary of DP&E, in consultation with the OEH.

11 TIMING AND RESPONSIBILITIES

In accordance with Condition 2.20(d) of Project Approval (06_0009), NCIG will fund or otherwise undertake the works described in the CHEMEP to facilitate the ongoing adaptive management and review of the performance of compensatory habitat works for the life of the Project. As stated in Section 5, NCIG will undertake a process of ongoing adaptive management and review of the performance of Green and Golden Bell Frog compensatory habitat works through the construction and ongoing monitoring of compensatory habitat works.

CHEMEP tasks completed to date are shown in Table 11. The proposed schedule for development of compensatory habitat is shown on Figure 38.

Table 11
Completed Compensatory Habitat and Ecological Monitoring Schedule
for the Green and Golden Bell Frog

Project Component	Timing	
	Start Date	End Date
Green and Golden Bell Frog Monitoring	2006	Ongoing
NCIG CET Commencement of Works	Q2 (2008)	
Receipt of DECCW (now OEH) Compensatory Habitat Framework	End Q3/Start Q4 (2008)	
DoP (now DP&E) Approval for Deferral of Commencement of Compensatory Habitat Works	Q4 (2008)	
Preparation and Submission of CHEMEP	Q3 (2008)	Q3 (2009)
Create Rail Culvert Green and Golden Bell Frog Habitat	Start 2009	Q2 (2009)
DoP (now DP&E) Approval of CHEMEP	Mid Q4 (2010)	
Consultative Board	End Q3/Start Q4 (2010)	Ongoing
Flora and Fauna Assessment – Ash Island	Start Q2 (2011)	End Q2 (2011)
Research Program Negotiation and Project Selection	Start Q2 (2011)	End Q3 (2011)
Soil, Surface Water and Groundwater Investigation Review of Environmental Factors (preparation and submission)	Mid Q3 (2011)	End Q3 (2011)
Approval for Soil, Surface Water and Groundwater Investigation	Q4 (2011)	
Wetland Vegetation (collection, growing)	Q4 (2011)	End Q2 (2012)
Design of the Research Ponds	Q1 (2012)	
Research Ponds Review of Environmental Factors (preparation and submission)	End 2011	End Q2 (2012)
Approval of the Research Ponds (Review of Environmental Factors)	Q3 (2012)	
Construction of the Research Ponds	Q2 (2012)	Q3 2012
Compensatory Habitat Stabilising Period	Q3 (2012)	Q4 2012
Green and Golden Bell Frog Populating into the Research Ponds	Q1 (2013)	
Flora and Fauna Assessment – Ash Island	Q1 (2013)	
Conceptual Design of the Green and Golden Bell Frog Compensatory Habitat	Q1 (2013)	
Security of the compensatory habitat location for the Green and Golden Bell Frog	Q4 2013	
Completion of the Green and Golden Bell Frog compensatory habitat works	Q4 2014	

NCIG will be responsible for the monitoring, reviewing and implementation of this CHEMEP. It is important to note that the timing, staging and responsibilities of the CHEMEP will be determined in accordance with the advice of the NCIG Consultative Board.

11.1 EVALUATION OF A VIABLE BREEDING POPULATION – PURCHASE OF ADDITIONAL LAND

In accordance with Condition 2.20(i)(iii) of Project Approval (06_0009), if a viable breeding population⁸ of Green and Golden Bell Frog has not been established as part of the implemented compensatory habitat works then NCIG is required to purchase an equivalent area of land that is known to contain the species and manage this land for the enduring conservation of the species in perpetuity. Any land required to be purchased is required to be completed by 31 December 2019.

The demonstration of the establishment of a viable breeding population will be subject to seasonal conditions that will reasonably present an opportunity for a breeding event. If extended unfavourable conditions occur (e.g. drought) after completion of the works this is likely to limit breeding activity rather than the quality/suitability of the habitat created. In this situation, the Secretary of DP&E will be approached to extend timing.

11.2 SECURITY OF THE COMPENSATORY HABITAT

In accordance with Condition 2.20(i)(iii) of Project Approval (06_0009), before 31 December 2013, the Proponent shall secure compensatory habitat locations required under Condition 2.20b of Project Approval [06_0009]). The Green and Golden Bell Frog compensatory habitat is located within the Hunter Wetlands National Park, therefore the area is already secured for conservation purposes. The Green and Golden Bell Frog compensatory habitat will be identified in the Plan of Management for the Hunter Wetlands National Park.

The Area E shorebird compensatory habitat is located on Part 11 Managed Land by NPWS and administered under the *National Parks and Wildlife Act, 1974*. The proposed location and works in Part 11 Managed Land are appropriate and consistent with the relevant management principles that NPWS is obliged to observe in respect of the land which it manages.

Adopting a similar approach for the provision of biodiversity offsets for Green and Golden Bell Frogs, a Memorandum of Understanding (subject to NPWS agreement) will be entered into to provide for shorebird compensatory habitat at the proposed location. Given the proposed location is on Part 11 Managed Land, and is zoned SP2 – Infrastructure under the *State Environmental Planning Policy (Major Development) 2005 – Tomago Industrial Site*, if a Memorandum of Understanding was to exist, NCIG will anticipate that any future development will need to consider and, if approved, appropriately offset any disturbance, and therefore will allow for conservation in perpetuity.

11.3 CONSTRUCTION OF THE HIGH CAPACITY OPTIONAL INLET RAIL SPUR AND RAIL SIDING

In accordance with Condition 2.20(b)(ii) of Project Approval (06_0009), the commencement of compensatory habitat works shall occur within 6 months of the commencement of construction of the High Capacity Optional Inlet Rail Spur and Rail Sidings, or as otherwise agreed by the Secretary of DP&E. Condition 1.6 of Project Approval (06_0009) states that NCIG may only proceed to construct the High Capacity Optional Inlet Rail Spur and Rail Siding upon receipt of the Secretary of DP&E satisfaction that the CHEMEP is being implemented according to the timeframes required, or to the extent agreed by the Secretary of DP&E.

⁸ Refer to definition of a 'viable breeding population' under Table 1 in Section 1 and Project Approval (06_0009).

12 REPORTING AND REVIEW

Monitoring Report - Green and Golden Bell Frog Compensatory Habitat

A report detailing the Green and Golden Bell Frog compensatory habitat monitoring results will be prepared annually. The report will document the parameters described in Section 5.7 and will include an analysis of the monitoring data over time. The monitoring reports will be held by NCIG.

Monitoring Report - Shorebird Compensatory Habitat

A report detailing the Area E shorebird compensatory habitat monitoring results will be prepared annually. The report will include an analysis of the monitoring data over time. The monitoring reports will be provided to OEH and NPWS by 31 December each year.

Annual Environmental Management Report (AEMR)

NCIG will prepare an AEMR that reviews the performance of the NCIG CET against the CEMP, and provides an overview of environmental management actions and summarises monitoring results over the 12 month reporting period. The AEMR will be distributed to relevant government agencies and the NCIG Consultative Board, and copies provided to other interested parties, if requested. The AEMR will also include a recommendation of the works required for the upcoming year.

Updates to the NCIG Consultative Board

Quarterly updates will be provided to the NCIG Consultative Board to ensure members are kept up to date on program developments. These reports will provide updates on each element of the program and make recommendations for any adjustment to agreed works.

Compliance Tracking Program

The Compliance Tracking Program prepared in accordance with Condition 5.1 of Project Approval (06_0009) provides for periodic reviews of the NCIG's compliance status against the requirements of Project Approval (06_0009). The Compliance Tracking Program also provides a response mechanism in the event that a non-compliance with Project Approval (06_0009) is identified. Notwithstanding, the CEMP will be revised prior to construction of the High Capacity Optional Inlet Rail Spur and Rail Sidings.

Publishing of the CEMP

In accordance with Condition 6.4 of Project Approval (06_0009), the CEMP will be made available on the NCIG website.

Revision of the CEMP

In accordance with Condition 6.4 of Project Approval (06_0009), in the event that the NCIG CET is modified such that it results in impacts to biodiversity different to those assessed, NCIG will submit, for the approval of the Secretary of DP&E, a revised CEMP within three months of any approval.

Incident Notification

In accordance with Condition 8.1 of Project Approval (06_0009), the Secretary of DP&E will be notified of any incident with actual or potential significant off-site impacts on people or the biophysical environment as soon as practicable after the occurrence of the incident. The Director-General will be provided with written details of the incident within seven days of the date on which the incident occurred.

13 REFERENCES

- Acid Sulphate Soil Management Advisory Committee (1998) *Acid Sulphate Soils Planning Guidelines*.
- Berger, L., Speare, R. and Hyatt, A. (1999) *Chytrid fungi and amphibian declines: overview, implications and future directions*. In Campbell, A. (Ed.) *Declines and Disappearances of Australian Frogs*. Environment Australia, Canberra, pp. 23-33.
- Biosphere Environmental Consultants (2006-2012) *Green and Golden Bell Frog Monitoring Results, Kooragang Island*. Data collected for NCIG.
- Browne, R.K. and Edwards, D.L. (2003) The effect of temperature on the growth and development of the endangered Green and Golden Bell Frog (*Litoria aurea*). *Journal of Thermal Biology*, 28(4), 295-299.
- Christy, M. (1996) The efficacy of using Passive Integrated Transponder (PIT) tags without anaesthetic in free-living frogs. *Australian Zoologist* 30, 139-142.
- Christy, M.T. and Dickman, C.R. (2002) Effects of salinity on tadpoles of the Green and Golden Bell Frog (*Litoria aurea*). *Amphibia-Reptilia* 23(1), 1-11.
- Connell Hatch (2006) *NCIG Kooragang Island CET – Seasonal Ecological Investigations – Green and Golden Bell Frog Survey*. Revision 2.
- Department of Environment and Climate Change (2008a) *Kooragang Island Threatened Species Offset Framework*.
- Department of Environment and Climate Change (2008b) *Best Practice Guidelines: Green and Golden Bell Frog Habitat*.
- Department of Environment and Climate Change (2008c) *Protecting and Restoring Green and Golden Bell Frog Habitat*.
- Department of Environment and Climate Change (2009) *Guidelines: Field Survey Methods for Fauna: Amphibians*.
- Department of Environment and Conservation (2005) *Green and Golden Bell Frog (Litoria aurea) Recovery Plan*.
- Department of the Environment, Water, Heritage and the Arts (2009) *Background Paper to EPBC Act Policy Statement 3.19 - Nationally Threatened Species and Ecological Communities. Significant Impact Guidelines for the vulnerable green and golden bell frog (Litoria aurea)*.
- Department of the Environment, Water, Heritage and the Arts (2010) *Survey Guidelines for Australia's Threatened Frogs*.
- EcoBiological (2011) *Baseline Fauna Study – Hunter Wetlands National Park*. Report prepared for the NSW Office of Environment and Heritage.
- Environmental Resources Management (2003a) *Kooragang Port and Transport Corridor, Species Impact Statement*.
- Environmental Resources Management (2003b) *The Green and Golden Bell Frog on Kooragang Island Monitoring Study*.

- Environmental Resources Management (2004) *Green and Golden Bell Frog Tadpole Surveys*.
- Hamer, A.J. (1998) *Aspects of the ecology of the Green and Golden Bell Frog Litoria aurea on Kooragang Island*. New South Wales, Australia.
- Hamer, A.J. and Mahony, M.J. (2007) Life history of an endangered amphibian challenges the declining species paradigm. *Australian Journal of Zoology* 55, 79-88.
- Hamer, A.J. and Mahony, M.J. (2010) Rapid Turnover in Site Occupancy of a Pond-breeding Frog Demonstrates the need for Landscape-level Management. *Society of Wetland Scientists*.
- Hamer, A.J., Lane, S.J. and Mahony, M.J. (2002) Management of freshwater wetlands for the endangered Green and Golden Bell Frog (*Litoria aurea*): roles of habitat determinants and space. *Biological Conservation* 106(3), 413-424.
- Hamer, A.J., Lane, S.J. and Mahony, M.J. (2008) Movement patterns of adult Green and Golden Bell Frogs *Litoria aurea* and implications for conservation management. *Journal of Herpetology* 42, 397-407.
- Harding, S.B., Wilson, J.R. and Geering, A.D.W. (2007) Threats to Shorebirds and Conservation Actions. In Geering, A.D.W. Agnew, L. and Harding, S.B. *Shorebirds of Australia*. CSIRO Publishing, Canberra.
- Herbert, C. (2007) *Distribution, Abundance and Status of Birds in the Hunter Estuary*. Report prepared for Newcastle City Council.
- Hunter Bird Observers Club (1999-2012) *Bird Monitoring Results for Swan and Wader Pond*.
- Hunter Bird Observers Club (2008-2012) *Bird Monitoring Results for Deep Pond*.
- Hunter Bird Observers Club (2010) *Mangrove Removal Techniques for Estuarine and Saltmarsh Restoration*. In Annual Report Appendix C Milham Pond Saltmarsh and Shorebird Habitat Restoration Project. Prepared by Hunter Bird Observers Club.
- Hunter-Central Rivers Catchment Management Authority (2011) *Managing Hydrodynamics for Shorebird Habitat in Area E, Ash Island, Hunter Estuary*. Prepared by Dr Pia Laegdsgaard for KWRP.
- Laegdsgaard (2014) *Area E Water Management Project*. Unpublished report.
- Lane, S.J., Hamer, A.J. and Mahony, M.J. (2007) Habitat correlates of five amphibian species and species-richness in a wetland system in New South Wales, Australia. *Applied Herpetology* 4, 65-82.
- Mahony, M. and Werkman, H. (2001) *The Distribution and Prevalence of Chytrid Fungus in Frog Populations in Eastern New South Wales and Developing a Means to Identify Presence or Absence of Chytrid Fungus in the Field*. Report prepared for NSW National Parks and Wildlife Service Declining Frog Working Group.
- McConville, A. (2011) *Bat Call Analysis Report Hunter Estuary and Hexham Swamp National Park*. Prepared for the Office of Environment and Heritage.
- National Parks and Wildlife Service (2008) *Threatened Species Management Information Circular No. 6 Hygiene Protocol for the Control of Disease in Frogs*.

- Newcastle Coal Infrastructure Group (2006) *Newcastle Coal Infrastructure Group Coal Export Terminal Environmental Assessment*.
- Newcastle Coal Infrastructure Group (2007) *Newcastle Coal Infrastructure Group Coal Export Terminal Green and Golden Bell Frog Management Plan*.
- Newcastle Coal Infrastructure Group (2010) *Newcastle Coal Infrastructure Group Coal Export Terminal Compensatory Habitat and Ecological Monitoring Program*.
- Newcastle Coal Infrastructure Group (2012a) *Newcastle Coal Infrastructure Group Coal Export Terminal Rail Flyover Modification Environmental Assessment*.
- Newcastle Coal Infrastructure Group (2012b) *Green and Golden Bell Frog Trial Ponds – Ash Island Review of Environmental Factors*.
- Newcastle Coal Infrastructure Group (2014) *Shorebird Compensatory Habitat Review of Environmental Factors*.
- Office of Environment and Heritage (2011a) *Principles for the Use of Biodiversity Offsets in NSW*.
Website: <http://www.environment.nsw.gov.au/biocertification/offsets.htm>
Date Accessed: June 2013.
- Office of Environment and Heritage (2011b) *Statement of Interim Management Intent (revised 2011) for Ash Island (Hunter Wetlands National Park)*.
- Office of Environment and Heritage (2012) *Land Available on Kooragang Island for Compensatory Habitat*. Map provided to Newcastle Coal Infrastructure Group.
- Pyke, G.H. and White, A.W. (2001) A review of the biology of the Green and Golden Bell Frog *Litoria aurea*. *Australian Zoologist* 31: 563-598.
- RCA Australia (2006) *Land Contamination and Groundwater Assessment, Newcastle Coal Infrastructure Group Coal Export Terminal*. Report prepared for the Newcastle Coal Infrastructure Group.
- RCA Australia (2012) *Soil, Surface Water and Groundwater Study – Proposed Green and Golden Bell Frog Trial Habitat*. Report prepared for the Newcastle Coal Infrastructure Group.
- Umwelt (Australia) Pty Limited (2012) *Ecological Assessment for Port Waratah Coal Services (PWCS) Proposed Terminal 4 (T4) Project, Port of Newcastle NSW*. Prepared on behalf of PWCS.
- University of New South Wales (2014) *Tidal Restoration and Wetland Creation at the Kooragang Nature Reserve (Tomago, NSW)*.
Website: <http://www.wrl.unsw.edu.au/site/projects/tidal-restoration-and-wetland-creation-at-the-kooragang-nature-reserve-tomago-nsw/>
Accessed: November 2014.
- White, A.W. and Pyke, G.H. (2008) Green and Golden Bell Frogs in NSW current status and future prospects. *Australian Zoologist* 34, 319-333.
- Wicks, C.C. (1992) *Groundwater Regime of Kooragang Island – Ash Island Study Final Report*. The University of Newcastle, Department of Civil Engineering and Surveying.

ATTACHMENT 1

DIRECTOR-GENERAL'S APPROVAL OF QUALIFIED ECOLOGIST
– DR ARTHUR WHITE



NSW GOVERNMENT
Department of Planning

Contact: Patricia Cabezas
Phone: 02 9228 6447
Fax: 02 9228 6366
Email: patricia.cabezas@planning.nsw.gov.au

Our ref: S06/00617
Your ref:

Mr Nathan Juchau
NCIG HSEC Manager
Level 9, 1 York Street
SYDNEY NSW 2000

Dear Mr Juchau

**Newcastle Coal Infrastructure Group Coal Export Terminal (Application No. 06_0009) –
Appointment of a Qualified Ecologist**

I refer to your letter dated 8 October 2007 requesting approval for the appointment of an additional qualified ecologist for the abovementioned project.

The Department has reviewed Dr Arthur White's qualifications and experience and considers that Dr White is suitably qualified for the appointment of ecologist should Professor Goldney be unavailable to take up the duties as described in the Minister's approval (conditions 2.16 and 2.19). The Director-General therefore approves of the employment of Dr Arthur White.

If you have any questions or require clarification of the above, please do not hesitate to contact Patricia Cabezas on (02) 9228 6447 or email at patricia.cabezas@planning.nsw.gov.au.

Yours sincerely

15.10.07

Chris Wilson
Executive Director
Major Project Assessments
As delegate for the Director-General

ATTACHMENT 2

DIRECTOR-GENERAL'S APPROVAL OF QUALIFIED ECOLOGIST –
PROFESSOR DAVID GOLDNEY



NSW GOVERNMENT
Department of Planning

2 May 2007

Contact: Ingrid Ilias
Phone: 02 9228 6411
Fax: 02 9228 6366
Email: ingrid.ilias@planning.nsw.gov.au

Mr Paul Beale
NCIG Operations Manager
Level 9, 1 York Street
SYDNEY NSW 2000

Our ref: S06/00617
Your ref:

Dear Mr Beale

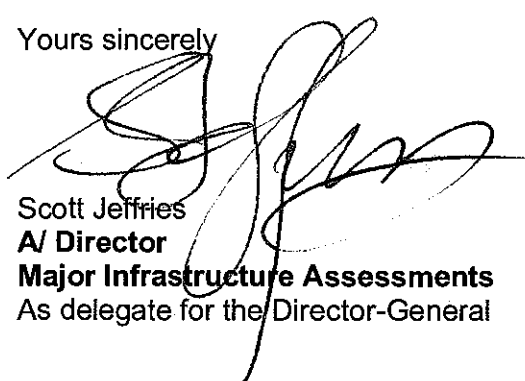
**Newcastle Coal Infrastructure Group Coal Export Terminal (Application 06_0009) –
Conditions 2.16 and 2.19**

I refer to your letter dated 1 May 2007 providing further information in relation to Professor David Goldney's ecological experience as a result of the Department's request by letter dated 23 April 2007.

The Department has reviewed the additional information provided and considers that Professor Goldney has the appropriate experience to be nominated as NCIG's qualified ecologist to address the specific requirements of the Minister's approval (conditions 2.16 and 2.19) and oversee the construction of the project with regard to the management of the ecological attributes of the site. The Director-General therefore approves of the employment of Professor David Goldney.

If you have any questions or require clarification of the above, please do not hesitate to contact Ingrid Ilias on 9228 6411 or via email at ingrid.ilias@planning.nsw.gov.au or Patricia Cabezas on 9928 6447 or email at patricia.cabezas@planning.nsw.gov.au.

Yours sincerely



Scott Jeffries
A/ Director
Major Infrastructure Assessments
As delegate for the Director-General

ATTACHMENT 3

GREEN AND GOLDEN BELL FROG HABITAT AND CONSERVATION
ASH ISLAND



<p>Mail Address: 69 Bestic St. Rockdale NSW 2216 e-mail: 1arthur@tpg.com.au A.C.N. 065 241 732 A.B.N. 32 065 241 732</p>
--

Green and Golden Bell Frog Habitat and Conservation Ash Island 2013

1.0 Introduction

Ash Island was traversed on foot on the 8th of April 2013 by Dr Arthur White so that habitat areas for Green and Golden Bell Frogs could be accurately determined and mapped.

Mapping of habitat areas was required so that potential compensatory areas for the Green and Golden Bell Frog could be determined. A similar process was carried out in 2011 to assess other potential sites on Ash Island (White 2011). By determining the nature and extent of each habitat type, a better appraisal can be made of which habitats need to be created or enhanced, which habitats are already ample and do not need amplification, and which areas are available for the creation of future habitats (should that be required).

Habitat assessments were based on published information for this species (DEC 2005, Pyke and White 2001, Pyke *et al.* 2002).

2.0 North-western Portion of Ash Island

The north-western portion of Ash Island has been chosen as the most suitable location to establish compensatory habitat for the Green and Golden Bell Frog.

This site was selected for three main reasons: firstly, the north-western portion of Ash island does not contain extant Green and Golden Bell Frog populations (but it has done so in the past); secondly, the area contains discontinuous patches of Green and Golden Bell Frog habitat that can be enhanced to greatly extend the amount of usable habitat for this frog species; thirdly, the north-western portion of the island is close to the NCIG Research Enclosure and can be readily incorporated into the overall extended habitat area of the frog.

3.0 Mapping of Green and Golden Bell Frog Habitat Areas

Green and Golden Bell Frog habitat areas were mapped according to the following criteria:

Breeding Habitat:

- Permanent or near-permanent freshwater bodies with substantial, open water areas.
- Ponds need to have high exposure to direct sunlight.
- Ponds need some protection from prevailing winds.
- Ponds should be fluctuating.
- Ponds should not contain predatory fish (or fish should be in low numbers, or there should be significant shelter areas in the ponds created by emergent vegetation).

Foraging Habitat:

- Areas of low, ground vegetation (such as exotic and native pastureland, herb fields) where crickets and grasshoppers proliferate.
- Margins of ponds where there is a well developed margin of fringing, low vegetation.
- Disturbed, open sites (where cockroaches may be found).

Potential Movement Habitat:

- Areas of low, ground vegetation (such as exotic and native pastureland, herb fields, edges of roads, tracks or drains).
- May include saline areas (provided there is a freshwater source nearby).

Shelter Habitat:

- Fallen trees or logs.
- Emergent vegetation in ponds; fringing vegetation around ponds.
- Industrial or domestic solid refuse items.

Over-winter Habitat:

- Fallen trees or logs.
- Tall, emergent vegetation in ponds.
- Rock piles.
- Industrial or domestic solid refuse items.

Based on these simple criteria, supported by the documented requirements of Green and Golden Bell Frogs (Pyke and White 2001), the site was traversed on foot and the habitat areas within were mapped onto the vegetation map.

4.0 Habitat for Green and Golden Bell Frogs

The majority of the north-western portion of Ash Island has been cleared and used for farming. As a result, large tracts of overgrown pastureland dominate the landscape (Figure 1). These areas typically comprise open areas of exotic grasses interspersed with smaller, low-lying depressions dominated by small sedges. The area also contains the remnants of three old river channels; these channels all lie in a north-west to south-easterly direction and act as ephemeral sumps in the old pasturelands. Long sections of the old channels have become colonised by Cumbungi (*Typha orientalis*) and so appear as narrow rushland corridors across the north-western portion of Ash Island (Figure 2).

Figure 1: Pastureland in the North-west Portion of Ash Island



Figure 2: Old Creek Channels Now Filled with Cumbungi

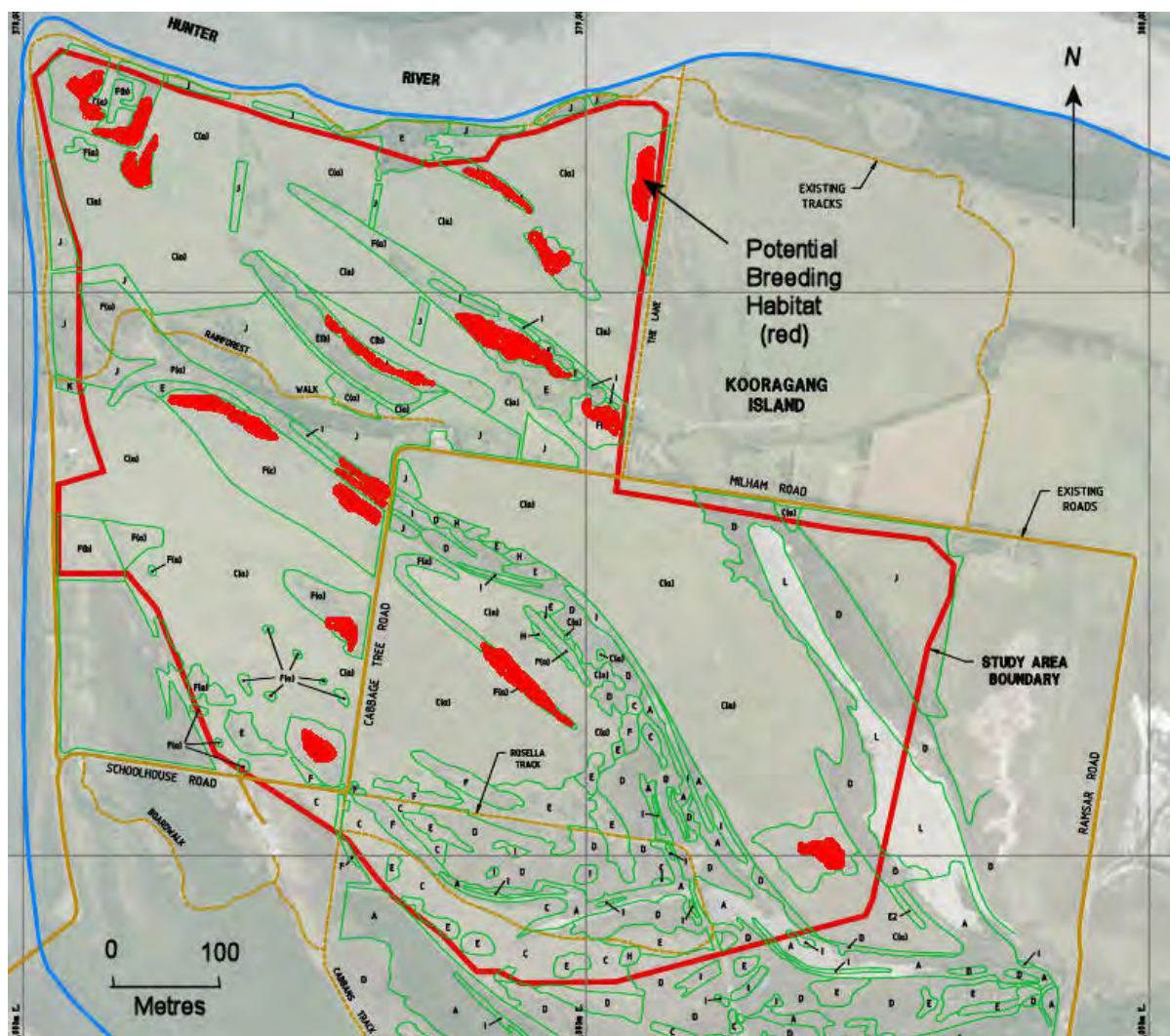


4.1 Breeding Habitat Areas

Figure 3 contains the habitat maps for breeding habitat in the north-western portion of Ash Island. Breeding sites in this part of Ash Island are quite ephemeral and so may not be usable for years at a time. The area of breeding habitat that appears to retain water for the longest periods is at the extreme north-western corner of the island, near Scotts Point.

Potential breeding habitat areas on Ash Island are fish-free depressions that can retain water for at least 2 months at a time. Most of these sites are ephemeral but are vegetated with either reeds or rushes indicating the damp soil areas around them.

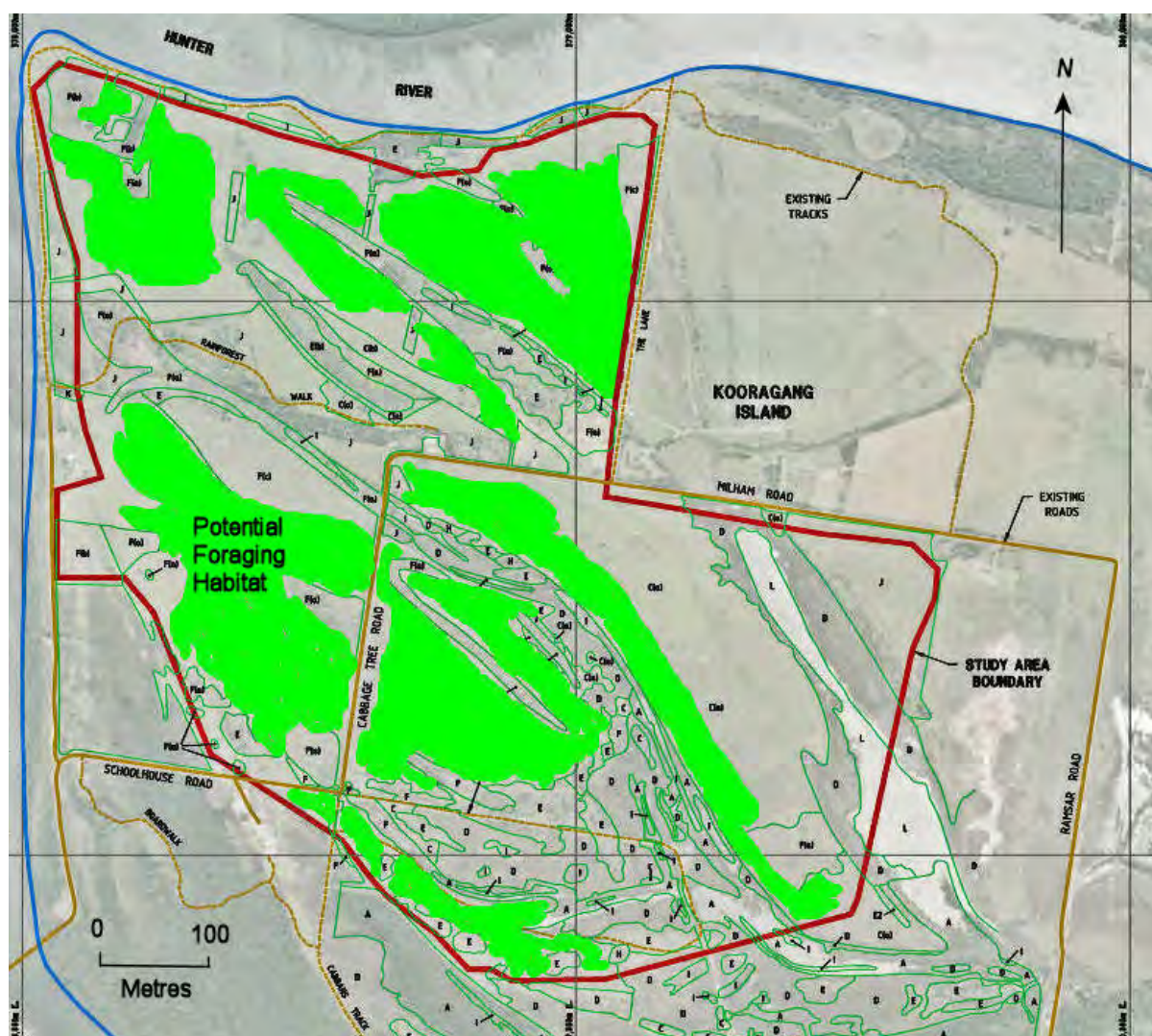
Figure 3: Breeding Habitat



4.2 Foraging Habitat Areas

Foraging areas generally comprise the areas of exotic pasturelands and the edges of the ephemeral and permanent wetlands. Potential foraging areas on Ash Island comprise exotic grassland, ephemeral reed beds and rushlands. These areas are shown in Figure 4 below:

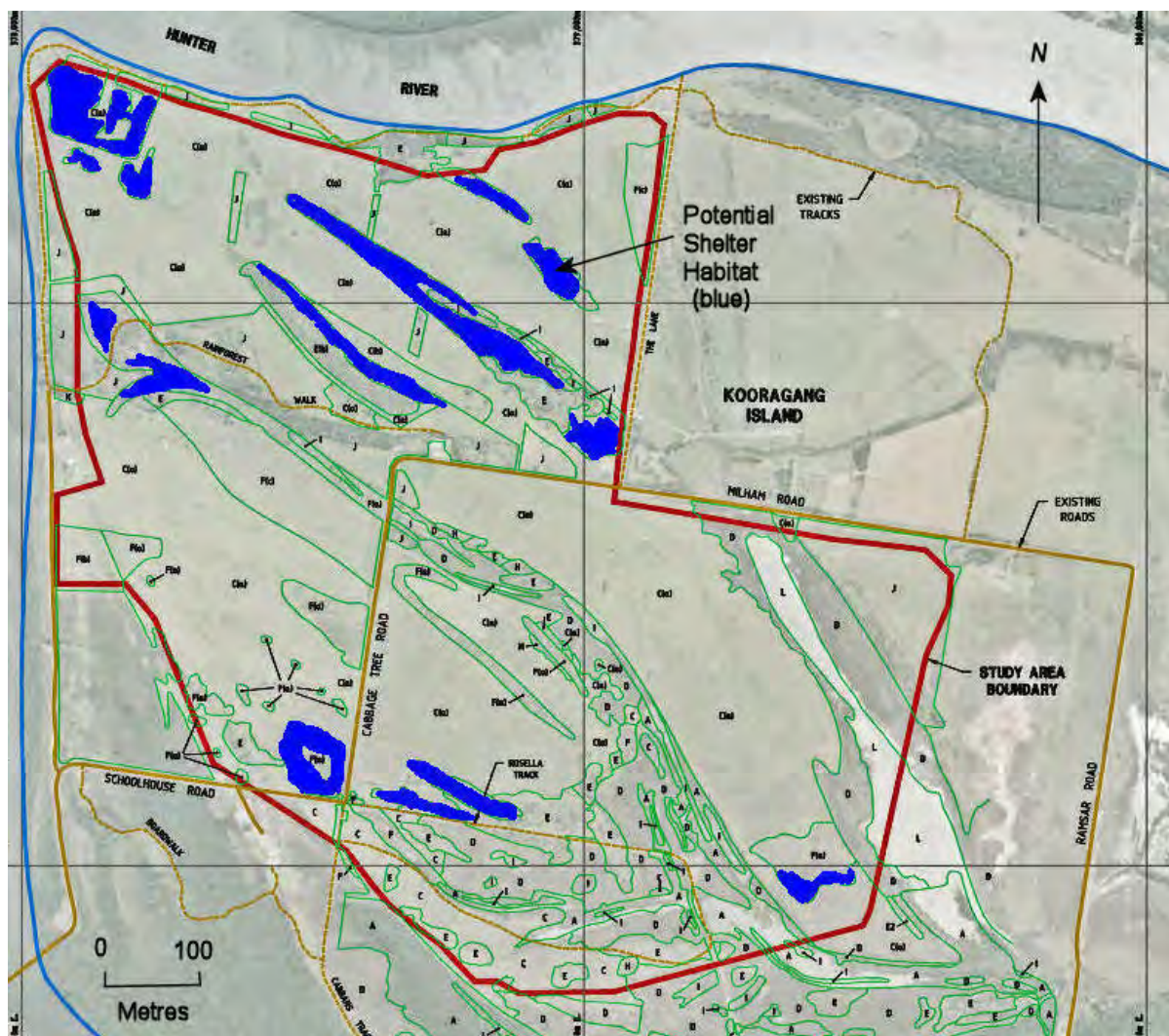
Figure 4: Foraging Habitat



4.3 Shelter Habitat Areas

Shelter habitat is provided by the tall rushes and overgrown vegetation around the edges of the wetland sites. On Ash Island, potential shelter habitat is provided by tall emergent vegetation growing in the old channels that cross the site, and by reed beds that occur in old drains and depressions. These areas are shown in Figure 5 below.

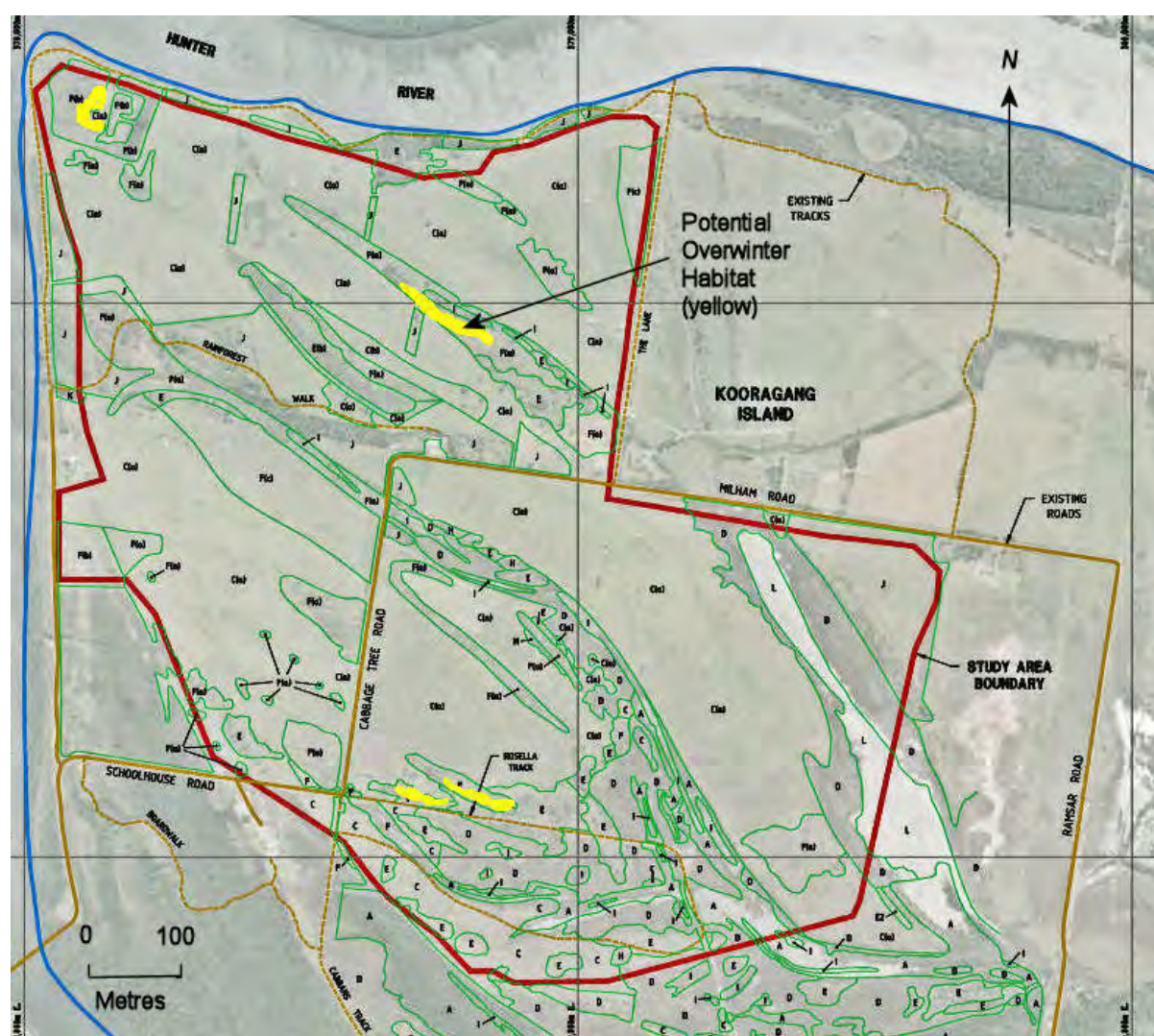
Figure 5: Shelter Habitat.



4.4 Over-winter Habitat Areas

Over-winter habitat is usually provided by fallen timber and logs, dense matted ground vegetation and by artificial shelter items (such as sheets of metal, plastic or timber). Rock piles may also be used. Over-winter sites are particularly scarce in the north-western portion of Ash Island and is limited to a few areas where there are accumulations of dead vegetation beside the permanent or semi-permanent pond areas. The location of potential over-winter habitat is shown in Figure 6 below:

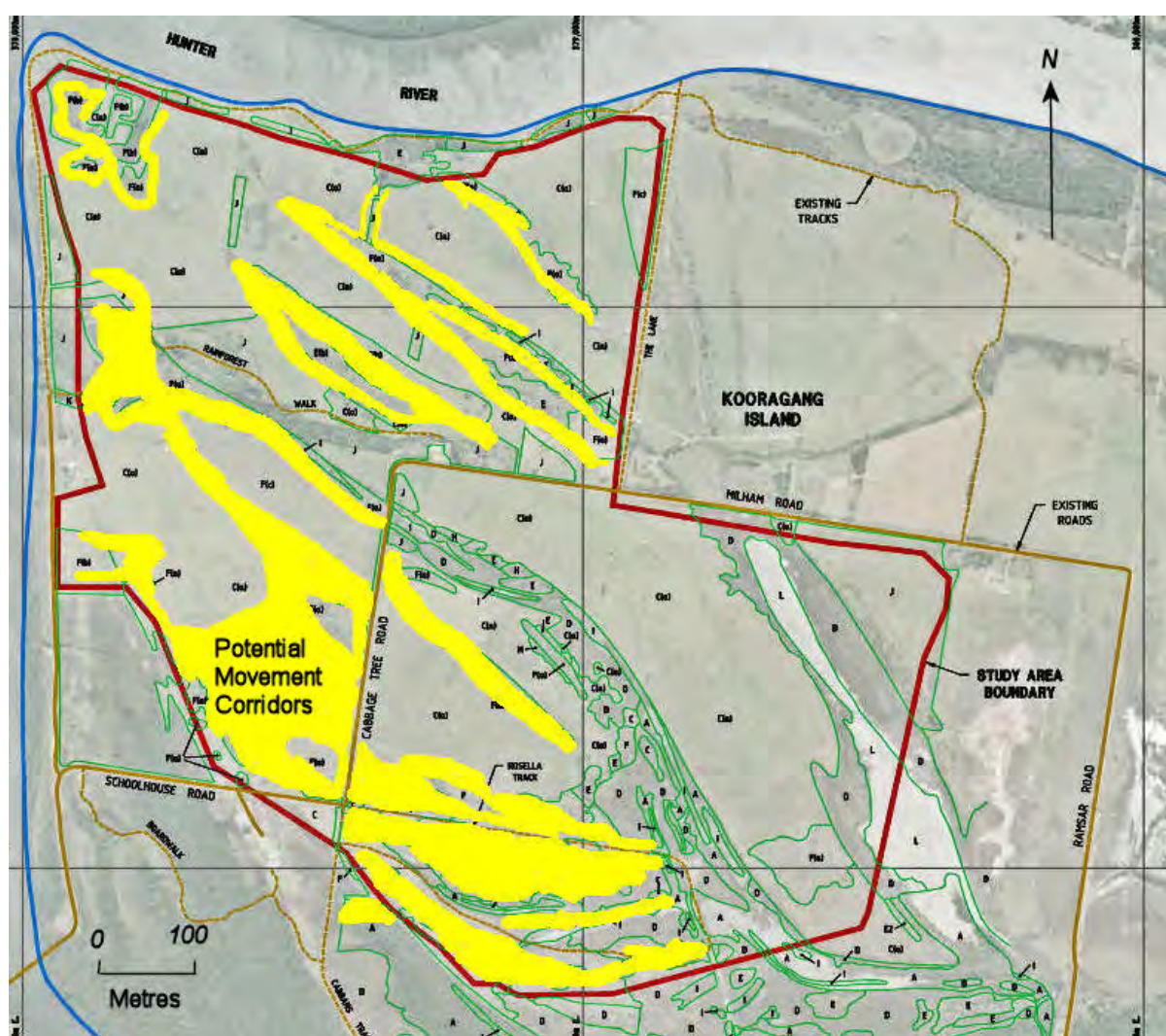
Figure 6: Over-winter Habitat



4.5 Potential Movement Areas

Green and Golden Bell Frogs typically disperse along relatively open areas associated with drainage lines, channels or ditches. These structures should also have areas of dense ground vegetation in them. On Ash Island, potential movement areas are best defined around the edges of the reed beds and rushlands that traverse the site. These areas of taller vegetation are flanked by expanses of lower exotic grassland or herb lands. Potential movement corridors have been marked on Figure 7 below:

Figure 7: Potential Movement Areas



5.0 The Biological Needs of Green and Golden Bell Frogs

The management of Green and Golden Bell Frogs should be based heavily on published information on the biology and environmental requirements (see above). The information consists of academic papers devoted to aspects of the biology of the species and management reports and Species Impact Statements that refer to the management of Green and Golden Bell Frog populations in redevelopment areas. Green and Golden Bell Frogs have been the focus of a number of conservation schemes, the best known ones being those at Homebush Bay (Greer 1993; Pyke 1995); Cronulla Waste Water Treatment Plant (White 1999) and at Arncliffe (M5-East Motorway project: White 1998).

From these studies, several important principles have become established in the conservation of Green and Golden Bell Frogs. These principles, as applied to the Green and Golden Bell Frogs on Kooragang Island, require:

5.1. Protection of regularly-used frog habitats: the areas where Green and Golden Bell Frogs have been regularly observed are in wetlands on the northern side of the Bell Frog Road on Ash Island, in sites close to Deep Pond, ponds on and near the Delta site and in the Kooragang Nature Reserve. There are other occasional and one-off records from many parts of Ash Island and Kooragang Island (Hamer *et al.* 2008).

5.2. Creation of Secure Breeding Sites: the survival of the Green and Golden Bell Frog population on Kooragang Island may depend on the creation of additional breeding habitats. Many of the existing breeding sites on Kooragang Island are highly ephemeral and cannot be used each year by the Green and Golden Bell Frogs. Additional breeding sites should be established close to known breeding sites.

5.3. Creation of Secure Foraging areas: Green and Golden Bell Frogs are known to forage widely, particularly after sustained rain. Reasonably large foraging areas exist on both Kooragang Island and Ash Island but in some cases, these areas are far removed from potential breeding sites. Additional foraging habitat should be created that links known breeding habitat areas.

5.4. Creation of secure diurnal shelter habitats: Shelter habitat is limited on both Kooragang Island and Ash Island. Additional diurnal shelter, in the form of tall emergent reeds and rushes, should be established in or close to newly-established breeding habitat areas.

5.5. Protection of Green and Golden Bell Frogs Site during Earth Works: The construction of new habitat areas will require earthworks and the movement of heavy machinery across areas known to be habitat areas for Green and Golden Bell Frogs. The earthworks and construction activity will make these areas high risk for Green and Golden Bell Frogs. Consequently, frog-exclusion fences will be used to limit frog movements and keep them out of work areas as much as possible.

6.0 Conclusion

The north-western portion of Ash Island contains existing potential habitat for the Green and Golden Bell Frog that can be readily enhanced and extended. The expansion and improvement of habitat areas associated with the Green and Golden Bell Frogs established in the NCIG Research Enclosure has the potential to create a secure stronghold for this species in the Hunter estuary.

6.0 References Cited

- Department of Environment and Conservation NSW 2005.** Green and Golden Bell Frog *Litoria aurea* (Lesson 1829) Recovery Plan. Department Environment and Conservation (NSW).
- Greer, A. 1993.** Draft Faunal Impact Statement for proposed development works at the Homebush Bay Brick Pit.
- Hamer, A.J., Lane, S.J., and M.J. Mahony. 2008.** Movement patterns of adult Green and Golden Bell Frogs *Litoria aurea* and the implications for conservation management. *Journal of Herpetology*, 42, 397-407.
- Pyke, G.H. and White, A.W. 2001.** A Review of the Biology of the Green and Golden Bell Frog (*Litoria aurea*). *Australian Zoologist* 31: 563-598.
- Pyke, G.H., White, A.W., Bishop, P.J. and Waldman, B. 2002.** Habitat-use by the Green and Golden Bell Frog *Litoria aurea* in Australia and New Zealand. *Australian Zoologist* 32: 12-31.
- Pyke, G.H. 1995.** Fauna Impact Statement for proposed development works at The Homebush Bay Development Area, excluding the Brickpit. Prepared for Olympic Co-ordination Agency.
- White, A.W. 1998.** Plan of Management. Green and Golden Bell Frogs. Eve Street and Marsh Street Wetlands, Arncliffe. M5 Motorway Project.
- White, A.W. 1999.** Management Plan. Green and Golden Bell Frogs and Wallum Froglets. Cronulla Sewage Treatment Plant and Upgrade to Tertiary Treatment and Pipeline Duplication.
- White, A. W. 2011.** Green and Golden Bell Frog Habitat and Conservation, Kooragang Island and Ash Island. Prepared for NCIG.

A handwritten signature in blue ink on a light green background. The signature is written in a cursive style, with the first name 'Arthur' clearly legible and the last name 'White' written in a more stylized, abbreviated form.

Dr Arthur White

5 June 2013.

ATTACHMENT 4
ASH ISLAND VEGETATION MAPPING AND SURVEY



FLORASearch

3/23 Sale Street, Orange, NSW 2800
PO Box 300, Orange, NSW 2800
Telephone/Fax: 02 6369 0252
Mobile: 0428 263 274
E-mail: ccbower@florasearch.com.au
ABN: 43060913622

Phil Reid
Environment Advisor
Newcastle Coal Infrastructure Group
PO Box 6003
Hunter Region Mail Centre NSW 2310

28 May 2013

Dear Phil.

Ash Island Vegetation Mapping and Threatened Flora Species Search

Newcastle Coal Infrastructure Group (NCIG) commissioned FloraSearch to map the vegetation of parts of Ash Island and conduct searches for threatened flora species. The scope of works included:

- Define, describe and map different vegetation types.
- Describe vegetation condition.
- Identify and describe the occurrence of environmental and noxious weeds.
- Identify and describe any threatened ecological communities listed under the relevant legislation.
- Identify and describe any threatened flora species or their habitats.
- Provide a series of photos showing:
 - different vegetation types; and
 - any threatened ecological communities.

This letter comprises the report of the survey findings and mapping.

1. Survey methods

The field survey was conducted on 21 and 22 March 2013. The study area was accessed from roads and management tracks which traverse or border the study area (Figure 1). Remote sections of the study area were walked on foot.

Vegetation mapping was conducted in two ways:

- By identifying the patterns, colour and texture of different vegetation types on high resolution aerial photographs of the study areas. The air photos were annotated in the field with the identity of each vegetation type according to its air photo 'signature'.
- By recording the composition of the vegetation at 32 sampling points scattered through the study area. The GPS coordinates (waypoints) of each site were recorded, along with the vegetation type at the waypoint and in the surrounds. Photographs were taken for later reference. The waypoints were downloaded from the GPS unit in the office for display in Google Earth®. This allowed the waypoint data and photographs to be used for calibrating the final mapping by air photo interpretation.

Threatened species and noxious weeds searches

Searches for threatened species and noxious weeds, using the random meander technique (Cropper, 1993) were conducted in conjunction with the vegetation mapping. All parts of the study area were visited and inspected on foot.



Vegetation Condition

The condition of the remnant natural vegetation on the study areas was rated according to the following scale:

- **Excellent.** The vegetation is considered to be in close to pristine condition with good plant health and virtually no introduced species present.
- **Good.** The vegetation is healthy, but the overstorey may have been thinned historically, and there are few introduced species present.
- **Moderate.** The vegetation has been thinned and/or has minor dieback, and some introduced species may be present (<50 percent cover). Overstorey regeneration is present.
- **Poor.** The vegetation has been severely thinned and/or has severe dieback, and/or the groundcover is dominated by introduced species. Little overstorey regeneration is present.
- **Very poor.** The overstorey is almost absent and/or the survivors are in poor health, and the groundcover is dominated almost entirely by exotics.

Only the condition of remnant natural communities is discussed below.

The study area

The study area is divided roughly in half by the alignments of Cabbage Tree Road and Milham Road. These roads are constructed of introduced fill material that has raised them above the surrounds and cut across the two main tidal channels that traverse the study area diagonally in a north-west to south east direction. In this report the areas north and west of Milham Road and Cabbage Tree Road, respectively, are referred to as the north-west half of the study area. Conversely, the south-east half of the study area is west and south of Cabbage Tree Road and Milham Road, respectively

2. Vegetation Types (Mapping units)

Part of the study area, and lands to the south-east, have been mapped previously by FloraSearch (2011). Eight vegetation types were identified in the wider region in that study (Table 1).

Table 1.
Mapping Units (MU) and Vegetation Types on the Study Area and in the Wider Region.

MU	Common name	Dominant species	Wider region (FloraSearch 2011)	Study area
A	Mangrove low forest	<i>Avicennia marina</i>	✓	✓
B	Sharp Rush rushland	<i>Juncus acutus</i>	✓	X
C	Exotic rank grassland	<i>Pennisetum clandestinum</i> , <i>Paspalum dilatatum</i>	✓	✓
D	Coastal saltmarsh (EEC)	<i>Sarcocornia quinqueflora</i> , <i>Sporobolus virginicus</i>	✓	✓
E	Swamp Oak floodplain forest (EEC)	<i>Casuarina glauca</i>	✓	✓
F	Freshwater wetlands on coastal floodplains (EEC)	<i>Bolboschoenus fluviatilis</i> , <i>Typha orientalis</i> , <i>Phragmites australis</i>	✓	✓
G	Grazed pasture	<i>Pennisetum clandestinum</i>	✓	✓
H	Melaleuca thicket (EEC)	<i>Melaleuca ericifolia</i>	✓	✓
I	Free Water	Not applicable	✓	✓
J	Plantings	A wide range of littoral rainforest species, including <i>Elaeodendron australe</i> , <i>Alectryon subcinereus</i> , <i>Scolopia braunii</i> , <i>Streblus brunonianus</i> and <i>Diospyros australis</i> .	X	✓
K	Littoral Rainforest (EEC)	<i>Elaeocarpus obovatus</i> , <i>Podocarpus elatus</i>	X	✓
L	Mudflat	Not applicable	X	✓

In this study, 12 mapping units (MU) have been designated for the study area (Figure 1). Two MU have no vegetation, representing free water (MUI) and mudflats (MUL). Nine vegetation types (i.e. excluding MUI and MUL) were identified on the current study area (Table 1), of which the most prominent are Exotic rank grassland (MUC), Plantings (MUJ), Freshwater wetlands (MUF), Swamp Oak floodplain forest (MUE) and Coastal saltmarsh (MUD) (Figure 1). The vegetation types are described briefly below.

Vegetation types A, D, E, F, H and K are native to the study area, while types B, C and G are dominated by introduced species. Vegetation type J represents extensive artificial plantings of native littoral rainforest species.

Mangrove low forest (MUA)

Closed Grey Mangrove (*Avicennia marina*) low forest is one of the main vegetation communities outside the southern boundary of the study area, but is less prominent within it (Plate 1). The mangroves form a monospecific tree canopy in tidal channels wherever the water depth is shallow enough to expose their aerial roots at low tide.

On smaller channels the mangroves form a dense low forest across the entire width. In various parts of the study area mangroves appear to be encroaching into the wetter parts of the salt marshes, especially around the margins of pools. Concerted efforts are being made by the Kooragang Wetland Rehabilitation Project, sponsored by the Hunter Central Rivers Catchment Management Authority (CMA), to remove mangroves from the saltmarshes and some of the tidal channels. In particular, mangroves are being actively removed from the mudflats on the eastern side of the study area south of Milham Road (Figure 1) (Plate 2).



Plate 1. Grey Mangrove forest.



Plate 2. Mudflat cleared of mangroves, eastern tidal channel south of Milham Road.

Condition

This community is in excellent condition across the study area, although it has been suppressed on the mudflats in the east of the study area (Figure 1). No evidence of natural dieback was observed and active healthy regeneration is present. This community appears to be expanding in some saltmarsh areas, particularly where there are pools of deeper open water.

Exotic rank grassland and grazed pasture (MUs C and G)

The introduced pasture grass, Kikuyu (*Pennisetum clandestinum*) dominates considerable portions of the study area where it may form dense monospecific swards (Figure 1). This pastureland is currently ungrazed to the east and west of Cabbage Tree Road and has developed a dense rank sward to 70 cm high (MUC[a]). Emergent tall weeds, mainly Purpletop (*Verbena bonariensis*), may occur and Paspalum (*Paspalum dilatatum*) may be co-dominant with Kikuyu in wetter areas (Plates 3 and 4). Couch (*Cynodon dactylon*) may form dense patches in some very wet areas (MUC[b]). Kikuyu pastures are being grazed by cattle (MUG) in areas north of Milham Road and the Rainforest Walk (Plate 5).



Plate 3. Exotic rank grassland dominated by Kikuyu with emergent Purpletop, west of Cabbage Tree Road.



Plate 4. Exotic rank grassland dominated by Paspalum and Kikuyu, east of Cabbage Tree Road.



Plate 5. Grazed pasture dominated by Kikuyu, north of the Rainforest Walk.

Coastal saltmarsh (MUD)

Coastal saltmarsh is a prominent vegetation type on parts of the study area (Plates 6 to 8). It generally occurs in wet saline conditions from the margins of mangroves to the edge of slightly higher and drier ground supporting Swamp Oak. The dominant saltmarsh species are Samphire (*Sarcocornia quinqueflora*) and Sand Couch (*Sporobolus virginicus*), often with Seablite (*Suaeda australis*) and Streaked Arrowgrass (*Triglochin striatum*). These may occur in mixed assemblages or in mosaics of monotypic patches. Saltmarsh areas may contain numerous small or large pools of free water (Plates 6 and 8).

Coastal saltmarsh is limited to the south-eastern half of the study area, where large stands occur beside the two tidal channels and in the area south of the Rosella Track (Figure 1). It is likely that coastal saltmarsh extended to the west of both Cabbage Tree Road and The Lane into the northern part of the study area, prior to the construction of these roadways and Milham Road. The elevated roadways have restricted tidal flows to the north-west resulting in the replacement of coastal saltmarsh by freshwater wetlands in the north-western half of the study area.



Plate 6. High quality Coastal Saltmarsh bordered by mangroves, east of powerline on the Rosella Track.



Plate 7. Coastal Saltmarsh beside mudflats with mangrove forest behind, eastern tidal channel, south of Milham Road.



Plate 8. Pool in Coastal Saltmarsh with mudflat and regenerating Swamp Oaks behind, eastern tidal channel, south of Milham Road.

Condition

Many large expanses of this community on the study areas are in excellent condition (Figure 1). In the lower and wetter areas, there is no evidence of invasion by introduced species. However, at the interface between coastal saltmarsh and former areas of Swamp Oak forest, there is often a zone of mixed saltmarsh and introduced species. Similarly, where soils have been disturbed and raised adjacent to roadworks and power lines there may be a mix of introduced and saltmarsh species present.

Swamp Oak floodplain forest (MUE and includes Melaleuca Thicket MUH)

Remnants of Swamp Oak (*Casuarina glauca*) forests (MUE) generally occur beside mangroves or coastal saltmarsh on higher dry ground (Plate 9). They comprise mainly monospecific stands that have been thinned to varying degrees historically. In addition, standing stags of older trees may be common (Plate 10), particularly in the south-eastern parts of the study area (Figure 1). These appear to have been dead for decades, perhaps going back to previous farming of the area. Also, some of the few remaining mature trees appear unhealthy and are declining. However, a relatively large, healthy stand of mature Swamp Oaks occurs near the centre of the study area's northern boundary (Figure 1). There is also significant regeneration of young Swamp Oak trees on sites north of the Rainforest Walk and Milham Road (Figure 1).

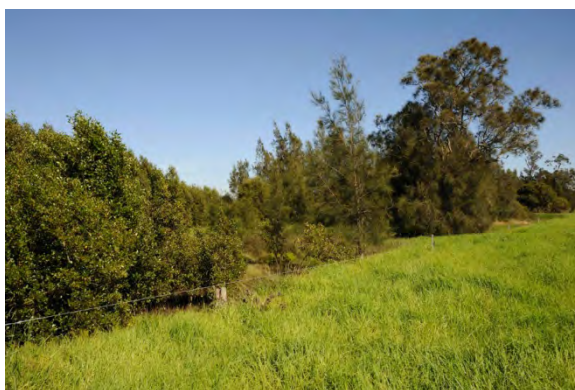


Plate 9. Swamp Oak floodplain forest (right) bordering Mangrove Low Forest (left) and dense ungrazed Kikuyu pasture (foreground), beside tidal channel east of Cabbage Tree Road.



Plate 10. Regenerating Swamp Oak floodplain forest with a Coastal Saltmarsh understory, beside tidal channel east of Cabbage Tree Road.

Few other tree and/or shrub species occur with Swamp Oak on the study area, except for scattered patches of Swamp Paperbark (*Melaleuca ericifolia*) and other *Melaleuca* species (MUH) near the corner of Cabbage Tree Road and Milham Road (Figure 1). Some stands of Swamp Oak have an understorey of predominantly saltmarsh species, which may have been the original natural understorey over much of the study area (Plate 10).

Condition

Swamp Oak forest varies in condition across the study area from good to very poor. There are few patches considered to be in close to pristine condition. One, comprising mature Swamp Oak, is near the centre of the northern boundary of the study area. However, the understorey of this patch is largely dominated by introduced species, such that the condition rating is moderate. A second comprising dense regeneration of young trees considered to be in good condition forms a large linear patch north of the Rainforest Walk (Figure 1). The area of Swamp Oak regeneration east of Cabbage Tree Road shown in Plate 10 is also considered to be in good condition.

Most patches of Swamp Oak have been thinned historically and some have lost nearly all of their tree cover. Kikuyu has invaded the ground cover of many thinned Swamp Oak patches (Plate 12).



Plate 12. Former Swamp Oak habitat colonised by a dense sward of Kikuyu, south of Rosella Track.

Freshwater wetlands on coastal floodplains (MUF)

Deeper fresh or brackish water areas around the Rosella Track and in the north-western half of the study area support a variety of reed and rush species.

The most prominent are Marsh Clubrush (*Bolboschoenus fluviatilis*), Cumbungi (*Typha orientalis*) and Common Reed (*Phragmites australis*). Freshwater wetlands often occur where ponds have been created by past excavation of soil, or where water has pooled due to obstruction of flows by road or track construction. It appears likely that the freshwater wetlands in most areas are artificial, particularly adjacent to the Rosella Track, in the far north west corner of the study area and in the former tidal channels west of Cabbage Tree Road and The Lane (Figure 1) (Plates 13 and 14). Consequently, the community is likely to be more widely distributed on the study area than originally. Nevertheless, some areas of freshwater wetlands occur in natural depressions that do not appear to be associated with earthworks (Plate 15).

Three types of freshwater wetlands are distinguished on the study area and are mapped separately on Figure 1:

1. *Natural* (MUF[a])

These are found in natural depressions and do not appear to be associated with man-made earthworks.

2. *Artificial* (MUF[b])

These are found in ponds created by excavations (artificial wetlands) or pools dammed by road and track construction (secondary wetlands).

3. *Water Couch Wetlands* (MUF[c])

Quite extensive areas of shallow water support almost pure stands of Water Couch (*Paspalidium distichum*) in the north of the study area; west of the northern end of Cabbage Tree Lane, and west of the northern end of The Lane (Figure 1).



Plate 13. Artificial Freshwater Wetland beside Rainforest Walk.



Plate 14. Artificial Freshwater Wetland, north-east corner of study area.



Plate 15. Natural Fresh Water Wetland in south-east corner of the study area with remnant Prickly-leaved Paperbark.

Condition

Large areas of freshwater wetlands occur sporadically across the study area and often appear to be associated with changes to water flows by construction of roads, tracks or past excavation work, although some areas are likely to be natural. The deeper artificial pooled areas appear to have been colonised by common, widespread reed and rush species to create vegetation resembling the *Freshwater Wetlands on Coastal Floodplains* community. Despite the artificial origin of most of the freshwater wetlands, they are in good to excellent condition. An exception is the large wetland extending north-west from the junction of Milham Road and The Lane, which has significant infestations of Alligator Weed (*Alternanthera philoxeroides*). The condition of this wetland is downgraded to poor owing to weed invasion.

Plantings (MUJ)

Extensive plantings as part of the Kooragang Wetland Rehabilitation Project sponsored by the Hunter Central Rivers CMA have taken place in the northern half of the study area (Figure 1). The plantings are most extensive in the areas around the Rainforest Walk and in the large triangular patch south of Milham Road and east of the mudflats. The species planted include Swamp Oak and a wide variety of littoral rainforest species.

Littoral Rainforest (MUK)

The historical record, and scattered remnant individuals and patches of rainforest shrubs and trees, indicate littoral rainforest once covered parts of the higher ground that is now dominated by exotic rank grassland on the study area. Most remnants occur in the centre west of the study area where the Rainforest Walk has been established (Figure 1). However, it is now difficult to separate the remnants of the original rainforest from the extensive plantings that have taken place within and around them. For this reason, the area designated as Littoral Rainforest in Figure 1 underestimates the size and distribution of remnants in the west of the study area. Further, small remnants occur in the south-eastern half of the study area, where they are designated by arrows on Figure 1. The two arrows point to small linear remnants that would have survived along old fences in the corner of a former paddock (Plates 16 and 17). Species represented include Prickly-leaved Paperbark (*Melaleuca styphelioides*), Whalebone Tree (*Streblus brunonianus*), Orange Thorn (*Pittosporum multiflorum*), Cockspur Thorn (*Maclura cochinchinensis*) and Stiff Jasmine (*Jasminum volubile*). These have recently been planted around with a range of other littoral rainforest species.



Plate 16. Remnant of Littoral Rainforest in exotic rank grassland.



Plate 17. Remnant of Littoral Rainforest in exotic rank grassland.

Condition

The few tiny remnant stands of Littoral Rainforest on the study area are difficult to rate for condition. Tree health is generally good and because of the heavy shading of the ground, the larger patches have few introduced species in the understory. However, the paddock remnants in the south-eastern half of the study area have been affected by grazing and are surrounded by dense swards of introduced grasses and weeds and consequently are in very poor condition. Large efforts by the Kooragang Wetlands Rehabilitation Project to protect and expand the littoral rainforest with extensive plantings should see the condition and extent of the community improve over time.

3. Environmental Weeds

A number of environmental weeds were observed on the study area. These are listed in Table 2 in approximate order of importance followed by comments on the more important species.

Many introduced weed species are present along vehicle tracks, around power poles and in other disturbed places. However, in this report emphasis is placed on those weeds that have colonised natural communities and have potential to further degrade them.

Few introduced species occur in undisturbed mangrove and saltmarsh habitats owing to the saline conditions. Most weeds are associated with existing or former Swamp Oak floodplain forest and littoral rainforest habitats. Alligator Weed is associated with freshwater wetlands.

Table 2. Environmental Weeds on the Study Area

Common Name	Scientific Name	Noxious Weed (Newcastle Local Government Area) ¹	Weed of National Significance ²
Kikuyu	<i>Pennisetum clandestinum</i>		
Alligator Weed	<i>Alternanthera philoxeroides</i>	✓	✓
Paspalum	<i>Paspalum dilatatum</i>		
Sharp Rush	<i>Juncus acutus</i>		
Blackberry	<i>Rubus fruticosus</i> sp. agg	✓	✓
Burr Ragweed	<i>Ambrosia confertifolia</i>	✓	
Buffalo Grass	<i>Stenotaphrum secundatum</i>		
Purpletop	<i>Verbena bonariensis</i>		

¹ NSW Department of Primary Industries (2013).

² National Weeds Committee (2013).

Three of these weeds are listed as noxious in the Newcastle City Council Local Government Area and two are listed as Weeds of National Significance (Table 2).

Kikuyu

Kikuyu is a dominant species in former pasture land throughout the study area (Figure 1). Elsewhere, Kikuyu is a major environmental weed in the Swamp Oak forest community, often dominating the understorey to the exclusion of the original native species (Plate 18). Many treeless areas of higher ground now dominated by Kikuyu are likely to have been Swamp Oak forests or littoral rainforest pre-European settlement. Although an aggressive species that spreads through growth of rhizomes and stolons, it does not appear to tolerate deep water or saline conditions. Consequently, it is largely absent from freshwater wetlands, saltmarshes and mangrove communities.



Plate 18. Kikuyu growing along powerline access track on introduced fill material.

Alligator Weed

Alligator Weed was found at three freshwater wetland locations in the north of the study area. Two of the infestations were small, but the third was quite large. Owing to the importance of Alligator Weed the GPS coordinates (GDA94) of each location are given below:

- 0378617 6366101 (large infestation);
- 0378239 6366381 (small infestation); and
- 0378668 6366028 (small infestation).

Paspalum

Paspalum is an abundant introduced grass in the wetter parts of exotic rank grasslands. It also frequently occurs in roadside drains. After Kikuyu, it is the second most abundant exotic species on the study area.

Sharp Rush

Sharp Rush is widespread through the study area generally in low to moderate numbers. The presence of dead stands of Sharp Rush on both sides of the tidal channel south of Milham Road suggests it has been controlled as part of the Kooragang Wetlands Rehabilitation Project. It occurs sparingly in the drier parts of saltmarshes and some raised areas formerly occupied by Swamp Oak forest. It favours open sunny locations and is not found below dense Swamp Oak canopies. It does not appear to be adapted to permanently wet sites.

Blackberry

Although present on the study area, blackberry is not abundant. The main occurrences are in rank pasture areas where the removal of grazing may be favouring its increase. It appears to have potential to become a problem in the study area, if not controlled.

Burr Ragweed, Buffalo Grass, Purpletop and other introduced species

A range of introduced species including Purpletop, Burr Ragweed and Buffalo Grass occur sporadically in rank exotic grassland and on disturbed sites such as road and track margins and earth mounds for tanks, buildings and powerline towers etc. However, none appear able to establish in wet saltmarsh or mangrove habitats.

Two other Noxious Weeds listed for the Newcastle City Council LGA were observed occasionally during the survey; Bitou Bush (*Chrysanthemoides monilifera* ssp. *rotundata*) and Lantana (*Lantana camara*).

4. Endangered Ecological Communities (EEC)

Four EECs were identified on the study areas as follows:

1. *Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (MUD, Figure 1).
2. *Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (MUs E and H, Figure 1).
3. *Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions* (MUF, Figure 1).
4. *Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions Endangered Ecological Community* (MUK, Figure 1).

All four communities are listed as Endangered under the NSW *Threatened Species Conservation Act 1995* (TSC Act). The corresponding map units for the communities are given after each EEC in the list above and their distributions are shown on Figure 1. Their landscape positions, ecological characteristics and their current condition as discussed in Section 2.

5. Threatened Flora Species

One threatened flora species, The Magenta Lilly Pilly (*Syzygium paniculatum*), listed as Endangered under the TSC Act and Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, was identified during the survey.

It has been planted by the Kooragang Wetlands Rehabilitation Project in littoral rainforest plantings on the Rainforest Walk, and possibly other plantings elsewhere. The Magenta Lilly Pilly is a small to medium sized rainforest tree that grows to 8 metres tall (Office of Environment and Heritage [OEH], 2013). The bark is flaky and the leaves are shiny, dark-green above, paler underneath and up to 10 cm long. Plants produce clusters of white flowers at the ends of branches between November and February. The deep magenta, spherical or egg-shaped fruits mature in May and contain a single seed. The Magenta Lilly Pilly is found only in NSW, in a narrow coastal strip from Upper Lansdowne to Conjola State Forest (OEH, 2013).

One threatened flora species, *Zannichellia palustris*, which is listed as Endangered under the TSC Act is considered to have potential to occur on the study areas (Department of Environment and Conservation [DEC], 2004, BioNet, 2013). This species is an ephemeral aquatic herb in the family Zannichelliaceae. It may occur in brackish ponds, which are common in the study areas (Figure 1) and has been recorded nearby (NCIG, 2006). *Z. palustris* is a cosmopolitan submerged, weakly rhizomatous, aquatic plant with thin filamentous leaves to 7 cm long (Jacobs, 1993). It occurs in fresh or slightly saline, still or gently flowing water (*ibid.*). It has been recorded only at the mouth of the Murray River in South Australia and at a few locations in the Lower Hunter Valley in NSW (DEC, 2004). Records include Black Creek at Cessnock; ponds on Kooragang Island, Ironbark Creek at Shortland and Wallsend; and near Belmont (DEC, 2004). *Z. palustris* is an annual that germinates in winter when the dried out soil of temporary wetlands is inundated by winter rains (Winning, 1992; Greenwood, 2001). It reaches its maximum development and flowers in summer before dying off. The timing of the current survey was unsuitable for detecting this species.

6. References

- BioNet, (2013). *NSW BioNet*.
Website: <http://www.bionet.nsw.gov.au/>
Date Accessed: 15 April 2013.
- Cropper, S. (1993). *Management of Endangered Plants*. CSIRO, Melbourne.
- Department of Environment and Conservation (2004). *Zanichellia palustris (a submerged aquatic plant) – endangered species listing*. NSW Scientific Committee – final determination.
Department of Environment and Conservation NSW.
- Department of Primary Industries (2013) *Noxious weeds*.
Website: <http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/noxweed>
Date Accessed: 15 April 2013.
- FloraSearch (2011). *Kooragang Island Vegetation Mapping and Survey*. Unpublished report to the Newcastle Coal Infrastructure Group.
- Greenwood, M.E. (2001). *Autecology and distribution of Zannichellia palustris L. (Zannichelliaceae) in the Hunter Region*. BSc (Hons) thesis. The University of Newcastle.
- Jacobs, S.W.L. (1993). Zannichelliaceae. In Harden GJ (Ed.) *Flora of New South Wales*. Volume 4, pp. 29-31.
- National Weeds Committee (2013) *Weeds of National Significance*.
Website: <http://www.weeds.org.au/WoNS/>
Date Accessed: 15 April 2013.
- Office of Environment and Heritage (2013). *NSW Threatened Species Profiles*.
Website: <http://www.environment.nsw.gov.au/threatenedspecies/>
Date Accessed: 14 April 2013.
- Newcastle Coal Infrastructure Group (2006). *Flora Assessment*. Appendix E in Environmental Assessment for the Newcastle Coal Infrastructure Group Coal Export Terminal.
- Winning, G (1992). *Conservation status of rare plants in the Lake Macquarie area*. Report to Lake Macquarie City Council. Shortland Wetlands Centre.

Signed



Principal Consultant Botanist
FloraSearch

ATTACHMENT 5

DIRECTOR-GENERAL'S APPROVAL OF ENVIRONMENTAL REPRESENTATIVE –
NATHAN JUCHAU



NSW GOVERNMENT
Department of Planning

Contact: Patricia Cabezas
Phone: 02 9228 6447
Fax: 02 9228 6366
Email: patricia.cabezas@planning.nsw.gov.au

Our ref: S06/00617 & S01/00533
Your ref:

Mr Paul Beale
NCIG Operations Manager
Level 9, 1 York Street
SYDNEY NSW 2000

Dear Mr Beale

Newcastle Coal Infrastructure Group Coal Export Terminal (Application 06_0009) & Dredging and Remediation of the South Arm of the Hunter River (DA-134-3-2003-i) – Appointment of Environmental Representative.

I refer to your letter of 22 August 2007 in which you nominate Mr Nathan Juchau as the Environmental Representative as required by condition 7.1 and condition B4.2 for the above projects respectively.

The Department has reviewed Mr Nathan Juchau qualifications and experience and considers that Mr Juchau is suitably qualified and experienced for appointment as the Environmental Representative for the NCIG Coal Export Terminal project and also for the Hunter River Dredge project. Approval to Mr Juchau's appointment is granted subject to written confirmation being sent to the Department which delineates Mr Juchau's areas of responsibility in terms of the different dredging stages and in the context of the various parties which will be dredging in the South Arm of the Hunter River.

If you have any questions or require clarification of the above, please do not hesitate to contact Patricia Cabezas on 9928 6447 or email at patricia.cabezas@planning.nsw.gov.au.

Yours sincerely

3.10.07

Chris Wilson
Executive Director
Major Project Assessments
As delegate for the Director-General

ATTACHMENT 6

HYGIENE PROTOCOL FOR THE CONTROL OF DISEASE IN FROGS

Threatened Species Management Information Circular No. 6



hygiene protocol for the control of disease in frogs

April 2008

Department of **Environment & Climate Change** NSW



**© Department of Environment and
Climate Change (NSW), 2008.**

* The National Parks and Wildlife Service is part of the
Department of Environment and Climate Change

This work is copyright. However, material presented in this protocol may
be copied for personal use or utilised for management and educational
purposes, providing that any extracts are fully acknowledged. Apart from
this and any other use as permitted under the Copyright Act 1968, no
part may be reproduced without prior written permission from DECC.

Department of Environment and Climate Change (NSW)
59-61 Goulburn Street
(PO Box A290)
Sydney South 1232

Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (environment information
and publications requests)
Phone: 1300 361 967 (national parks information
and publications requests)
Fax: (02) 9995 5999
TTY: (02) 9211 47 23
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

This document can be sourced from the DECC website:
www.environment.nsw.gov.au/resources/nature/hypfrog.pdf

This document should be cited as:
Department of Environment and Climate Change (NSW) 2008.
Hygiene protocol for the control of disease in frogs.
Information Circular Number 6. DECC (NSW), Sydney South.

ISBN 0 7313 6372 8
DECC 2008/199

Acknowledgments

NSW National Parks and Wildlife Service Declining Frog Working
Group who recommended the preparation and provided input into the
development of this strategy.

Ross Wellington and Ron Haering (both DECC) the authors of this
document.

Thanks to Jack Baker, Lee Berger, Mark Endersby, Jeff Hardy, Frances
Hulst, Alex Hyatt, Keith McDougall, Diana Mendez, Deborah
Pergolotti, Graham Pyke, Marjo Rauhala, Julie Ravallion, Karrie Rose,
Lothar Voigt and Arthur White for their advice and/or technical review.

This hygiene protocol is an adaptation of the Declining Amphibian
Population Task Force (DAPTF) Fieldwork Code of Practice and
the recommendations of Speare et al. (1999) and has drawn on
recommendations from earlier guidelines prepared by Environment
ACT.

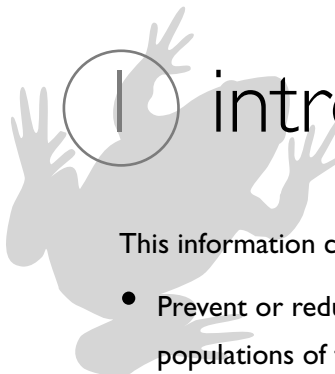
Foundation for National Parks and Wildlife funded the printing of this
protocol.



hygiene protocol for the control of disease in

frogs

1.	INTRODUCTION	1
1.1	WHO SHOULD READ THIS DOCUMENT?	1
1.2	BACKGROUND	1
1.2.1	Amphibian Chytrid Fungus	1
1.3	OBJECTIVES....	2
2.	SITE HYGIENE MANAGEMENT	3
2.1	DEFINING A SITE.....	3
2.2	ON-SITE HYGIENE.....	3
2.3	HANDLING OF FROGS IN THE FIELD	4
2.4	DISINFECTION METHODS.....	5
3.	CAPTIVE FROG HYGIENE MANAGEMENT	6
3.1	HOUSING FROGS AND TADPOLES	6
3.2	TADPOLE TREATMENT	6
3.3	FROG TREATMENT	6
3.4	DISPLACED FROGS	7
3.4.1	Banana Box Frogs	8
3.4.2	Cane Toads	8
3.4.3	Local Frog Species	8
4.	SICK OR DEAD FROGS	9
4.1	SYMPTOMS OF SICK AND DYING FROGS	9
4.2	WHAT TO DO WITH SICK OR DEAD FROGS.....	10
	Appendix 1 HYGIENE PROTOCOL CHECKLIST AND FIELD KIT	12
	Appendix 2 DESIGNATED SICK AND DEAD FROG RECIPIENTS	13
	Appendix 3 NSW ANIMAL WELFARE ADVISORY COUNCIL METHODOLOGY.....	14
	Appendix 4 LICENSED WILDLIFE CARER AND RESCUE ORGANISATIONS	15
	Appendix 5 SICK OR DEAD FROG COLLECTION FORM	16



I introduction

This information circular outlines measures to:

- Prevent or reduce disease causing pathogens being transferred within and between wild populations of frogs.
- Ensure captive frogs are not infected prior to release.
- Deal safely with unintentionally transported frogs.
- Assist with the proper identification and management of sick and dead frogs in the wild.

1.1 Who should read this document?

This protocol is intended for use by all researchers, wildlife consultants, fauna surveyors and students undertaking frog field-work. In addition, the protocol should be read by Department of Environment and Climate Change (DECC) personnel, frog keepers, wildlife rescue and carer organisations, herpetological/frog interest groups/societies, fauna park/zoo operators/workers and other individuals who regularly deal with or are likely to encounter frogs.

This protocol outlines the expectations of the DECC regarding precautionary procedures to be employed when working with frog populations. The intention is to promote implementation of hygiene procedures by all individuals working with frogs. New licences and licence renewals will be conditional upon incorporation of the protocol. The DECC recognises that some variation from the protocol may be appropriate for particular research and frog handling activities. Such variation proposals should accompany any licence application or renewal to the DECC.

1.2 Background

1.2.1 Amphibian Chytrid Fungus

The apparent decline of frogs, including extinctions of species and local populations, has attracted increased international and national concern. Many

potential causes for frog declines have been proposed (eg see Pechmann et al., 1991; Ferrero and Bergin, 1993; Pechmann and Wilbur, 1994; Pounds and Crump, 1994; Pounds et al., 1997). However, the patterns of decline at many locations suggest that epidemic disease maybe the cause (Richards et al., 1993; Laurance et al., 1996; Alford and Richards, 1997). Recent research has implicated a water-borne fungal pathogen *Batrachochytrium dendrobatidis* as the likely specific causative agent in many of these declines both in Australia and elsewhere (Berger et al., 1998; 1999). This agent is commonly known as the amphibian or frog chytrid fungus and is responsible for the disease Chytridiomycosis (Berger et al., 1999).

B. dendrobatidis is a form of fungus belonging to the phylum Chytridiomycota. Most species within this phylum occur as free-living saprophytic fungi in water and soil and have been found in almost every type of environment including deserts, arctic tundra and rainforest and are considered important primary biodegraders (Powell 1993). *B. dendrobatidis* is a unique parasitic form of Chytridiomycete fungi, in that it invades the skin of amphibians, including tadpoles, often causing sporadic deaths with up to 100% mortality in some populations. Chytridiomycosis has been detected in over 40 species of native amphibian in Australia (Mahony and Workman 2000). However, it is not currently known whether the fungus is endemic or exotic to Australia.

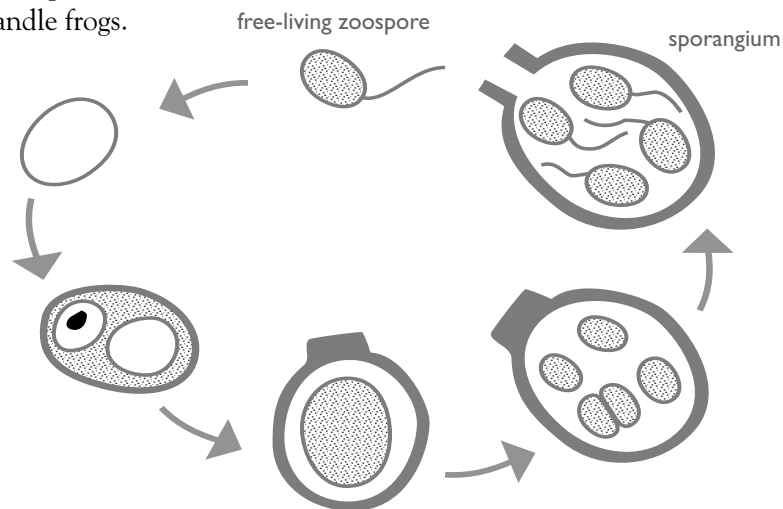
The infective stage of *B. dendrobatidis* is the zoospore and transmission requires water (Berger et al., 1999). Zoospores released from an infected amphibian can potentially infect other amphibians in the same water. More research is needed on the dynamics of infection in the wild. *B. dendrobatidis* is known to be susceptible to seasonal temperature changes, dehydration, salinity, water pH, light, nutrition and dissolved oxygen (Berger et al., 1999).

1.3 Objectives

The objectives of the hygiene protocol are to:

- Recommend best-practice procedures for DECC personnel, researchers, consultants and other frog enthusiasts or individuals who handle frogs.

- Suggest workable strategies for those regularly working in the field with frogs or conducting fieldwork activities in wetlands and other aquatic environments where there is the potential for spreading pathogens such as the frog chytrid fungus.
- Provide background information and guidance to people who provide advice or supervise frog related activities.
- Provide standard licence conditions for workers engaged in frog related activities.
- Inform Animal Care and Ethics Committees (ACEC) for their consideration when granting research approvals.



Life cycle of frog chytrid fungus from infective free-living zoospore stage to sporangium (adapted from L. Berger).

A large, light grey silhouette of a frog is positioned behind the page number '2'. The number '2' is enclosed in a circle and is part of the page header.

2 site hygiene management

A checklist of risk management procedures and recommended standard hygiene kit is provided in Appendix I. Please note Footnote I on page 4.

Individuals studying frogs often travel and collect samples of frogs from multiple sites. Some frog populations can be particularly sensitive to the introduction of infectious pathogens such as the frog chytrid fungus. Also, the arrangement of populations in the landscape may make frogs particularly vulnerable to transmission of infectious pathogens. Therefore, it is important that frog workers recognise the boundaries between sites and undertake measures which reduce the likelihood of spreading infection.

Where critically endangered species or populations of particular risk are known to occur, this protocol should be applied over very short distances ie a single site may need to be subdivided and treated as separate sites.

When planning to survey multiple sites, always start at a site where frog chytrid fungus is not known to be present before entering other infected areas.

2.1 Defining a site

Defining the boundary of a site maybe problematic. In some places, the boundary between sites will be obvious but in others, less so. Undertaking work at a number of sites or conducting routine monitoring at a series of sites within walking distance creates obvious difficulties with boundary definitions. It is likely that defining the boundary between sites will differ among localities. It may be that a natural or constructed feature forms a logical indicator of a site boundary eg a road/ track, a large body of water such as a river or the sea, a marked habitat change or a catchment boundary.

As a guiding principle, each individual waterbody should be considered a separate site.

When working along a river or stream or around a wetland or a series of interconnecting ponds it is reasonable, in most instances, to treat such examples as a single site for the purposes of this protocol. Such a case would occur in areas where frogs are known to have free interchange between ponds.

Where a stream consists of a series of distinctive tributaries or sub-catchments or where there is an obvious break or division then they should be treated as separate sites, particularly if there is no known interchange of frogs between sites.

2.2 On-site hygiene

When travelling from site to site it is recommended that the following hygiene precautions be undertaken to minimise the transfer of disease from footwear, equipment and/or vehicles.

Footwear

Footwear must be thoroughly cleaned and disinfected at the commencement of fieldwork and between each sampling site.

This can be achieved by initially scraping boots clear of mud and standing the soles in a disinfecting solution. The remainder of the boot should be rinsed or sprayed with a disinfecting solution that contains *benzalkonium chloride* as the active ingredient. Disinfecting solutions should be prevented from entering any water bodies.

Rubber boots such as 'gum boots' or 'Wellingtons' are recommended because of the ease with which they can be cleaned and disinfected.

Several changes of footwear bagged between sites might be a practical alternative to cleaning.

Equipment

Equipment such as nets, balances, callipers, bags, scalpels, headlamps, torches, wetsuits and waders etc that are used at one site must be cleaned and disinfected before re-use at another site.

Disposable items should be used where possible. Non-disposable equipment should be used only once during a particular field exercise and disinfected later or disinfected at the site between uses using procedures outlined in 2.4 below.

Vehicles

Where necessary, vehicle tyres should be sprayed/flushed with a disinfecting solution in high-risk areas.

Transmission of disease from vehicles is unlikely to be a problem. However, if a vehicle is used to traverse a known frog site, which could result in mud and water being transferred to other bodies of water or frog sites, then wheels and tyres should undergo cleaning and disinfection. This should be carried out at a safe distance from water bodies, so that the disinfecting solution can infiltrate soil rather than run-off into a nearby water body.

Spraying with 'toilet duck' (active ingredient *benzalkonium chloride*) is recommended to disinfect car wheels and tyres.

Cleaning of footwear before getting back into the car will prevent the transfer of pathogens from/to vehicle floor and control pedals.

2.3 Handling of frogs in the field

The spread of pathogenic organisms, such as the frog chytrid fungus, may occur as a result of handling frogs.

Frogs should only be handled when necessary.

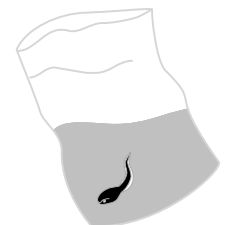
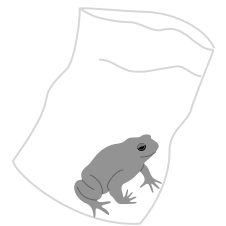
Where handling of frogs is necessary the risk of pathogen transfer should be minimised as follows:

- Hands should be either cleaned and disinfected between samples or a new pair of disposable gloves used for each sample¹. This may be achieved by commencing with a work area that has a dish containing a disinfecting solution and paper towels.
- A 'one bag – one frog' approach to frog handling should be used especially where several people are working together with one person processing frogs and others doing the collecting. Bags should not be reused.
- A 'one bag – one sample' approach to tadpole sampling should be used. Bags should not be reused.

Researchers who use toe clipping or Passive Integrated Transponder (PIT) tagging are likely to increase the risk of transmitting disease between frogs due to the possibility of directly introducing pathogens into the frogs' system. This can be minimised by using:

- Disposable sterile instruments
- Instruments disinfected previously and used once
- Instruments disinfected in between each frog

Disinfecting solutions containing *benzalkonium chloride* are readily available from local supermarkets. Some brands include Toilet Duck, Sanpic, New Clenz and Pine Clean.



¹ As a principle, this protocol assumes that not all frogs in an infected pond will be contaminated by the frog chytrid fungus. The infective load of a body of water may not be high enough to cause cross contamination of individual frogs in the same pond. Therefore care should be taken to use separate gloves and bags and clean hands for each sample, to avoid transmission of high infective loads between individuals.

Open wounds from toe clipping and PIT tagging should be sealed with a cyanoacrylate compound such as *Vetbond*® to reduce the likelihood of entry of pathogens. The DECC ACEC further recommends the application of topical anaesthetic *Xylocaine*® cream and *Betadine*® disinfectant (1% solution) before and after any surgical procedure. This should then be followed by the wound sealant.

All used disinfecting solutions, gloves and other disposable items should be stored in a sharps or other waste container and disposed or sterilised appropriately at the completion of fieldwork. Disinfecting solutions must not come into contact with frogs or be permitted to contaminate any water bodies

2.4 Disinfection Methods

Disinfecting agents for hands and equipment must be effective against bacteria and both the vegetative and spore stages of fungi. The following agents are recommended:

- Chloramine and Chlorhexidine based products such as *Halamid*®, *Halasept*® or *Hexifoam*® are effective against both bacteria and fungi. These products are suitable for use on hands, footwear, instruments and other equipment. The manufacturers instructions should be followed when preparing these solutions.
- Bleach and alcohol (ethanol or methanol), diluted to appropriate concentrations can be effective against bacteria and fungi. However, these substances may be less practical because of their corrosive and hazardous nature.

When using methanol either:

- immerse in 70% methanol for 30 minutes or
- dip in 100% methanol then flame for 10 seconds or boil in water for 10 minutes

Fresh bleach (5% concentration) may be also effective against other frog pathogens such as Rana Virus.

Some equipment not easily disinfected in these ways can be effectively cleaned using medical standard 70% isopropyl alcohol wipes – *Isowipes*®.



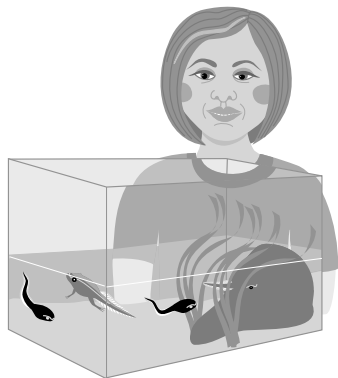
3 captive frog hygiene management

3.1 Housing frogs and tadpoles

Frogs and tadpoles should only be removed from a site when absolutely necessary.

When it is necessary for frogs or tadpoles to be collected and held for a period of time, the following measures should be undertaken:

- Animals obtained at different sites should be kept isolated from each other and from other captive animals.
- Aquaria set up to hold frogs should not share water, equipment or any filtration system. Splashes of water from adjacent enclosures or drops of water on nets may transfer pathogens between enclosures.
- Prior to housing frogs or tadpoles, ensure that tanks, aquaria and any associated equipment are disinfected.
- Tanks and equipment should be cleaned, disinfected and dried immediately after frogs/tadpoles are removed.



Careful maintenance of your enclosures will ensure a safe and hygienic environment for captive frogs and tadpoles.

When contemplating a release of captive bred tadpoles for conservation purposes a Translocation Proposal should be submitted to the DECC and pathological screening for disease should be undertaken (see also DECC Translocation Policy).

Tadpoles can be tested by randomly removing 10 individuals at 6 weeks and again at 2 weeks before anticipated release. Testing could be undertaken by the pathology section at Taronga Zoo, Newcastle University, CSIRO Australian Animal Health Laboratories at Geelong and James Cook University at Townsville. Such an arrangement would need to be negotiated by contacting one of these institutions well before the anticipated release date. (see Appendix 2 for contact details)

DECC have licenced NSW Schools to allow students and/or teachers to remove tadpoles for classroom life cycle studies. They are authorised to remove individuals from only one location, each school also requires endorsement from Department of Education and Training Animal Care and Ethics Committee and comply with this protocol.

Tadpoles collected for these purposes are to be obtained from the local area of the school and are not to be obtained from DECC Reserves. As soon as tadpoles have transformed, froglets must be returned to the exact point of capture. Tadpoles from different locations are not to be mixed.

Antifungal cleansing treatments to clear tadpoles of the frog chytrid fungus are currently being trialed. In the future, such a treatment may be an added procedure required prior to froglet releases.

Detailed information on safely maintaining frogs in captivity is provided in Voigt (2001).

3.2 Tadpole treatment

In most instances:

Release to the wild of tadpoles held or bred in captivity should be avoided.



3.3 Frog treatment

The rigour with which frogs must be treated to ensure pathogens are not introduced to native populations means that any proposal for the removal of adult frogs (particularly threatened species) from wild populations should be given careful consideration.

When it is essential for frogs to be removed from the wild, the following should apply.

Individuals to be released should be quarantined for a period of 2 months and monitored for any signs of illness or disease.

Frogs must not be released if any evidence of illness or infection is detected. If illness is suspected, further advice must be sought from a designated frog recipient (Appendix 2) as soon as possible to determine the nature of the problem. Chytridiomycosis can be diagnosed in live frogs by microscopical examination of preserved toe clips or from shedding skin samples. Research is still in progress on the development of a simple technique for the detection of Chytridiomycosis and a treatment for infected frogs.

Current methods which may be used include:

- A technique for the treatment of potentially infected frogs is to place the frogs individually in a 1mg/L benzalkonium chloride solution for 1 hour on days 1, 3, 5, 9, 11 and 13 of the treatment period. Frogs are then isolated/quarantined for two months. This and other possible treatments are documented in Berger and Speare (1998)
- *Betadine*® and *Bactone*® treatments have also been used on adult frogs with some success (M. Mahony, Newcastle University pers. comm.)
- *Itraconazole*® is an expensive drug

which has been used successfully (Lee Berger CSIRO Australian Animal Health Laboratory pers. comm.). Information on this method is available on the Website <http://www.jcu.edu.au/school/PHTM/frogs/adms/attach6.pdf>.

Frogs undergoing treatment should be housed individually and kept separate from non-infected individuals.

3.4 Displaced frogs

Displaced frogs are those native frog species and introduced Cane Toads (*Bufo marinus*) which have been unintentionally transported around the country with fresh produce, transported produce and landscaping supplies. Procedures to be undertaken when encountering introduced/displaced native frog species (as well as Cane Toads) are as follows.

3.4.1 Banana box frogs

'Banana Box' frog is the term used to describe several native frog species (usually *Litoria gracilentia*, *L. infrafrenata*, *L. bicolor* and *L. caerulea*) commonly transported in fruit and vegetable shipments and landscaping supplies. In the past, well meaning individuals have attempted to return these frogs to their place of origin but this is usually impossible to do accurately. There is risk of spread of disease if these frogs are transferred from place to place.

It is strongly recommended that:

Displaced Banana Box frogs should be treated as if they are infected and should not to be freighted anywhere for release to the wild unless specifically approved by DECC.

When encountering a displaced frog:

- Contact a licensed wildlife carer organisation to collect the animal. The frog should then undergo a quarantine period of 2 months along with an approved disinfection treatment.
- Post-quarantine, the frog (if one of the species identified above) may be transferred to a licensed frog keeper. All other species require the permission from DECC Wildlife Licensing and Management Unit (WLMU) prior to transfer. Licensed carer groups are to record and receipt frogs obtained and disposed of in this way.
- Licensed Frog Keepers are to list these frogs in their annual licence returns to DECC.

Frogs held by licensed frog keepers are not to be released to the wild except with specific DECC approval.

Displaced frogs may be made available to recognised institutions for research projects, display purposes or perhaps offered to the Australian Museum as scientific specimens once approval has been provided by the DECC WLMU.



Frogs are often unintentionally transported with fresh produce and landscaping supplies. They are collectively known as 'banana box' or displaced frogs.

3.4.2 Cane toads

Cane toads are known carriers of the Frog chytrid fungus and should not be knowingly transported or released to the wild.

If a cane toad is discovered outside of its normal range, it should be humanely euthanased in accordance with the recommended NSW Animal Welfare Advisory Council procedure (see Appendix 3). Care should be taken to avoid euthanasia of native species due to mistaken identity.

3.4.3 Local frog species

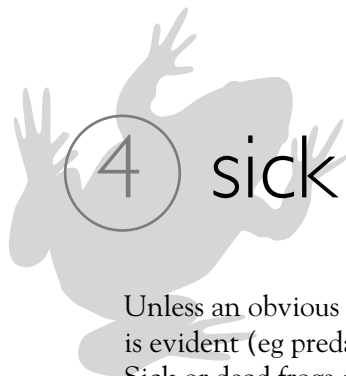
Frogs encountered on roads, around dwellings and gardens or in swimming pools should not be considered as displaced frogs.

Frogs encountered in these situations should be assisted off roads, away from dwellings, or out of swimming pools preferably to the nearest area of vegetation or suitable habitat.

Incidences of frogs spawning or tadpoles appearing in swimming pools should be referred to a wildlife carer/rescue organisation for assistance (see Appendix 4).

Contact the Frogwatch Helpline if you are unsure whether a frog is a local species or displaced.

An NPWS information brochure titled 'Cane Toads in NSW' provides further information on cane toads and assistance with identification of some of the commonly misidentified native species. This information is also available on the DECC website.



sick or dead frogs

Unless an obvious cause of illness or death is evident (eg predation or road mortality): Sick or dead frogs encountered in the wild should be collected and disposed of in accordance with the procedures described in section 4.2 below.

4.1 Symptoms of sick and dying frogs

Sick and dying frogs exhibit a range of symptoms characteristic of chytrid infection. Symptoms may be expressed in the external appearance or behaviour of the animal. A summary of these symptoms are described below. More detailed information can be found in Berger et al., (1999) or at the James Cook University Amphibian Disease website at: <http://www/jcu.edu.au/school/phtm/PHTM/frogs/ampdis.htm>.



Appearance (one or more symptoms)

- darker or blotchy upper (dorsal) surface
- reddish/pink-tinged lower (ventral) surface and/or legs and/or webbing or toes
- swollen hind limbs
- very thin or emaciated
- skin lesions (sores, lumps)
- infected eyes
- obvious asymmetric appearance

Behaviour (one or more symptoms)

- lethargic limb movements, especially hind limbs
- abnormal behaviour (eg a nocturnal, burrowing or arboreal frog sitting in the open during the day and making no vigorous attempt to escape when approached)
- little or no movement when touched

Great barred frog (*Mixophyes fasciolatus*) with severe Chytrid infection — note lethargic attitude and sloughing skin. Photo: L. Berger

Diagnostic behaviour tests

Sick frogs will fail one or more of the following tests:

test	healthy	sick
Gently touch with finger	Frog will blink	Frog will not blink above the eye
Turn frog on its back	Frog will flip back over	Frog will remain on its back
Hold frog gently by its mouth	Frog will use its forelimbs to try to remove grip	No response from frog

4.2 What to do with sick or dead frogs

A procedure for the preparation and transport of a sick or dead frog is given below². Adherence to this procedure will ensure the animal is maintained in a suitable condition for pathological examination and assist the DECC and researchers to determine the extent of the disease and the number of species affected.


- Disposable gloves should be worn when handling sick or dead frogs. Avoid handling food and touching your mouth or eyes as this could transfer pathogens and toxic skin secretions from some frog species.
- New gloves and a clean plastic bag should be used for each frog specimen to prevent cross-contamination. When gloves are unavailable, use an implement to transfer the frog to a container rather than using bare hands.
- If the frog is dead, keep the specimen cool and preserve as soon as possible (as frogs decompose quickly after death making examination difficult). Specimens can be fixed/preserved in 70% ethanol or 10% buffered formalin.

Cut open the belly and place the frog in about 10 times its own volume of preservative. Alternatively, specimens can be frozen (although this makes tissues unsuitable for some tests). If numerous frogs are collected, some should be preserved and some should be frozen. Portions of a dead frog can be sent for analysis eg a preserved foot, leg or a portion of abdominal skin.

- The container should be labelled showing at least the species, date and location. A standardised collection form is provided in Appendix 5.
- If the frog is alive but unlikely to survive transportation (death appears imminent), euthanase the frog (see Appendix 3) and place the specimen in a freezer. Once frozen, the specimen is ready for shipment to the address provided below.
- If the frog is alive and likely to survive transportation, place the frog into either a moistened cloth bag with some damp leaf litter or into a plastic bag with damp leaf litter and partially inflated before sealing. Remember to keep all frogs separated during transportation.
- Preserved samples can be sent in jars or wrapped in wet cloth, sealed in bags and placed inside a padded box.
- Send frozen samples in an esky with dry ice (available from BOC/CIG Gas outlets).
- Place live or frozen specimens into a small styrafoam esky (available from K-Mart/Big W for approximately \$2.50).
- Seal esky with packaging tape and address to one of the laboratories listed in Appendix 4.
- Send the package by courier.

Further information on sick and dying frogs is available on the Amphibian Disease Home Page at <http://www.jcu.edu.au/dept/PHTM/frogs/ampidis.htm> — in particular refer to 'What to do with dead or ill frogs'.

² The measures described below are standard procedures and may vary slightly depending on the distance and time required to reach the intended recipient. Contact the intended recipient of the sick or dead frog prior to sending to confirm the appropriate procedure.



5 references

Alford, R.A. and Richards, S.J. (1997) Lack of evidence for epidemic disease as an agent in the catastrophic decline of Australian rainforest frogs. *Conserv. Biol.* 11: 1026-1029.

Berger, L., Speare, R. (1998) Chytridiomycosis - a new disease of amphibians. *ANZCCART News* 11(4): 1-3.

Berger, L., Speare, R., Daszac, P., Green, D.E., Cunningham, A.A., Goggin, C.L., Slocombe, R., Ragan, M.A., Hyatt, A.D., McDonald, K.R., Hines, H.B., Lips, K.R., Marantelli, G. and Parkes, H. (1998) Chytridiomycosis causes amphibian mortality associated with population declines in the rainforests of Australia and Central America. *Proc. Nat. Acad. Sci.* 95: 9031-9036.

Berger, L., Speare, R. and Hyatt, A. (1999) Chytrid fungi and amphibian declines: Overview, implications and future directions. In: Campbell, A. (Editor) *Declines and disappearances of Australian frogs*. Biodiversity Group, Environment Australia.

Environment ACT (1999) Guidelines for minimising introduction and spread of frog pathogens. Environment ACT. Canberra.

Ferrero, T.J. and Bergin, S. (1993) Review of environmental factors influencing the declines of Australian frogs. In: Lunney, D. and Ayers, D. (Editors) *Herpetology in Australia: a diverse discipline*. Trans. R. Zool. Soc. Mosman.

Laurance, W.F., McDonald, K.R. and Speare, R. (1996) Epidemic disease and catastrophic decline of Australian rainforest frogs. *Conserv. Biol.* 77: 203-212.

Mahony, M. and Werkman, H. (2000) The distribution and prevalence of Chytrid fungus in frog populations in eastern New South Wales and developing a means to identify presence or absence of Chytrid fungus in the field. Unpublished report to NSW National Parks and Wildlife Service.

National Parks and Wildlife Service (2000) Helping frogs survive- A guide for frog enthusiasts. (Prepared by Voight, L., Haering, R., and Wellington, R). NPWS Hurstville. NSW.

Pechmann, J.H.K. and Wilbur, H.M. (1994) Putting declining amphibian populations into perspective: natural fluctuations and human impacts. *Herpetologica* 50: 64-84.

Pechmann, J.H.K., Scott, D.E., Semlitsch, R.D., Caldwell, J.P., Vitt, L.J. and Gibson, J.W. (1991) Declining amphibian populations: the problem of separating human impacts from natural fluctuations. *Science* 253: 892-895.

Pounds, J.A. and Crump, M.L. (1994) Amphibian declines and climate disturbance: the case for the golden toad and harlequin frog. *Conserv. Biol.* 8: 72-85.

Pounds, J.A., Fogden, M.P.L., Savage, J.M. and Gorman, G.C. (1997) Test of null models for amphibian declines on a tropical mountain. *Conserv. Biol.* 11: 1307-1322.

Powell, M.J. (1993) Looking at mycology with a Janus face: A glimpse of chytridiomycetes active in the environment. *Mycologia* 85: 1-20.

Richards, S.J., McDonald, K.R. and Alford, R.A. (1993) Declines in populations of Australia's endemic tropical rainforest frogs. *Pacific Conserv. Biol.* 1: 66-77.

Speare, R., Berger, L. and Hines, H. (1999) How to reduce the risk of you transmitting an infectious agent between frogs and between sites. Amphibian Diseases Home Page 22/1/99, (<http://www.jcu.edu.au/dept/PHTM/frogs/ampdis.htm>).

Voight, L. (2001) Frogfacts No. 8. Frog hygiene for captive frogs (draft publication). FATS. Group. Sydney.

appendix I

hygiene protocol checklist and field kit

The following checklist and field kit are designed to assist with minimising the risk of transferring pathogens between frogs.

Have you considered the following questions before handling frogs in the field:

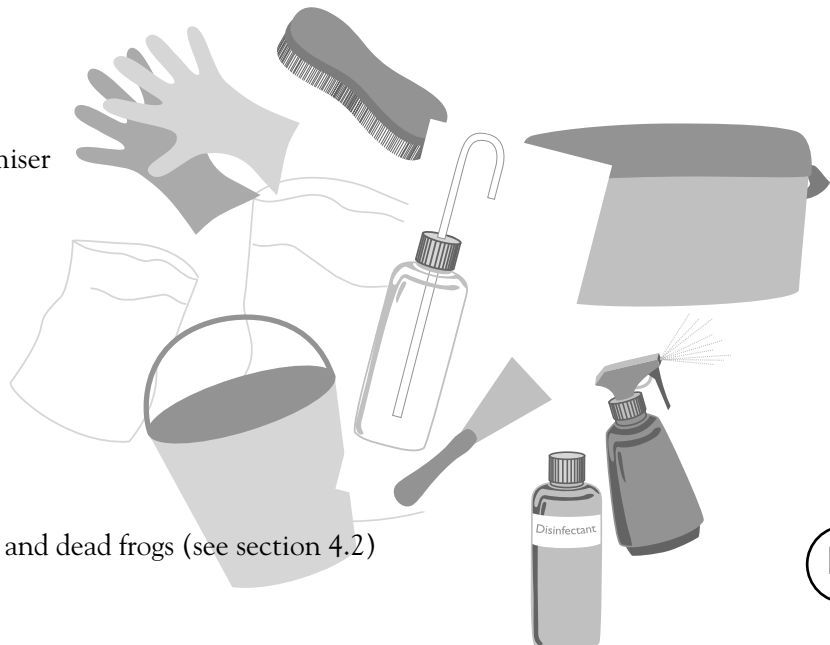
- Has your proposed field trip been sufficiently well planned to consider hygiene issues?
- Have you taken into account boundaries between sites (particularly where endangered species or populations at risk are known to occur)?
- Have footwear disinfection procedures been considered and a strategy adopted?
- Have you planned the equipment you will be using and developed a disinfection strategy?
- Are you are planning to visit sites where vehicle disinfection will be needed (consider both vehicle wheels/tyres and control pedals) and if so, do you have a plan to deal with vehicle disinfection?
- Have handling procedures been planned to minimise the risk of frog to frog pathogen transmission?
- Do you have a planned disinfection procedure to deal with equipment, apparel and direct contact with frogs?

If you answered NO to any of these questions please re-read the relevant section of the DECC Hygiene Protocol for the Control of Disease in Frogs and apply a suitable strategy.

Field hygiene kit

When planning to survey frogs in the field a portable field hygiene kit should be assembled to assist with implementing this protocol. Recommended contents of a field hygiene kit would include:

- Small styrofoam eski
- Disposable gloves
- Disinfectant spray bottle (atomiser spray) and/or wash bottle
- Disinfecting solutions
- Wash bottle
- Scraper or scrubbing brush
- Small bucket
- Plastic bags large and small
- Container for waste disposal
- Materials for dealing with sick and dead frogs (see section 4.2)



appendix 2

Always contact the relevant specialist prior to sending a sick or dead frog. In some cases, only wild frogs will be assessed for disease. Analysis may also attract a small fee per sample.

designated sick and dead frog recipients

Contact one of the following specialists to arrange receipt and analyse sick and dead frogs. Make contact prior to dispatching package:

Karrie Rose
Australian Registry of Wildlife Health
Taronga Conservation Society, Australia
PO Box 20
MOSMAN NSW 2088

Phone: 02 9978 4749
Fax: 02 9978 4516
Krose@zoo.nsw.gov.au

Diana Mendez or
Rick Speare
School of Public Health,
Tropical Medicine and
Rehabilitation Sciences
James Cook University
Douglas Campus
TOWNSVILLE QLD 4811

Phone: 07 4796 1735
Fax: 07 4796 1767
Diana.Mendez@jcu.edu.au
Richard.Speare@jcu.edu.au

Michael Mahony
School of Biological Sciences
University of Newcastle
CALLAGHAN NSW 2308

Phone: 02 4921 6014
Fax: 02 4921 6923
bimjm@cc.newcastle.edu.au

For information on frog keeping licences and approvals to move some species of displaced frog contact:

Co-ordinator, Wildlife Licensing
Wildlife Licensing and Management Unit
DECC
PO Box 1967
Hurstville NSW 1481
Ph 02 9585 6481
Fax 02 9585 6401
wildlife.licensing@environment.nsw.gov.au

For information on the possible identity of displaced frogs contact:

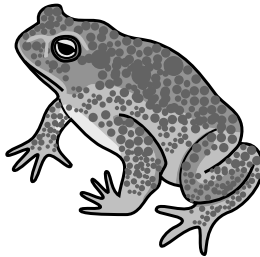
Frog and Tadpole Society (FATS)
Frogwatch Helpline
Ph: 0419 249 728

appendix 3

NSW Animal Welfare Advisory Council methodology

The NSW Animal Welfare Advisory Council procedure for humanely euthanasing cane toads or terminally ill frogs is stated as follows:

- Using gloves, or some other implement, place cane toad or terminally ill frog into a plastic bag.
- Cool in the refrigerator to 4°C.
- Crush cranium with a swift blow using a blunt instrument.



Note: Before killing any frog presumed to be a cane toad, ensure that it has been correctly identified and if outside the normal range for cane toads in NSW (north coast) that local DECC regional office is informed.

appendix 4

licensed wildlife carer and rescue organisations

Following is a list of wildlife rehabilitation groups licensed by
Department of Environment and Climate Change (NSW):

Northern NSW

Australian Seabird Rescue
For Australian Wildlife Needing Aid (FAWNA)
Friends of the Koala
Friends of Waterways (Gunnedah)
Great Lakes Wildlife Rescue
Koala Preservation Society of NSW
Northern Rivers Wildlife Carers
Northern Tablelands Wildlife Carers
Tweed Valley Wildlife Carers
Seaworld Australia
WIRES branches in Northern NSW

Southern NSW

Looking After Our Kosciuszko Orphans (LAOKO)
Native Animal Network Association
Native Animal Rescue Group
Wildcare Queanbeyan
WIRES branches in Southern NSW

Sydney, Hunter and Illawarra

Hunter Koala Preservation Society

Ku-ring-gai Bat Colony Committee
Kangaroo Protection Co-operative
Native Animal Trust Fund
Organisation for the Rescue and Research of Cetaceans (ORRCA)
Sydney Metropolitan Wildlife Services
Wildlife Aid
Wildlife Animal Rescue and Care (Wildlife ARC)
Waterfall Springs Wildlife Park
Oceanworld
Wildlife Care Centre, John Moroney
Correctional Centre
Koalas in Care
WIRES branches around Sydney, Hunter and Illawarra

Western NSW

Rescue and Rehabilitation of Australian Native Animals (RRANA)
RSPCA Australian Capital Territory Inc.
Wildlife Carers Network (Central West)
WIRES branches in Western NSW
Cudgegong Wildlife Carers

appendix 5 — sick or dead frog collection form

Sender details:

name: _____ address: _____ postcode: _____
phone: (w) _____ (h) _____ fax: _____ email: _____

Collector details: (where different to sender)

name: _____ address: _____ postcode: _____
phone: (w) _____ (h) _____ fax: _____ email: _____

Specimen details:

record no: _____ no. of specimens: _____ species name: _____ date collected: _____
day/month/year

time collected: _____ sex: _____ status at time of collection: _____ date sent: _____
male/female healthy(H)/ sick(S)/ dead(D) day/month/year

location: _____ map grid reference: _____
(easting) (northing)

reason for collection: _____

Batch details for multiple species collection:

species	no.	locality	(AMG)	date	sex	status (H/S/D)

habitat type: _____ vegetation type: _____ micro habitat: _____
eg creek, swamp, forest eg rainforest, sedgeland eg creek bank, under log, amongst emergent vegetation,
on ground in the open

unusual behaviour of sick frogs: _____
eg lethargic, convulsions, sitting in the open during the day, showing little or no movement when touched.

dead frogs appearance: _____
eg thin, reddening of skin on belly and/or toes, red spots, sore, lumps or discolouration on skin

deformed frogs: _____ dead/sick tadpoles: _____
eg limb(s) missing, abnormal shape or length eg numbers/behaviour

unusual appearance of egg masses: _____ recent use of agricultural chemicals in area: _____
eg grey or white eggs eg pesticides, herbicides, fertilisers

other potential causes of sickness/mortality/comments/additional information:

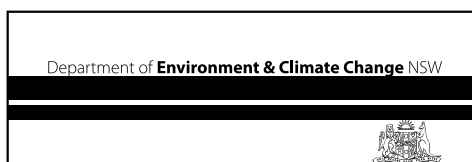


**NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE**

General inquiries: PO Box A290 South Sydney 1232

Phone: 9995 5000 or 1300 361967

Fax: 02 9995 5999 **Web site:** www.environment.nsw.gov.au



ATTACHMENT 7

GREEN AND GOLDEN BELL FROG MONITORING DATA RECORDING SHEET

