Appendix 8: Terrestrial and Aquatic Flora and Fauna Impact Assessment

WorleyParsons

resources & energy

CHAFFEY DAM AUGMENTATION AND SAFETY UPGRADE

TERRESTRIAL AND AQUATIC FLORA AND FAUNA IMPACT ASSESSMENT

301015-02980-REP-0006

DECEMBER 2012

ngh environmental

www.nghenvironmental.com.au

Document Verification

Project Title: Terrestrial and aquatic flora and fauna impact assessment
301015-02980-REP-0006

Project Number:	2400
Project File Name:	Chaffey Dam EIS Final v4 061212

Revision	Date	Prepared by (name)	Reviewed by (name)	Approved by (name)
Draft	13/08/12	Freya Gordon Dave Maynard Raphael Morgan	Jacqui Coughlan	
Final Draft	26/10/12	Freya Gordon Dave Maynard Raphael Morgan	Jacqui Coughlan	
Final v1	02/11/2012	Freya Gordon Dave Maynard Raphael Morgan	Jacqui Coughlan	Erwin Budde
Final v2	08/11/2012	Freya Gordon	Jacqui Coughlan	
Final v3	08/11/201212	Jacqui Coughlan		
Final v4	06/12/201212	Jacqui Coughlan Dave Maynard Freya Gordon Raphael Morgan	Jacqui Coughlan	

nghenvironmental is a registered trading name of **ngh**environmental Pty Ltd; ACN: 124 444 622.
ABN: 31 124 444 622

unit 18, level 3, 21 mary st surry hills nsw 2010 australia t 61 2 8202 8333

www.nghenvironmental.com.au e ngh@nghenvironmental.com.au

unit 17, 27 yallourn st (po box 1037)
fyshwick act 2609 australia
t 61 2 6280 5053 f 61 2 6280 9387

suite 1, 216 carp st (po box 470)
bega nsw 2550 australia
t 61 2 6492 8333

suite 1, 39 fitzmaurice st (po box 5464)
wagga wagga nsw 2650 australia
t 61 2 6971 9696 f 61 2 6971 9693

suite 7, 5/18 griffin dr (po box 1037)
dunsborough wa 6281 australia
t 61 8 9759 1985

CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Terrestrial and aquatic flora and fauna surveys were conducted in autumn and spring 2012 in order to assess the potential ecological impacts of the Project and to address the Director General's environmental assessment requirements (DGRs). The Project was deemed a controlled action by the Commonwealth Environment Minister, and supplementary DGRs were issued in October 2012. This report addresses both State and Commonwealth government requirements.

The NSW Dams Safety Committee was constituted by the NSW Government under the NSW *Dams Safety Act 1978* to ensure the safety of dams in NSW. Chaffey Dam is ranked by the NSW Dams Safety Committee as being in the "extreme" hazard category, having inadequate flood capacity, which is based on the population at risk and the severity of damage and loss that would result from dam failure (Dams Safety Committee 2008/2009). In terms of the Australian National Committee on Large Dams (ANCOLD) guidelines and NSW Dams Safety Committee risk framework, the dam failure risks at Chaffey Dam are considered to be intolerable. The proposed upgrade will provide the opportunity to bring the dam up to an acceptable level of risk. The proposed augmentation will increase water security for the region.

The *Environmental Planning and Assessment Act 1979* (EP&A Act) provides a framework for environmental planning and assessment in NSW. Amendments to the EP&A Act repealed the previous Part 3A (1 October 2011) and introduced Part 5.1 to provide an assessment and approval process for State Significant Infrastructure projects. The Project comprises "*development for the purpose of water storage… carried out by or on behalf of a public authority that has a capital investment value of more than $30 million*" pursuant to Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011 and as such, comprises a State Significant Infrastructure project.

Consultation was undertaken with the NSW Office of Environment and Heritage (OEH), the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities (SEWPaC), the Namoi Catchment Management Authority (CMA) and NSW Department of Primary Industries (Fisheries) to seek their input on survey methodology. The Project will result in the inundation of an area previously recorded as supporting a large population of the endangered Booroolong Frog (*Litoria booroolongensis)* (NWES 2009b). This will result in the loss of approximately 2721 m^2 of known and potential Booroolong frog habitat on the Peel River. A further 5294 m^2 of potential Booroolong Frog habitat was mapped within a 1.7 km stretch of the Peel River, immediately upstream of the impacted area. Existing information suggests there is at least a further 8.5 km of suitable habitat for the species upstream of the mapped area. Inundation to the new full supply level (FSL) may also result in the loss of individuals of this species. Inundation will be gradual and occur over a period of time (a minimum of between eight and 21 weeks, although taking several years) that may allow upstream migration of the frogs. In order to manage Project impacts to the species, it is proposed to develop and implement a Booroolong Frog Management Plan, including provision for additional population and habitat surveys, relocation of juvenile frogs upstream and threat mitigation in upstream areas of potential and known habitat. Given the large number of individuals that may be impacted by inundation to the new FSL, the impact assessment has concluded that given the potential loss of approximately 600 individuals the Project is likely to have a significant impact on the population of the endangered Booroolong Frog that currently occurs immediately upstream of Chaffey Dam on the Peel River. However, this impact will be localised and the impact to the species across its range is unlikely to be significant.

The Border Thick-tailed Gecko (*Uvidicolus sphyrurus)* will be impacted by construction activities on the dam wall through the temporary loss of habitat but given it's occurrence in surrounding areas and the likelihood that it will recolonise the dam wall post construction, the impact is unlikely to be significant.

The Endangered Ecological Community White Box-Yellow Box-Blakely's Red Gum Woodland and Derived Native Grasslands will not be significantly impacted, provided that appropriate offsets and mitigation measures are carried out to ensure that a net positive 'maintain or improve' outcome will be achieved.

Although not detected within or near the study area since 2003, using the precautionary principle it is assumed that a population of Queensland Bluegrass (*Dichanthium sericium*) may exist at the study site and should it be present, there will be a significant impact on it. If summer surveys find this species to be absent from the study site, the impact is unlikely to be significant.

Without implementation of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, Project impacts to the Darling River EEC located downstream of the dam would include a reduction of annual flows by an average of two per cent. Cold water pollution may also result. Impacts due to modified flow regime and cold water pollution currently occur as a result of the dam and the changes that would result with the augmentation of the dam are unlikely to significantly increase these impacts. With adequate management, significant impacts to the Darling River EEC are unlikely.

Mitigation and management measures will be put in place and will include measures such as an Offset Strategy and vegetation and fauna management plans to adequately address impacts associated with the Project, both direct and indirect.

1 INTRODUCTION

1.1 BACKGROUND

nghenvironmental have been engaged by WorleyParsons Services Pty Ltd (WorleyParsons) to undertake a terrestrial and aquatic flora and fauna assessment of the potential impacts associated with the proposed augmentation and safety upgrade of Chaffey Dam. Chaffey Dam is located on the Peel River approximately 30 km south-east of Tamworth.

The existing dam wall is a 54 m high, 430 m long, earth and rockfill embankment with a morning glory spillway and an auxiliary spillway. The dam has an existing storage capacity of 62 gigalitres (GL) at full supply level (FSL) (GHD 2008b). Chaffey Dam is presently an extreme hazard consequence dam, which is currently unable to safely pass the Probable Maximum Flood (PMF), therefore the proposed works also aim to provide sufficient freeboard to the dam crest so that the auxiliary spillway can safely pass a PMF (Molino Stewart 2011).

State Water Corporation (State Water) has received Commonwealth and NSW State Government funding to carry out the Project in order to meet current dam safety standards to accommodate extreme floods and to improve water security for the region, including town water supply for Tamworth and for irrigation. Water from the dam will continue to be managed through the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, developed by the NSW Office of Water and approved by the NSW Minister for Primary Industries.

The Chaffey Dam Augmentation and Safety Upgrade Project (the Project) comprises "*development for the purpose of water storage… carried out by or on behalf of a public authority that has a capital investment value of more than $30 million*" pursuant to Schedule 3 of State Environmental Planning Policy (State and Regional Development) 2011 and as such, comprises a State Significant Infrastructure project.

Director-General's Environmental Assessment Requirements (DGR) for the Environmental Impact Statement (EIS) were issued on 23 January 2012 by the Director-General of the Department of Planning and Infrastructure. The DGRs were accompanied by comments from other relevant NSW Government Agencies, comprising the Department of Primary Industries (Office of Water, Agriculture, Mineral Resources, Forestry and Fisheries), Environment Protection Authority, Office of Environment and Heritage (Heritage Council of NSW), Namoi Catchment Management Authority and Roads and Maritime Services. The Project was also referred to the Commonwealth Department of Sustainability, Environment, Water, Populations and Communities under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and was deemed to be a Controlled Action by the Commonwealth Environment Minister pursuant to that Act. Supplementary DGRs were provided in response to this on the 19th October 2012.

This flora and fauna assessment forms part of the EIS for the Project, pursuant to Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 STUDY AREA DESCRIPTION

The study site is defined as the areas directly affected by the Project, and includes those areas within the augmented FSL and works areas (Figure 1-1). The works areas includes the roads and bridges to be realigned or relocated along Western Foreshore Road, Tamworth-Nundle Road and Rivers Road, as well as the area impacted by works to the dam wall, morning glory spillway and auxiliary spillway.

The study area centres on Chaffey Dam (Figure 1-1) which is located on the Peel River within the upper Namoi River catchment in north-east New South Wales. The dam is approximately 6 km south of the town of Woolomin, and approximately 13 km north of the town of Nundle. The study area is defined as the study site and surrounding areas which were investigated in order to undertake the impact assessment.

The Project is located on land comprising Crown land, freehold, leasehold, road reserve and State Water acquired land. Existing land uses around the Chaffey Dam include:

- The existing dam and reservoir
- Recreational and open space land uses, including:
    - Bowling Alley Point Recreation Area (managed by the Bowling Alley Point Recreation Reserve Trust)
    - South Bowlo Fishing Club
    - Nundle Fishing Club
    - Dulegal Arboretum (established by the now dissolved Dulegal Arboretum Association and opened in 1982, this area is noted for its scientific and recreational value, however it is no longer being maintained)
- Land under private ownership and leasehold, including rural residential properties and land used for grazing and dairy farming
- Roads and bridges
- State Water administration and maintenance facilities and Storage Custodian's residence

1.3 STUDY AIMS

The aims of this flora and fauna assessment are to:

- Determine the terrestrial and aquatic biodiversity values of the study site and study area
- Determine the potential impacts of the Project on terrestrial and aquatic flora and fauna
- Recommend mitigation measures and considerations for appropriate offsets to minimise residual impacts of the Project on flora and fauna
- Address the DGRs provided on the 23rd January 2012 and the supplementary DGRs provided on the 19th October 2012

1.4 PROPOSED DEVELOPMENT

1.4.1 Project Location and Layout

The Project comprises the augmentation and safety upgrade of the existing Chaffey Dam (Figure 1-1). The proposed works will result in an increase in the FSL of 6.5 m and an increase in the permanent storage capacity from 62 GL to 100 GL.

The Project is proposed to be carried out by State Water and includes the following components:

- Augmentation of the dam to 100 GL at FSL, through raising of the dam wall and modification of the existing spillways.
- Modification of roads and bridges, including Tamworth-Nundle Road, Western Foreshore Road, Rivers Road and Bowling Alley Point Bridge.

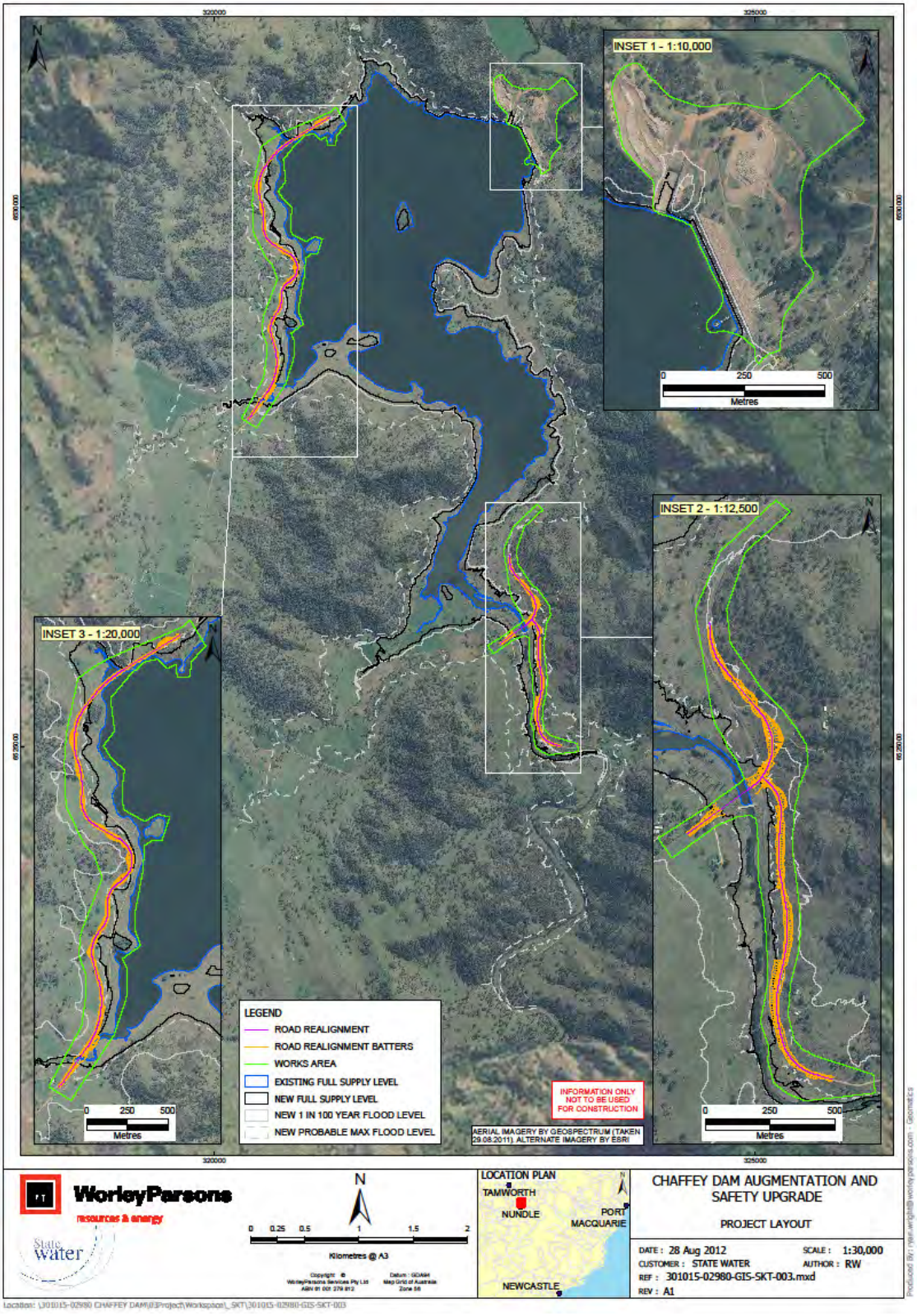


Figure 1-1 Project layout

- Relocation of facilities within the Bowling Alley Point Recreation Area and the South Bowlo Fishing Club.

The Project will result in an increase to the FSL of approximately 185 ha surrounding the existing reservoir and a footprint of up to 161.5 ha for development of new roads and bridges.

1.4.2 Project Scope

Construction works to achieve the required outcomes will include raising the dam wall by 8.4 m, raising the morning glory spillway by 6.5 m and reconfiguration of the auxiliary spillway fuse plug. Realignment of some roads and bridges, as well as modification to other surrounding land uses, is also required due to the increased FSL.

Conventional construction methods are anticipated to be used, except for works to the morning glory spillway, which will require some work over water using a barge.

1.4.3 Timing

Construction is expected to commence in March 2013 (pending receipt of relevant approvals) and will continue for approximately 24 months, as follows:

- Weeks 1 to 12: Construction documentation, approvals and establishment (up to 20 personnel on site)
- Weeks 13 to 60: Raising of dam wall, realignment of roads and bridges and reconfiguration of auxiliary spillway (up to 50 personnel on site)
- Weeks 61 to 90: Raising of morning glory spillway (up to 40 personnel on site)
- Weeks 90 to 104: Commissioning and site disestablishment (up to 20 personnel on site)

2 LEGISLATIVE REQUIREMENTS

2.1 NSW THREATENED SPECIES CONSERVATION ACT 1995

The *Threatened Species Conservation Act 1995* (TSC Act) sets out to conserve biological diversity and promote ecologically sustainable development, prevent the extinction and promote the recovery of threatened species, populations and ecological communities, protect the critical habitat of those species, populations and ecological communities that are endangered, eliminate or manage certain threatening processes, ensure proper assessment of activities impacting threatened species, populations and ecological communities and encourage the conservation of threatened species, populations and ecological communities through co-operative management.

For the purposes of the TSC Act, biodiversity values include the composition, structure and function of ecosystems, and include (but are not limited to) threatened species, populations and ecological communities, and their habitats.

An Assessment of Significance is a set of factors which must be considered by decision makers regarding the effect of a proposed development or activity on threatened species, populations or ecological communities, or their habitats, listed under the TSC Act. These factors form part of the threatened species assessment process under section 5A of the EP&A Act. Assessments of significance were undertaken for species and communities likely to be impacted by the Project, however they have not been included in this report as they are not a requirement for State Significant Infrastructure.

If a development is on land containing critical habitat or is likely to significantly affect threatened species, populations or ecological communities, the development application must be accompanied by a species impact statement. Species impact statements are not required for State Significant Infrastructure developments. Biodiversity factors are to be addressed in the EIS as per the DGRs for environmental impact assessment.

2.2 NSW NATIONAL PARKS AND WILDLIFE ACT 1974

The *National Parks and Wildlife Act 1974* (NPW Act) aims to conserve nature, habitat, ecosystems, ecosystem processes and biological diversity at the community, species and genetic levels. Under this Act all native fauna is protected, threatened or otherwise. Schedule 13 of the Act lists protected plants which shall not be harmed or picked on any land either on or off National Park estate.

With regard to threatened species a person must not, without the appropriate authority:

(a) harm any animal that is of, or is part of, a threatened species, an endangered population or an endangered ecological community, or

(b) use any substance, animal, firearm, explosive, net, trap, hunting device or instrument or means whatever for the purpose of harming any such animal.

2.3 NSW FISHERIES MANAGEMENT ACT 1994

The objectives of the *Fisheries Management Act* 1994 (FM Act) are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.

Where works would require the blockage of fish passage within the Peel River and its tributaries, such as for the installation of sediment controls downstream, a permit would be required under Part 7 of the FM Act.

Dredging works refers to work that involves the removal of woody debris, snags, gravel beds, cobbles, rocks, boulders, rock bars or aquatic vegetation from water land, or work that involves the removal of any other material from water land that disturbs, moves or harms woody debris, snags, gravel beds, cobbles, rocks, boulders, rock bars or aquatic vegetation (native vegetation that inhabits freshwater but does not include noxious weeds).

Under the Act 'water land' means 'land submerged by water, whether permanently or intermittently or whether forming an artificial or natural body of water'.

Section 198 and 199 of the FM Act states that a public authority (other than a local government authority) must, before it carries out or authorises the carrying out of dredging or reclamation work:

> (a) Give the Minister written notice of the proposed work, and
>
> (b) Consider any matters concerning the proposed work that are raised by the Minister within 28 days after the giving of the notice (or such other period as is agreed between the Minister and the public authority).

An Assessment of Significance is a set of factors which must be considered by decision makers regarding the effect of a proposed development or activity on threatened species, populations or ecological communities, or their habitats, listed under the FM Act. These factors form part of the threatened species assessment process under section 5A of the EP&A Act.

If a development is on land containing critical habitat or is likely to significantly affect threatened species, populations or ecological communities, the development application must be accompanied by a species impact statement. Species impact statements are not required for State Significant Infrastructure developments. Biodiversity factors are to be addressed in the EIS as per the DGRs for environmental impact assessment.

2.4 NOXIOUS WEEDS ACT 1993

This act aims to prevent the establishment, reduce the risk of spread and minimise the extent of noxious weeds. The *Noxious Weeds Act 1993* guides the management of declared noxious weeds within Local Government Areas (LGAs).

2.5 ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999 (COMMONWEALTH)

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protects nationally and internationally important flora, fauna, ecological communities and heritage places, which are defined in the EPBC Act as matters of national environmental significance.

The EPBC Act identifies eight Matters of National Environmental Significance (MNES) protected under national environment law:

- Listed threatened species and communities
- Listed migratory species

- Ramsar wetlands of international importance
- Commonwealth marine environment
- World heritage properties
- National heritage places
- The Great Barrier Reef Marine Park
- Nuclear actions

If a proposed development has the potential to have a significant impact on any MNES, such as nationally listed threatened species, ecological community or migratory species (and/or their habitats), the Project must be 'Referred' to the Australian Government environment minister for further consideration. When a Project is declared a controlled action, approval from the Minister is required. Further information on the referral and approval process is available at *Assessment and approval process - EPBC Act*.

All MNES addressed in this report are also listed under NSW state legislation (the TSC Act).

2.6 NATIVE VEGETATION ACT 2003

The *Native Vegetation Act 2003* (NV Act) aims to regulate the clearing of native vegetation on all land in NSW. Exemption from obtaining consent under the NV Act is achieved through Clause 25(h) of the Act, which provides an exemption for "*any clearing that is, or is part of, an activity carried out in accordance with an approval of a determining authority within the meaning of Part 5 of the EPA Act if the determining authority has complied with that Part.*"

State Significant Infrastructure projects do not require approval to clear native vegetation under the NV Act.

2.7 WATER MANAGEMENT ACT 2000

The *Water Management Act 2000* (WM Act) is administered by the NSW Office of Water in the Department of Primary Industries. The operation of Chaffey Dam is licensed under the WM Act. The WM Act enables the preparation of water sharing plans, which are legal documents under the Act. All water sharing plans in NSW are required to be developed to ensure consistency with the Murray-Darling Basin Cap. The Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010 was developed and approved by the NSW Government. The Project was considered in this Water Sharing Plan and water use from Chaffey Dam will continue to be managed in accordance with the approved Plan following implementation of the Project.

Cold water releases from a water supply works are subject to the provisions of the *Protection of the Environment Operations Act 1997*. The release of water two degrees Celsius colder than receiving waters is considered an offense. However, the *Protection of the Environment Operations (General) Regulations 1998* makes an exemption from a water pollution offence if cold water is discharged from a water supply work pursuant to an approval under the WM Act that contains conditions dealing with the cold water releases.

The necessary conditions in the approval under section 100(3) of the WM Act may include any or all of the following matters:

> (a) The undertaking of an investigation of the environmental impact of cold water releases and the options for mitigation of that impact

(b) The preparation of a program to mitigate the impact of cold water releases and the obtaining of approval to the program from the Minister

(c) The implementation of the program

(d) The monitoring and reporting on actions taken to implement the program and the impact of those actions on the environment

(e) The carrying out of new works or the making of alterations to existing works, or both

(f) The method of operation of water management works

State Water currently has policies and operational protocols to manage cold water releases. These have been considered in this assessment and when recommending mitigation measures.

2.8 SEPP 44 – KOALA HABITAT PROTECTION

The Nundle LGA is identified under Schedule 1 of *State Environmental Planning Policy No 44-Koala Habitat Protection* (SEPP 44). However, most of the Nundle LGA was absorbed into Tamworth Regional Council LGA in 2004. The Tamworth Regional Council LGA is not listed within Schedule 1 of SEPP 44, however the site was assessed for its likelihood of supporting Koalas, due to the existence of known records of Koalas elsewhere in the Tamworth Regional Council area.

This SEPP aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas to ensure a permanent free-living population over their present range and reverse the current trend of Koala population decline:

(a) By requiring the preparation of plans of management before development consent can be granted in relation to areas of core koala habitat
(b) By encouraging the identification of areas of core koala habitat
(c) By encouraging the inclusion of areas of core koala habitat in environment protection zones

Clause 9 states that:

(1) Before a council may grant consent to a development application for consent to carry out development on land to which this Part applies that it is satisfied is a core koala habitat, there must be a plan of management prepared in accordance with Part 3 that applies to the land.

(2) The council's determination of the development application must not be inconsistent with the plan of management.

2.9 LICENCES

nghenvironmental hold current NSW Department of Primary Industries (DPI) and National Parks and Wildlife Services (NPWS) licences that permit all of the activities that have been undertaken as part of this assessment:

- NPWS Scientific licence no. S10443 to capture and handle fauna
- DPI – Animal Ethics Approval
- DPI - Animal Research Authority

3 METHODOLOGY

3.1 APPROACH

The flora and fauna assessment has been undertaken in three stages:

1. Desktop review
2. Field surveys (Autumn and Spring 2012)
3. Impact assessment

3.2 DESKTOP REVIEW

A desktop review was undertaken to identify terrestrial and aquatic biodiversity constraints with the potential to occur within the study area and to guide field survey effort required. The desktop review included an analysis of the existing literature relating to Chaffey Dam and informed the need for additional field surveys, and the nature and extent of those surveys. The aim of the literature review was to ensure that information from previous studies was utilised and built upon in the current project. The study area includes water courses upstream and downstream of the dam potentially impacted by the proposed upgrade works.

Studies that have previously been undertaken at Chaffey Dam and formed the basis of the literature review included:

- Austeco (1990). Chaffey Dam Enlargement Proposal: Impact on Terrestrial Fauna. Report prepared for Department of Water Resources, August 1990
- GHD (2007). Chaffey Dam upgrade, further assessment of long-term options. Contract No 3571, State Water Corporation
- GHD (2008a). Chaffey Dam Upgrade Ecological Assessment
- GHD (2008b). Chaffey Dam Upgrade Preliminary environmental assessment (stage 1) summary report, State Water Corporation
- MHL (2005). Chaffey Dam Upgrade Environmental Investigations, Manly Hydraulics Laboratory and NSW Department of Commerce
- Grant (2007). *in* GHD (2008a) Chaffey Dam Upgrade Ecological Assessment. Proposed Augmentation of Chaffey Dam: Environmental Assessment: The Platypus. Report prepared by Dr T.R. Grant of Education and Environment Services Pty. Ltd. for GHD Services Pty Ltd and State Water
- Molino Stewart (2010). Chaffey Dam safety upgrade – Auxiliary spillway REF
- Molino Stewart (2011). Chaffey Dam Augmentation, Preliminary Environmental Assessment
- NWES (2009a). Flora and Fauna Impact Assessment for the proposed Chaffey Dam Safety Upgrade Options 1 & 2 – Addendum report to the GHD Ecological Assessment Report
- NWES (2009b). Review of the conservation status of the Booroolong Frog (*Litoria booroolongensis)* within the Namoi River Catchment. Report prepared for the Namoi Catchment Management Authority.

Additional information reviewed included:

- The Ecology Lab (2007). Aquatic Ecology Assessment for the Keepit Dam Upgrade
- Thoms *et al.* (1999). Environmental Scan of the Namoi River Valley

- Government agency comments on assessment requirements
- Davies *et al.* (2008). Sustainable Rivers Audit report 1. A report on the ecological health of rivers in the Murray-Darling Basin, 2004-2007

Additional documentation consulted throughout this report is provided in the References.

Background searches identified threatened species, populations and threatened ecological communities (TECs) and any other significant ecological features that have the potential to occur in the study area. The currency of threatened species listings on both state and Commonwealth schedules and any issues relating to recent listings of threatened species, populations or ecological communities were also addressed. Relevant sources included:

- Atlas of NSW Wildlife (Bionet), NSW Office of Environment and Heritage (OEH)
- EPBC Act Protected Matters search tool
- DPI Fisheries fish files
- Atlas of Living Australia (ALA) database
- DPI Fisheries Records Viewer for species occurring within the Murray-Darling Catchment Management Authority (CMA)

3.3 SITE SELECTION, SURVEY TIMING AND SCOPE

Preliminary field surveys were carried out in May 2012 at the commencement of the project to gain an understanding of the distribution of habitats and undertake fauna and flora surveys for those species that could be detected during autumn (Survey 1). More detailed surveys were undertaken in October 2012 for those species that require spring survey timing (Survey 2). Survey 1 allowed for in-depth habitat assessments for flora and fauna, however the late autumn timing of Survey 1 was sub-optimal in terms of detection for many threatened flora and fauna species. Some geophytic species, spring or summer flowering annuals and species which are inconspicuous or difficult to identify in their vegetative state would not have been recorded.

Survey 2 was designed to detect threatened species that would not have been detectable during Survey 1, however some additional flora and fauna species are best surveyed during summer. These species include Bluegrass (*Dichanthium setosum*), *Euphrasia arguta*, the Booroolong Frog (DEWHA 2010), and Border Thick-tailed Gecko (SEWPaC 2011).

Survey effort during Survey 1 encompassed the perimeter of Chaffey Dam, both within and outside the proposed FSL. Areas were chosen for survey based on existing aerial photographs, vegetation maps, and known records from previous studies. Site selection for targeted searches was further refined during the course of the field study after determining the existing vegetation types and habitat resources. Areas which were difficult to access by land were accessed from the water by boat.

Survey effort during Survey 2 was guided by the preliminary site assessment carried out in Survey 1, with greater emphasis and effort directed towards areas of better quality habitat and known records of threatened species.

Flora and fauna surveys were undertaken both within and outside the proposed FSL. Targeted searches were guided by the results of previous studies and Survey 1, and were specific to vegetation types and habitat resources. Survey effort is described in detail in the relevant sections below.

3.4 FLORA SURVEYS

3.4.1 Flora Survey Effort

Survey Techniques (Survey 1)

The initial flora survey was undertaken from the 28th to the 31st May 2012 (Survey 1). The aim of the survey was to broadly assess vegetation types and condition to enable accurate mapping of vegetation community boundaries and to inform a more detailed spring survey. A map of survey effort is shown in Figure 3-1.

The study area was surveyed using informal transects (random meander after Cropper 1993) and inspection points. In total, 15 random meanders and 36 inspection points were surveyed as described below (Figure 3-1). A total of 28 person hours was spent on the flora survey during Survey 1.

Random Meanders

Formal random meanders (after Cropper 1993) within relatively homogeneous vegetation of up to 30 minutes duration and covering up to one hectare were undertaken at a number of sites in each vegetation type, recording floristics, with structural and physical data. This method provides comprehensiveness in terms of the number of species and variation within vegetation types, and improves opportunities for detecting significant or sparsely distributed plant species.

Inspection Points

In addition to the traverse and random meanders, the majority of the study area was inspected on foot or by vehicle to confirm vegetation types, map the distribution of TECs and search for threatened species. TECs and areas of natural vegetation in better condition were given particular attention. Dominant species occurring at the inspection points were recorded to adequately confirm the vegetation type and condition where necessary.

Candidate areas of heavily disturbed habitats or areas carrying mainly exotic species, such as improved pasture and cultivated paddocks, were surveyed to record general species composition. Because of their low likely conservation significance, these highly modified areas were not inspected in detail.

Results of these surveys were used to determine the number of plots required to survey the vegetation according to the BioBanking Assessment Methodology (BBAM) (DECC 2009).

Survey Techniques (Survey 2)

A second flora survey was undertaken from the 8th to the 13th October 2012. This survey focused on collecting data to incorporate into the BBAM, conducting targeted searches for threatened flora species, confirming TEC boundaries and establishing inspection points to facilitate broad mapping of the vegetation types surrounding the study area. In total, 16 biometric plots, five targeted threatened species transects and 21 inspection points were completed as described below and shown in Figure 3-1. Approximately 62 person hours was spent in active surveys at the site.

Biometric Plots (BBAM)

The required number of biometric plots was established in areas of homogenous vegetation type and condition as defined by the BBAM. The location of these plots was determined by randomly assigning a location using GIS software and located in the field using a hand held GPS. The spread of plots was designed to capture the variation observed within each vegetation type during the spring survey. The

number of plots conducted within each homogenous vegetation type is shown in Table 3-1. A total of 37 person hours was spent on this component of the survey.

Table 3-1: Biometric plots conducted within the study area by vegetation type

Biometric vegetation type	Number of plots
Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion (line 141)	5
Rough-barked Apple - Silvertop Stringybark - Manna Gum shrub/grass open forest of the southern Nandewar Bioregion	4
Bluegrass - Spear Grass - Redleg Grass derived grasslands of the Nandewar Bioregion	3
River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions	3
Semi-permanent open freshwater wetlands of the inland slopes and plains	1

Aside from providing the data required to complete the BBAM, the surveys incorporated standardised 20 m x 20 m quadrats recording floristic and structural data. This information compliments and enhances the data recorded during Survey 1 particularly considering the spring timing of Survey 2 which identified a number of species not recorded in Survey 1.

Data obtained from the biometric plots is also utilised in comparing the characteristics of the vegetation communities at the site to ecological benchmarks published by the Namoi CMA (Namoi CMA 2012).

Targeted Searches

Targeted searches were carried within the study area for the species and locations identified in Figure 3-1. Searches were carried out according to the Draft Threatened Biodiversity Survey and Assessment Guidelines (DEC 2004) employing transects spaced approximately 5 m apart in all areas of suitable habitat within the study area (Figure 3-1). The targeted surveys were conducted by two botanists for the durations given in Table 3-2 (total of 10 person hours). The occurrence of Queensland Bluegrass and *Euphrasia arguta* at the locations of nearby recent records of these species was also investigated in an attempt to validate the detectability of these species at the time of the survey as the survey timing was not considered ideal for these species. Ideal survey timing for Queensland Bluegrass is summer to autumn (OEH 2012). Optimal survey timing for *Euphrasia arguta* is between January and April however it may also be possible to survey for this species between October and January (OEH 2012).

Table 3-2: Survey effort for targeted threatened flora transects

Location	Species targeted	Duration (hours)
Box-gum grassy woodland north of the Bowling Alley Point Recreation Area on the eastern foreshore	Small Snake Orchid Queensland Bluegrass *Euphrasia arguta*	1.5
Box-gum grassy woodland north of Bowling Alley Point Bridge on the eastern foreshore	Small Snake Orchid Queensland Bluegrass *Euphrasia arguta*	1
River-oak riparian woodland south of Bowling Alley Point Bridge	Dungowan Star-bush	1
Silvertop Stringybark grassy open forest along the northern foreshore	Small Snake Orchid *Euphrasia arguta*	1
Silvertop Stringybark grassy open forest to the north of	Small Snake Orchid	0.5

the dam wall	*Euphrasia arguta*	
Box-gum woodland north of the Bowling Alley Point Recreation Area on the eastern foreshore	Small Snake Orchid Queensland Bluegrass *Euphrasia arguta*	1.5
Box-gum woodland north of Bowling Alley Point Bridge on the eastern foreshore	Small Snake Orchid Queensland Bluegrass *Euphrasia arguta*	1
River-oak riparian woodland south of Bowling Alley Point Bridge	Dungowan Star-bush	1
Stringybark woodland along the northern foreshore	Small Snake Orchid *Euphrasia arguta*	1
Stringybark woodland to the north of the dam wall	Small Snake Orchid *Euphrasia arguta*	0.5

Assessment of Vegetation Surrounding the Study Site (Inspection Points)

To put the impacts of the Project into the context of the surrounding area (particularly for TECs) a rapid assessment approach utilising inspection points (as described for Survey 1 above) was employed to facilitate mapping of vegetation types within an area of one kilometre surrounding the study area. A large area on the western side of the dam was traversed by vehicle and a number of inspection points (refer Figure 3-1) established to record floristic and structural data sufficient to establish the type and general condition of the vegetation. Aspects important to determining the presence of TECs (such as the presence of overstorey regeneration) were also recorded. The boundaries of vegetation types were recorded using a handheld GPS. Along the eastern and southern sides of the dam, similar data was collected along transects undertaken from low to high elevations. A total of 15 person hours was spent on this component of the survey.

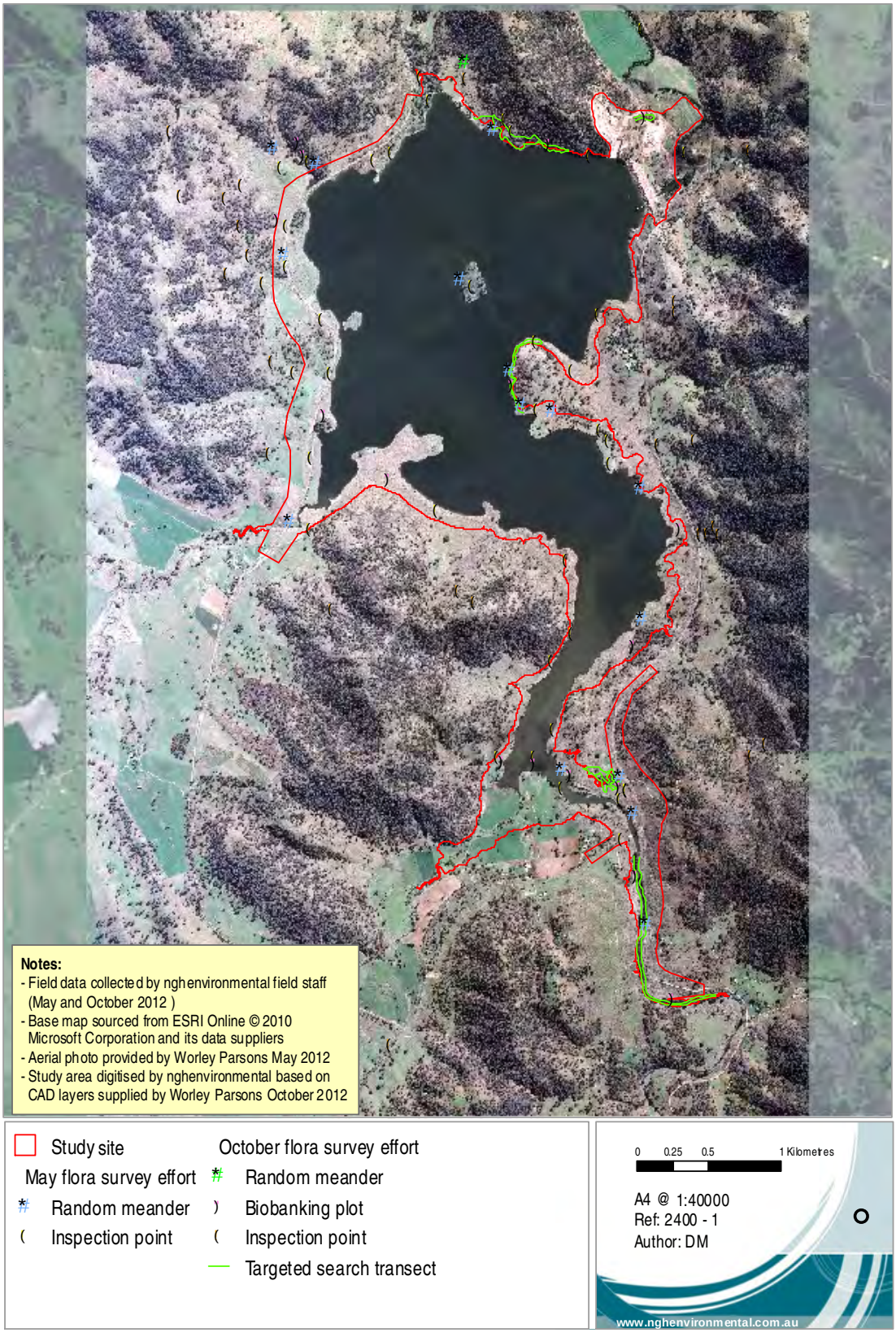


Figure 3-1 Flora survey effort Survey 1 and Survey 2 (May and October 2012)

3.4.2 Flora and Vegetation Condition Assessment

Condition assessment was applied to all survey points within the study area that may be impacted by the Project to adequately assess impacts by both vegetation type and condition. This included all random meanders and a number of inspection points.

Vegetation surveyed using random meander and inspection techniques in woodland, shrubland and grassland were rated according to a four-point condition class scale (derived by **ngh**environmental), focusing on floristic integrity in the understorey:

Exotic	Groundlayer dominated by exotics, no native overstorey present.
Poor	Groundlayer dominated by one or two native grass species, <5 native non-grass species **OR** native overstorey present and groundlayer dominated by exotics.
Moderate	Groundlayer dominated by native grasses, 5-11 native non-grass species present.
Good	Groundlayer dominated by native grasses with a diversity of native non grass (at least 12 native non-grass species).

These classes are most relevant for vegetation types with a grassy groundcover, such as the woodland and derived grassland observed on the site.

The Dry Forest community identified on site however, was distinctly different to grassy woodland vegetation. This vegetation type was observed on the rocky slopes and ridge tops, is distinctly different in structure to woodland vegetation and is generally characterised by a lower diversity within the understorey. For this vegetation type, condition classes were based on the ratio of native species to exotics as per below:

Exotic	Groundlayer dominated by exotics (exotics > natives), no native overstorey present.
Poor	Groundlayer dominated by exotics, native overstorey present.
Moderate	Some exotics present in the groundlayer but mostly native dominated.
Good	Groundlayer dominated by native species, few exotics present.

The classes above have been used in this assessment as they provide more detail and are considered more informative than the current two point scale endorsed under the biometric guidelines (DECC 2008a) which apply to methodologies such as BioBanking. With the exception of the 'exotic' class, the classes described above would all fall within the 'moderate to good' definition specified within the biometric guidelines due to the dominance of native vegetation in the ground layer or having a native overstorey with a percent foliage cover greater than 25% of the lower value of the over-storey percent foliage cover benchmark of that vegetation type. The exotic class would equate to 'low' condition vegetation under these guidelines. To provide a more detailed interpretation of the condition of vegetation at the site, the four point scale derived by **ngh**environmental has been used to describe vegetation condition throughout this assessment.

3.4.3 Vegetation Mapping

Spatial data obtained during the survey using hand-held Garmin GPS units were plotted over aerial imagery (sourced from WorleyParsons and ESRI Online) using ESRI's ArcGIS software for mapping, planning and presentation. Vegetation and condition boundaries within the study area were extrapolated from point and traverse data and notes taken during the general site inspection. All map references are based on the GDA 94 datum.

Surrounding area vegetation mapping

Mapping of the vegetation within one kilometre of the augmented FSL was predominately based on data collected in the field. However, due to the large area to be covered (approximately 2500 ha) it was not possible to collect field data comprehensively across the entire area. Vegetation boundaries across the broader area were extrapolated based on topographic relationships (such as elevation and slope) from patterns observed in the field data and from interpretation within the GIS of high resolution aerial imagery. Vegetation communities of conservation significance were mapped conservatively (only mapped where field validated or very likely to occur) so as to not overestimate their extent beyond the area of impact.

3.4.4 Plant and Community Nomenclature

The vegetation of the study area has been classified according to the Namoi CMA Regional Vegetation Community (RVC) classifications (Namoi CMA 2012) which provides the most recent and comprehensive classification for the study area. The equivalent biometric vegetation types are also identified and were used in determining the plot requirements according to the BBAM. However, the vegetation types are referred to by their RVC classification throughout this report. The condition of the vegetation of the study area is classified as described above and is discussed further in this report with regard to the ecological benchmarks published for each RVC.

Botanical nomenclature follows Harden (1990-2002), except where recent taxonomic changes have occurred. In the body of this report, flora species are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Where a species does not have a generally accepted common name, the scientific name is used throughout the body of the report. Common and scientific names are included in the Appendices.

Noxious weeds identified are those declared for the Tamworth Regional Council control area under the *Noxious Weeds Act 1993*.

3.5 FAUNA SURVEYS

Two fauna survey periods were undertaken: 28th to 31st May 2012 (Survey 1) and 8th to 13th October 2012 (Survey 2). Weather conditions during the survey periods are presented in Appendix C.

3.5.1 Survey Techniques

The following survey techniques were used during the fauna surveys.

Diurnal bird surveys

Surveys consisted of 20 minute, two hectare searches (as recommended by DEC 2004) and were conducted in the early morning and late afternoon. A total of 13 surveys were conducted during Survey 2 accumulating to a total of five person hours (Table 3-4).

Opportunistic observations of all bird species were also recorded during Survey 1 and Survey 2.

All bird surveys were conducted in optimal conditions by experienced bird observers using high powered binoculars.

Anabat

The use of Anabat detectors provides complementary information on the presence, diversity and relative abundance of microchiropteran bats by recording the number of passes of each species and capturing the echolocation calls of species.

One Anabat detector was set at Bowling Alley Point Bridge during Survey 1, as the bridge will be removed as part of the proposed road realignment (Figure 3-2). The device was placed beneath the bridge and directed towards the Peel River.

During Survey 2, one active Anabat survey was conducted during a spotlight survey on the eastern foreshore, and one passive Anabat survey was conducted overnight at the crest of the dam wall (Figure 3-2).

Anabat calls were analysed by Narawan Williams, a wildlife ecologist trained in Anabat call analysis. Call identification was given a certainty ranking as defined below:

C = Confident	No possibility of confusion of calls with other species expected in the vicinity.
P = Probable	Limited possibility of confusion of calls with those of other bat species expected in the vicinity.
Po = Possible	Likelihood of confusion with other species, but possible identification based on calls.

Spotlighting

Spotlighting was undertaken by two observers using 50-watt spotlights traversing the study area on foot. Target species included the Squirrel Glider (*Petaurus norfolcensis*) listed as Vulnerable under the TSC Act, the Border Thick-tailed Gecko (*Uvidicolus sphyrurus)* listed as Vulnerable under both the TSC Act and EPBC Act, and the Booroolong Frog (*Litoria booroolongensis)* listed as Endangered under both the TSC Act and EPBC Act. These species were targeted because they were either known to occur or had the potential to occur within the study area due to the availability of suitable habitat.

A total of five spotlighting surveys were conducted during Survey 2 accumulating to a total of 13.3 person hours (Table 3-4). Two of these surveys were focussed on the Border Thick-tailed Gecko.

Each survey was conducted in suitable habitat for the target species (Table 3-3). Spotlight survey locations are displayed in Figure 3-2.

Table 3-3: Number and location of spotlighting surveys

Location	Number of surveys	Target species
Box-gum Woodland	2	Squirrel Glider
Dam Wall	1	Border Thick-tailed Gecko
Goat Mountain	1	Squirrel Glider Border Thick-tailed Gecko
Peel River – upstream of Dam	1	Booroolong Frog

3.5.2 Survey Effort

A summary of the survey effort is displayed in Table 3-4.

Table 3-4: Fauna survey effort summary

Survey Type	Survey Period	Number of surveys	Total person minutes
Diurnal bird surveys	October	13	300
Anabat	May and October	2	n/a
Spotlighting - Squirrel Glider	October	2	640
Spotlighting - Border Thick-tailed Gecko	October	2	240
Spotlight - Booroolong Frog search	October*	1	160
River Snail search	October	4	105

**it is acknowledged that this survey was outside the optimal timing for detecting the species and that summer surveys are required. This was an opportunistic survey and does not accord with Draft Guidelines for Threatened Species Assessment (DEC, 2005) and Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna – Amphibians (DECCW, 2009).*

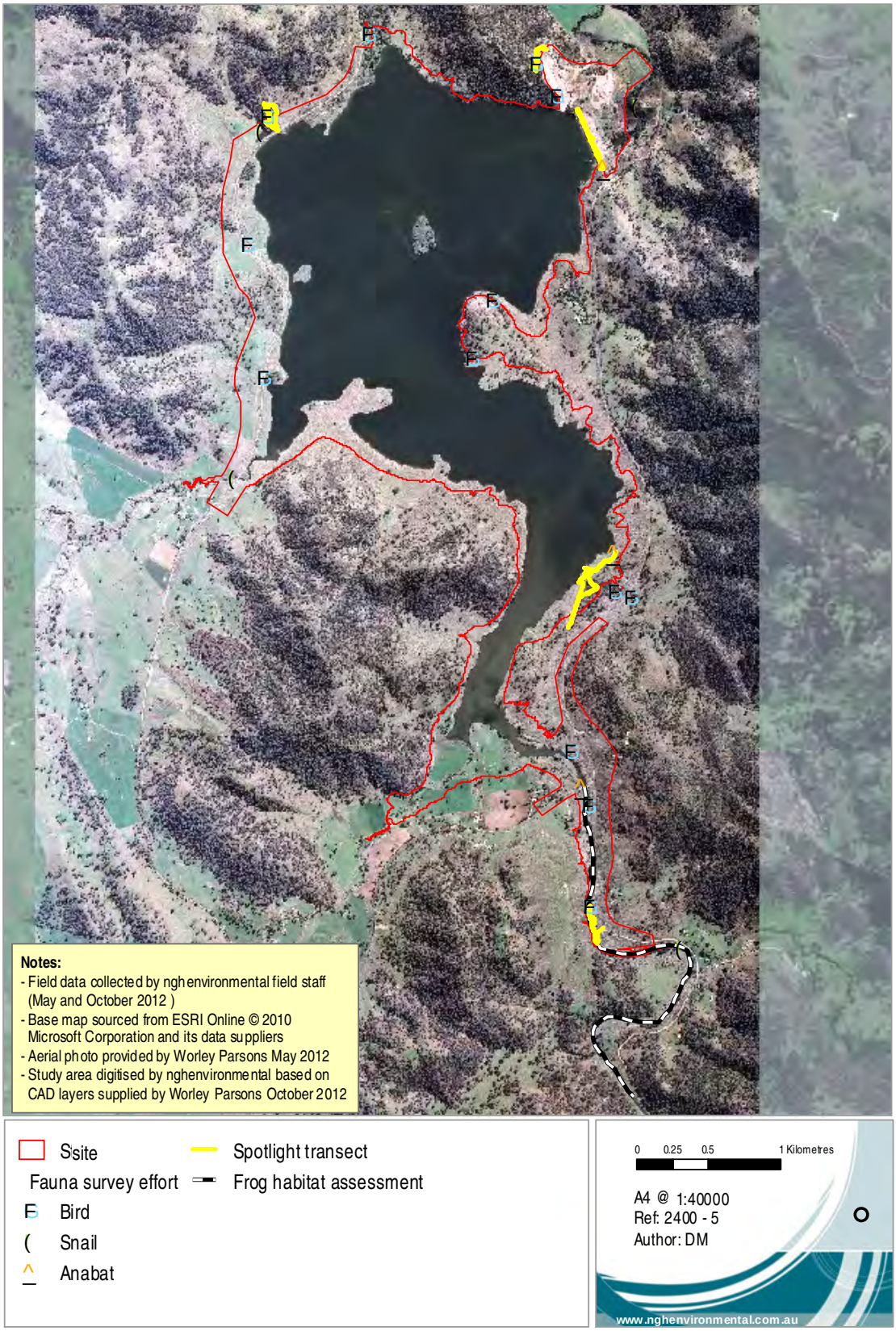


Figure 3-2. Fauna Survey Effort

3.5.3 Fauna Habitat Assessment

General

An assessment of all habitat types available and their quality and suitability as threatened species habitat was conducted during Survey 1 and Survey 2 whilst traversing the study area. Information collected included:

- A record of hollow-bearing trees, ground cover, and vegetation structure
- Incidental sightings of fauna, including fauna signs (scats, scratch marks, diggings, nests and dreys etc.)
- Presence of specific foraging habitat for target threatened species (e.g. patches of *Allocasuarina*, presence of chewed cones, mistletoe etc.).

Hollow-bearing trees

During Survey 1 the majority of the study site was traversed to identify and describe hollow-bearing trees that will be impacted by the Project. Areas of mature growth in better condition were given particular attention. Details that were recorded included:

- Tree species
- Diameter at breast height (DBH)
- Presence, size and number of hollows (small <10 cm; medium 10-20 cm; large >20 cm)
- Photograph
- General condition of vegetation to be impacted
- Any other important features (e.g. evidence of use such as scratches or nests)

The location of hollow-bearing trees is presented in Figure 4-10

Booroolong Frog (*Litoria booroolongensis*) habitat

The Booroolong Frog is listed as Endangered under both the TSC Act and EPBC Act. A large population of this species has previously been recorded upstream of Chaffey Dam on the Peel River (NWES 2009b). Part of this area will be inundated by implementation of the Project.

An assessment was conducted by **ngh**environmental during Survey 2 to quantify and describe the area of suitable Booroolong Frog habitat to be impacted by the new FSL and the amount of suitable habitat that exists upstream, outside of the augmented FSL. The Peel River was traversed from Bowling Alley Point Bridge approximately 2.5 km upstream. A length of 836 m within the augmented FSL and 1.7 km outside of the augmented FSL was assessed. A description of each riffle/rapid location was taken.

Potential habitat indicator features taken into account included:

- Width and length of the riffle/rapid
- Shade or full sun
- Substrate (rocks, boulders, gravel)
- Depth of the riffle/rapid

Each section of suitable habitat was recorded with a handheld GPS and was mapped to give an indication of potential Booroolong Frog habitat both within and outside of the augmented FSL (Figure 4-12).

Koala (*Phascolarctos cinereus*) habitat

The Koala is listed as Vulnerable under the TSC Act. The study area was assessed for the presence of Koalas during Survey 1, to identify whether areas to be impacted by the Project would constitute *potential* or *core* koala habitat as defined by SEPP 44:

- *Core koala habitat* is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females, and recent and historical records of a population.
- *Potential koala habitat* is defined as areas of native vegetation where the trees listed in Schedule 2 of SEPP 44 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

3.5.4 Fauna Nomenclature

Field guides and standard texts used as a reference are provided in the reference list. The naming of species recorded or known for the region follows the nomenclature present in these texts. The conservation significance of plants, animals and vegetation communities recorded is made with reference to the EPBC Act and the TSC Act. In the body of this report fauna are referred to by both their common and scientific names when first mentioned. Subsequent references to these species cite the common name only. Common and scientific names are included in the Appendices.

3.6 AQUATIC SURVEYS

3.6.1 Field survey

The aquatic environment of Chaffey Dam and the Peel River including tributaries upstream and downstream of the dam wall were assessed during field surveys on the 28th and 29th May 2012 (Survey 1). These surveys aimed to describe the existing aquatic flora and fauna habitat condition of the study area. Sites within the study area were selected to assess the range of habitats present upstream and downstream of the dam. Site selection took into consideration results of desktop assessment and analysis of recent aerial photographs. Site accessibility was also considered. Ten sites were selected, the locations of which are summarised in Table 3-5 and Figure 3-3. A full description of these sites can be found in Appendix F.

During the survey the weather was clear with little cloud cover (Appendix C). There had been around 14 millimetres of rain within the week leading up to the survey (*pers. comm.,* State Water, 28 May 2012).

Table 3-5 Aquatic Sites Surveyed

Site	Waterway	Description
US1	Peel River	Around 5 km upstream of the dam wall
US2	Peel River	Around 7 km upstream of the dam wall
US3	Cannes Creek	Around 1 km upstream of the confluence with the Peel River (around 7 km upstream of the dam wall)
US4	Cannes Creek	Around 2.5 km upstream of the confluence with the Peel River (around 4 km upstream of the dam wall)

Site	Waterway	Description
US5	Hydes Creek	Around 0.5 km upstream of the confluence with the Peel River (around 3 km upstream of the dam wall)
US6	Silver Gully	Gully drains into the dam through three box culverts around 2 km upstream of the dam wall
US7	Sheep Station's Creek	Tributary drains into Chaffey Dam around 3 km upstream of the dam wall
DS1	Peel River	Around 0.5 km downstream of the dam wall
DS2	Peel River tributary	Tributary meets the Peel River around 5.5 km downstream of the dam wall
DS3	Peel River	Around 6 km downstream of the dam wall

At all sites the quality of aquatic habitat was assessed, the location of each site was recorded and photographs taken. A visual assessment of instream habitat quality was undertaken using the following measures of habitat quality:

- Type and condition of riparian vegetation
- Flow types (pools, riffles, runs)
- Type of substrate and the presence of bars
- Bed and bank stability
- Aquatic habitat features such as snags, woody debris, vegetation and undercuts
- Any physical barriers or influences to fish passage
- Visible signs of habitat disturbances

The presence of native and exotic macrophytes (aquatic plants) was identified at each site. Percentage cover of submerged, floating (free-floating or attached) and emergent macrophytes was recorded. When left bank and right bank is discussed this refers to the position of the bank when facing downstream.

Stream order was identified using the Strahler System where waterways are given an 'order' according to the number of additional tributaries associated with each waterway (Strahler 1952).

One of the objectives of the FM Act is to 'conserve key fish habitats'. Available mapping of Key Fish Habitats within the Tamworth region (NSW DPI n.d.) were used to determine if waterways in the study area were considered Key Fish Habitat in accordance with the NSW Department of Primary Industries (Fisheries) definition.

Class of waterway was identified according to the definitions identified in Table 3-6 (Fairfull and Witheridge 2003).

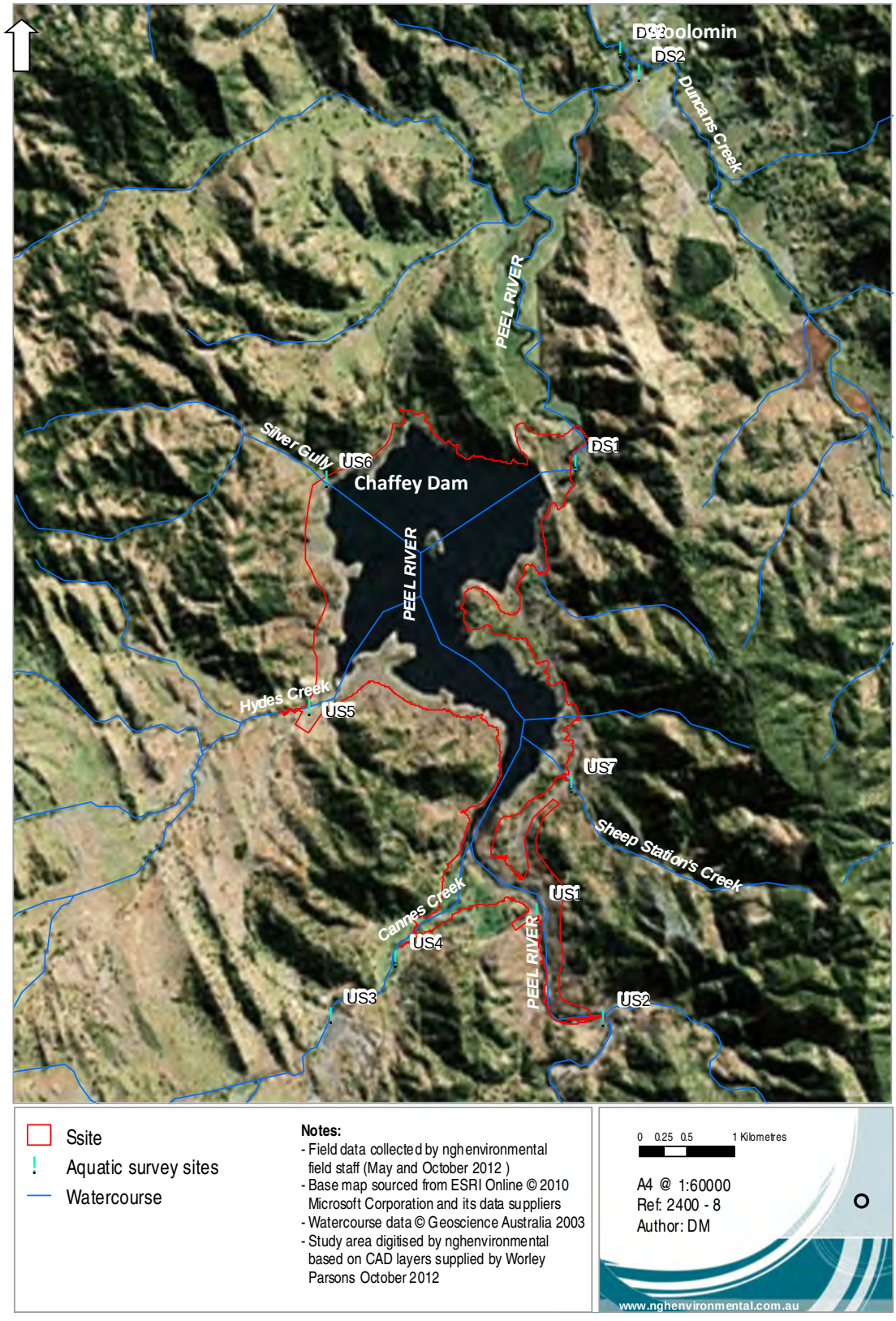


Figure 3-3: Aquatic sites surveyed at Chaffey Dam

Table 3-6: Classification of waterways according to natural characteristics (Fairfull and Witheridge 2003).

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

Targeted searches for threatened species

The desktop assessment revealed a large amount of recent data on aquatic species occurring within the Namoi Catchment including Chaffey Dam and the Peel River system. As such, the likelihood of occurrence of all threatened species revealed through database searches and the literature review within the study area could be clearly determined except for the River Snail (*Notopala sublineata*). Limited data is available on the distribution of this species. Considering potential habitat for this species is present in the study area, targeted searches for the species were undertaken in suitable habitats.

During Survey 2, four aquatic sites were assessed for potential River Snail habitat (Figure 3-2). Three of these sites were actively searched. At each survey location, a 50 m transect along the waterway was traversed searching for live snails or snail shells. This was conducted by two surveyors. The three active searches conducted accumulated to a total of 105 person minutes. Opportunistic searches were also undertaken upstream of Chaffey Dam along the Peel River during the Booroolong Frog habitat assessment surveys.

3.7 IMPACT ASSESSMENT

A conservation significance assessment was undertaken to assess the likelihood of impacts to species, populations and ecological communities listed on State and Commonwealth environmental legislation as threatened (vulnerable, endangered or critically endangered).

This process includes a consideration of the life cycle of species, population, or community, its local and regional distribution, the extent and quality of habitat available on the site, and the type and magnitude of impacts that may be expected. Where an impact is likely, an assessment of significance is undertaken.

4 RESULTS

4.1 FLORA

4.1.1 Landform, topography and soils

The study area comprises land of varying gradients. Steeper grades of around 30% occur at the northern extent of the reservoir, with gentler slopes to less than 1% surround the remainder of the reservoir.

Broadscale soil mapping (1:2 million scale; AUSLIG 1990) shows that the Nandewar bioregion, in which the study site lies, is dominated by shallow and stony sandy loams, associated with the granites, sediments, red brown earths and black cracking clays associated with volcanic substrate (DEC 2004). Less widespread soils include deep alluvial loams. The deeper, more fertile soils occur at lower elevations along the valley floors, where the associated Box-type vegetation has been extensively cleared in the past and where reservation is poor (DEC 2004). The low Ironbark, Tumbledown Red Gum (*Eucalyptus dealbata*), Stringybark and Cypress vegetation communities on the shallow and less fertile skeletal loams of the steeper slopes and ridges are often intact and are relatively well reserved (DEC 2004).

In a regional context, the vegetation of the Nandewar bioregion contains elements of three vegetation types. The high elevation eastern margins support vegetation communities typical of the New England Tableland Bioregion, while the low elevation western parts support communities more typical of the Brigalow Belt South Bioregion. Vegetation considered typical of the Nandewar bioregion (north-western slopes) occurs in a broad longitudinal band between these types (DEC 2004).

Soil landscapes within the study area are mapped as saline scalded lake bed clays, with deep alluvial loams to the west and southwest (Natural Resource Atlas 2012).

4.1.2 Vegetation Communities

Seven vegetation communities were identified at the study area as presented in Table 4-1. These vegetation types are described below and mapped in Figure 4-1. A complete list of species identified during the survey is provided in Appendix D. The RVC vegetation types are used to describe the vegetation throughout this report as they are specific to the vegetation within the Namoi CMA. The biometric vegetation types are also listed in Table 4-1 below as these are required to be utilised as part of the BBAM which was used to obtain data for comparison against the ecological benchmarks for each RVC. Table 4-1 shows the equivalency between these two systems of classification.

Table 4-1 Vegetation communities within the study area

Regional Vegetation Community (RVC)	Equivalent Biometric vegetation type
Box – gum grassy woodlands, Brigalow Belt South and Nandewar (RVC 17)	Yellow Box - Blakely's Red Gum grassy woodland of the Nandewar Bioregion (line 141)
Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (RVC 39)	Rough-barked Apple - Silvertop Stringybark - Manna Gum shrub/grass open forest of the southern Nandewar Bioregion

Regional Vegetation Community (RVC)	Equivalent Biometric vegetation type
Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)	Bluegrass - Spear Grass - Redleg Grass derived grasslands of the Nandewar Bioregion
River Oak Riparian Woodland, eastern NSW (RVC 71)	River Oak riparian woodland of the Brigalow Belt South and Nandewar Bioregions
Wetlands and marshes, inland NSW (RVC 70)	Semi-permanent open freshwater wetlands of the inland slopes and plains
Planted non-indigenous native vegetation (no RVC)	Nil
Exotic non-native vegetation	Nil

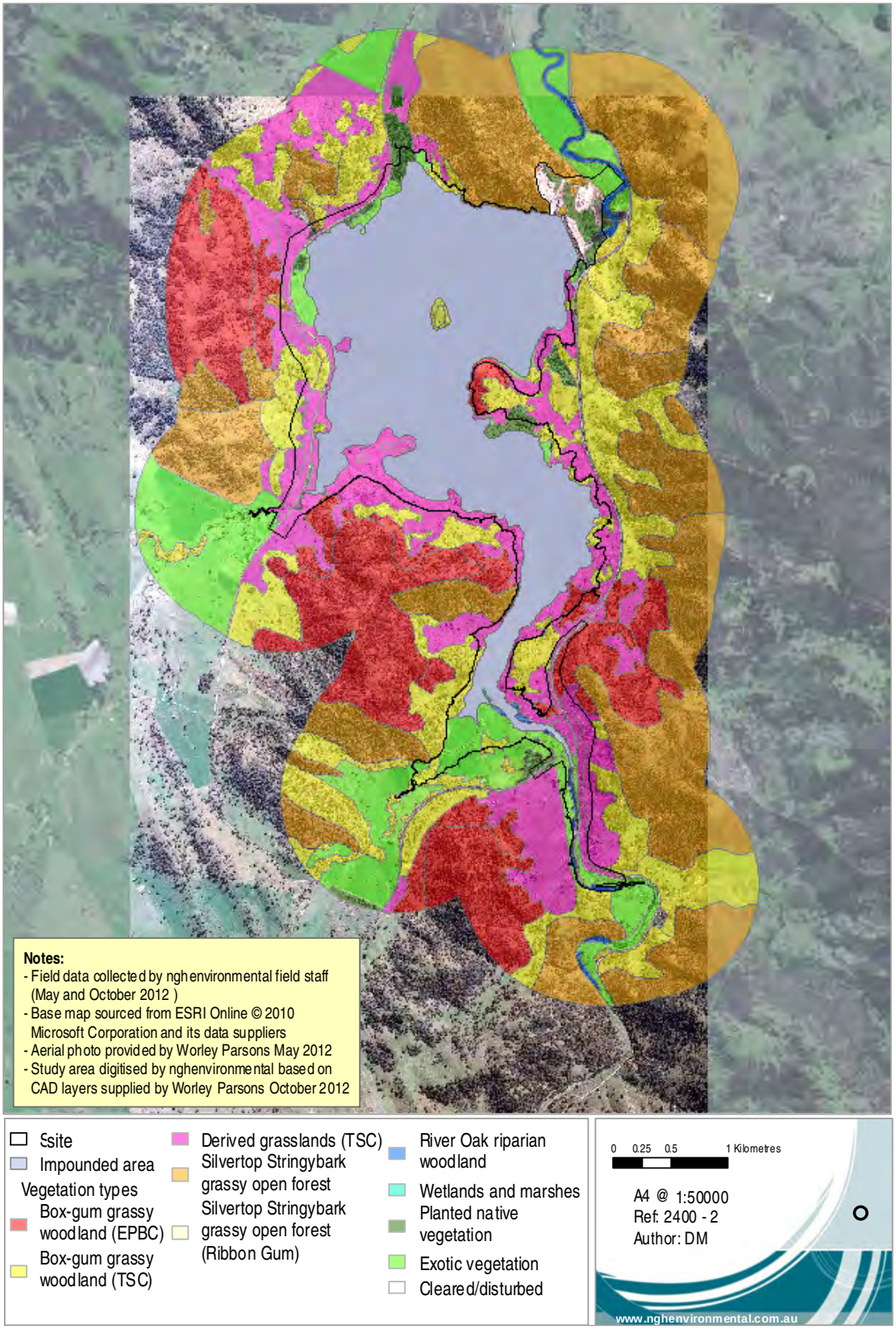


Figure 4-1. Vegetation communities within the study area

Box-gum grassy woodland, Brigalow Belt South and Nandewar (RVC 17)

The Box-gum grassy woodland community is the most common and widespread wooded community across the site. It occurs primarily on the lower slopes and flats surrounding the dam and is dominated by Yellow-Box (*Eucalyptus melliodora*) and Blakely's Red Gum (*Eucalyptus blakelyi*) (Figure 4-2). Native Olive (*Notelaea microcarpa* var. *microcarpa*) is a common small tree particularly in the north of the site. A shrub layer may be present or more often absent with common species including Cough Bush (*Cassinia laevis*), Grey Guinea Flower (*Hibbertia obtusifolia*) and Urn Heath (*Melichrus urceolatus*).

The condition of the understorey is variable across the site. Ground cover diversity is highest in the area north of the Bowling Alley Point recreation area on the eastern shore of the dam. With common species including Bulbine Lily (*Bulbine bulbosa*), Creamy Candles (*Stackhousia monogyna*), Tufted Bluebell (*Wahlenbergia communis*), Yellow Burr-daisy (*Calotis lappulacea*), Native Geranium (*Geranium solanderi*), Stinking Pennywort (*Hydrocotyle laxiflora*), Clustered Everlasting (*Chrysocephalum apiculatum*) and Twining Glycine (*Glycine clandestina*). The vegetation in this area is considered to be in good condition. Another area in good condition occurs to the south of the Bowling Alley Point recreation area where Scaly Buttons (*Leptorhynchos squamatus*), Common Buttercup (*Ranunculus lappaceus*) and Smooth Rice-flower (*Pimelea glauca*) are common. A broad range of native grasses is present including Speargrasses (*Austrostipa scabra* subsp. *scabra, Austrostipa ramosissima*), Wallaby Grasses (*Rytidosperma* spp.), Purple Wire Grass (*Aristida personata*), Hedgehog Grass (*Echinopogon ovatus*) and Weeping Grass (*Microlaena stipoides*). More commonly across the site, the understorey of this community is of a low diversity most likely due to grazing pressures and vegetation is mostly in poor condition. Areas of moderate condition occur in proximity to the higher diversity areas.

This community is listed as an Endangered Ecological Community (EEC) under the TSC Act with better quality remnants in good condition also qualifying as the Critically Endangered Ecological Community (CEEC) listed under the EPBC Act. Areas of this community in good condition can also provide habitat for threatened flora.

Figure 4-2 Box-gum grassy woodland typical of the study site

Assessment against RVC ecological benchmarks

In general, the plot data gathered for this community illustrate that the vegetation is generally below the ecological benchmark values determined for this RVC (Namoi CMA 2012) (Table 4-2). The exceptions being native canopy cover and native ground cover which are mostly exceeded and this is

likely an artefact of disturbance and subsequent regrowth. Plot D06, which was conducted within a good quality area on the eastern foreshore, generally exceeds the benchmarks except for the fauna habitat values (trees with hollows and woody debris) which is indicative of the generally young age of the trees and the plot's proximity to a camping area (evidence of open fires is widespread around the dam). Overall the vegetation within the study area would be considered to be below the benchmark condition excluding a small number of isolated areas such as the EPBC listed Box-gum woodland on the eastern foreshore.

Table 4-2 Plot data compared to the ecological benchmarks for Box-gum grassy woodland

Data source	Native canopy cover (%)	Native midstorey cover (%)	Native ground cover (%)	Species richness				No. of trees with hollows	Length of woody debris (m)
				Canopy	**Canopy recruitment**	**Midstorey**	**Ground cover**		
Benchmark	**15**	**5**	**50**	**2**	**2**	**2**	**25**	**4**	**30**
Biometric plot D05	24	0	42	1	0	1	6	0	11
Biometric plot D06	30.5	0.5	80	3	2	7	29	1	5
Biometric plot D09	14.5	1.5	56	2	2	1	13	1	0
Biometric plot D14	23	0	54	1	0	0	4	3	27

Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)

The derived grasslands community currently occurs as native pasture but is likely to have been derived from Box-gum grassy woodland that has been cleared of overstorey vegetation (Figure 4-3). This community was generally in poor condition across the site and exhibited a low diversity groundcover of native grasses dominated by Slender Rats-tail Grass (*Sporobolus creber*), Queensland Bluegrass (*Dichanthium sericeum*) and Red-leg Grass (*Bothriochloa macra*). Native forbs were generally absent and exotic species were common.

Despite its degraded condition, this community is also considered to comprise an EEC under state legislation (Refer to Section 4.1.4).

Figure 4-3 Derived grassland at the site

Assessment against RVC ecological benchmarks

As this vegetation is derived from the clearing of a previous woodland vegetation type, there are no ecological benchmarks for this community.

Silvertop Stringybark grassy open forest, eastern Nandewar and New England Tablelands (RVC 39)

The Silvertop Stringybark grassy open forest community typically occurs on the upper slopes and ridge tops surrounding the dam and is characterised by the presence or dominance of Silvertop Stringybark (*Eucalyptus laevopinea*) (Figure 4-4). On the northern shore of the dam (to the west of the dam wall) this community is co-dominated by Rough-barked Apple (*Angophora floribunda*). Ribbon Gum (*E. viminalis*) occurs as a dominant species within a drainage line north of Silver Gully and this area is mapped separately on Figure 4-1. In other areas this community also intergrades with Box-gum grassy woodland with occasional occurrences of Bundy (*E. goniocalyx*).

The shrub layer of this community is generally sparse with common species including Sticky Daisy-bush (*Olearia elliptica* subsp. *elliptica*), Blackthorn (*Bursaria spinosa*), Native Olive and Grey Guinea-flower. Sticky Daisy-bush does however, form the occasional dense thicket in more disturbed areas. The understorey is generally grassy with characteristic species including Barbed-wire Grass (*Cymbopogon refractus*), Purple Wiregrass (*Aristida ramosa*) and Hedgehog Grass. A range of forbs are present including Bluebells (*Wahlenbergia* spp.) Native Geranium, Kidney Weed (*Dichondra repens*), *Acaena ovina*, Cotton Fireweed (*Senecio quadridentatus*) and Common Woodruff (*Asperula conferta*).

All occurrences of this vegetation type within the study area are considered to be in good condition excluding areas of the south facing slope above the Ribbon Gum dominated area on the western foreshore which are dominated by exotics and considered to be in poor condition. Large patches of Blackberry also occurred within this community to the east of the South Bowlo Fishing Club on the northern foreshore of the dam.

Figure 4-4 Silvertop Stringybark grassy open forest at the site

Assessment against RVC ecological benchmarks

The data in Table 4-3 indicates that generally this vegetation type within the study area meets or exceeds the benchmark values. The number of trees with hollows is below the benchmark value which is indicative of the predominately young age class of the overstorey.

Table 4-3 Plot data compared to the ecological benchmarks for Silvertop Stringybark grassy open forest

Data source	Native canopy cover (%)	Native midstorey cover (%)	Native ground cover (%)	Species richness				No. of trees with hollows	Length of woody debris (m)
				Canopy	**Canopy recruitment**	**Midstorey**	**Ground cover**		
Benchmark	**30**	**10**	**35**	**3**	**2**	**4**	**30**	**3**	**40**
Biometric plot D01	12.5	14.5	74	2	1	1	17	0	5
Biometric plot D02	11	3	58	3	2	7	23	2	18
Biometric plot D03	22	14.5	36	3	2	4	23	2	71
Biometric plot D16	38	16.5	50	3	3	5	22	1	68

River Oak Riparian Woodland, eastern NSW (RVC 71)

The River Oak riparian woodland community is distinguished by the dominance of River Oak (*Casuarina cunninghamiana*). At the site it mostly occurs as isolated patches along the shoreline of the upper reaches of the dam and the Peel River (Figure 4-5) but also commonly occurs along the Peel River downstream of the dam. The understorey is mostly highly disturbed with a large component of exotic species however there are areas where native grasses such as Weeping Grass and River Tussock (*Poa labillardieri*) and native sedges dominate. This vegetation type is in mostly poor condition within the study area with some moderate condition patches.

Figure 4-5 River Oak riparian woodland at the southern end of the dam

Assessment against RVC ecological benchmarks

Excluding the species richness of the canopy (which solely consists of River Oak) the vegetation within the study area generally falls well short of the benchmark values for this vegetation type (Table 4-4). This reflects the highly disturbed nature of this community at the site.

Table 4-4 Plot data compared to the ecological benchmarks for River Oak riparian woodland

Data source	Native canopy cover (%)	Native midstorey cover (%)	Native ground cover (%)	Species richness				No. of trees with hollows	Length of woody debris (m)
				Canopy	Canopy recruitment	Midstorey	Ground cover		
Benchmark	**35**	**5**	**35**	**1**	**1**	**2**	**20**	**3**	**50**
Biometric plot D11	29.5	0	20	1	0	0	15	0	3
Biometric plot D12	16.5	0	10	1	1	0	7	0	30
Biometric plot D13	41	0	22	1	0	0	8	1	27

Wetlands and marshes, inland NSW (RVC 70)

The wetlands and marshes community occurs as an isolated area on the southern shore of the dam. It is dominated by Rushes (*Juncus* spp.) with patches of Phragmites (*Phragmites australis*) and Broad-leaf Cumbungi (*Typha orientalis*) (Figure 4-6).Groundcover below the rushes is generally sparse with Weeping Grass colonising areas on slightly higher ground. Predominately the inter-tussock spaces consist of bare mud.

This community is considered to be in moderate condition at the site.

Figure 4-6 Wetland and marshes community at the southern end of Chaffey Dam

Assessment against RVC ecological benchmarks

As shown in Table 4-5, only two benchmark criteria are relevant to this community. Native ground cover slightly exceeds the benchmark value, however, native species richness is less than half of the benchmark for this community.

Table 4-5 Plot data compared to the ecological benchmarks for the wetland and marshes community

Data source	Native canopy cover (%)	Native midstorey cover (%)	Native ground cover (%)	Species richness				No. of trees with hollows	Length of woody debris (m)
				Canopy	**Canopy recruitment**	**Midstorey**	**Ground cover**		
Benchmark	**n/a**	**n/a**	**50**	**n/a**	**n/a**	**n/a**	**15**	**n/a**	**n/a**
Biometric plot D10	-	-	68	-	-	-	6	-	-

Planted non-indigenous native vegetation (no RVC)

Specific areas around the dam have been planted with native vegetation that is not naturally occurring at the site. This includes trees associated with the Dulegal Arboretum (Figure 4-8), demonstration plantings on the western shore of the dam (Figure 4-7) and plantings around the Bowling Alley Point Recreation Area on the eastern shore of the dam. Given that these areas comprise non-indigenous vegetation, they were not investigated in detail.

Figure 4-7 Planted native vegetation on the western shore of the dam

Figure 4-8 Planted native vegetation at Dulegal Arboretum

Exotic non-native vegetation

Exotic dominated vegetation occurs commonly as isolated patches around the dam and more extensively in the form of cropped paddocks on the southern shore of the dam (Figure 4-9). Patches are commonly associated with areas that are subject to disturbance from recreational or grazing pressures and also where weeds such as Blackberry (**Rubus fruticosus* aggregate) have become extensively established. Around the dam wall Coolatai Grass (**Hyparhenia hirta*[1]) forms almost pure stands. Coolatai grass poses a major threat to natural biodiversity (Storrie 2010).

[1] The names of exotic species are proceeded by an * throughout this document


Figure 4-9 Exotic vegetation at the site

4.1.3 Conservation status of vegetation communities present

The conservation status of each of the natural vegetation types present within the study area is summarised in Table 4-6, based on data presented in the Namoi CMA RVC descriptions (Namoi CMA, 2012).

Table 4-6 Conservation status within the Namoi catchment of natural vegetation types occurring within the study site.

Vegetation type	Former extent (ha)	Current extent (ha)	Total area formally reserved (ha)
Box–gum grassy woodlands, Brigalow Belt South and Nandewar (RVC 17)	220,000	37,250 (83% cleared)	191 (<0.01% of former extent)
Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (RVC 39)	84,500	51,100 (39% cleared)	1,480 (0.02% of former extent)
Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)	n/a[2]	950,000	n/a
River Oak riparian woodland, eastern NSW (RVC 71)	17,500	10,800 (38% cleared)	910 (0.05% of former extent)
Wetlands and marshes, inland NSW (RVC 70)	11,200	14,800 (33% increase due to clearing of wooded vegetation)	0 (0% of former extent)

[2] A former extent is not listed for this community as it did not occur prior to European settlement.

Table 4-6 shows the high level of depletion and poor protection status of the majority of the natural vegetation types which would have originally occupied much of the study site. The exception is the derived grasslands and wetlands and marshes which have increased due to the clearing of overstorey vegetation. At the study site, the grassland is derived from the clearing of Box-gum grassy woodland which is a highly depleted vegetation type.

Applying the general JANIS reservation target of 15% of the original extent for each forest type (JANIS 1997), almost all of the natural vegetation types within the study area are under-represented in the conservation reserve system. Under JANIS criteria, 60% of the remaining stands of vulnerable types and 100% of endangered types should be reserved or otherwise protected.

The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands. White Box-Yellow Box-Blakely's Red Gum woodland (referred to above as Box-gum grassy woodland) is a listed Endangered Ecological Community (EEC) and remnants are threatened by a range of processes including further clearing, firewood cutting, livestock grazing, weed invasion, inappropriate fire regimes, soil disturbance, increased nutrient loads, soil acidification and salinisation and loss of connectivity (NSW SC 2002).

4.1.4 Endangered Ecological Communities

Database searches revealed six endangered ecological communities with potential to occur within a 10 km radius of the study site. Four of these were considered unlikely to occur in the study area on the basis of absence of suitable habitat. Two of the communities were confirmed during field work to be present in the study area. The detailed descriptions and habitat preferences of these communities, along with an assessment of likelihood of occurrence and potential for impact, are provided in Appendix B.2.

Of the vegetation that occurs within the study site, one community broadly named 'Box-gum grassy woodland' meets the definition of a listed Endangered Ecological Community. The definition and name of this community is slightly different under the TSC Act and EPBC Act and is further described and explained below:

- White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland (EPBC Act)
- White Box-Yellow Box-Blakely's Red Gum woodland (TSC Act)

Box-gum grassy woodland habitat often coincides with prime farmland. Historically, this community has been heavily impacted by clearing, grazing, cultivation and the introduction of weed and pasture species. The impact of this depletion is compounded by the severe fragmentation and continuing degradation of remaining stands.

NSW TSC Act Endangered Ecological Community (EEC)

The White Box-Yellow Box-Blakely's Red Gum woodland EEC listed under the NSW *Threatened Species Conservation Act 1995* includes:

- Woodland areas which include Yellow Box or Blakely's Red Gum (with or without native understorey); and
- Grasslands and pastures dominated by native grasses that are derived from this community.

All areas of Box-gum grassy woodland and derived grassland within the study site are considered to be part of this community.

EPBC Act Critically Endangered Ecological Community (CEEC)

The Commonwealth EPBC Act sets more stringent criteria for the recognition of the Box-gum grassy woodland Critically Endangered Ecological Community (CEEC) listed under that Act.

Under the EPBC Act, Box-gum grassy woodland remnants belong to the CEEC if:

- One of the most common overstorey species is/was Yellow Box, Blakely's Red Gum or White Box; *AND*
- The understorey is predominantly native; *AND*
- The patch is greater than 0.1 ha; *AND*
- either:
    - There are 12 or more non-grass species in the understorey including at least one important species (based on a list issued by the Commonwealth Government); *OR*
    - The patch is greater than 2 ha with an average of 20 or more mature trees per hectare, or natural regeneration of the dominant overstorey eucalypts is present.

An area north of the Bowling Alley Point recreation area and another north of Bowling Alley Point Bridge on the eastern shore of the dam meets the criteria for this community based on diversity in the understorey and the presence of overstorey regeneration. Another area to the south of the Bowling Alley Point recreation area has relatively low diversity but is greater than two hectares and has overstorey regeneration present.

4.1.5 Biometric status

Under the NSW DECCW Biometric guidelines (DECC 2008a), 'red flag' areas are important for biodiversity conservation and cannot easily be replaced. They include:

- Over-cleared vegetation (>70%) in moderate to good condition
- TEC in moderate to good condition
- Threatened species records (where species cannot withstand further loss in the CMA).

Approval to impact red flag areas may be granted provided:

- All reasonable measures have been considered – to avoid adverse impacts on the red flag area or to retain the viability of the red flag area
- The contribution that the development site's impacted biodiversity values make to regional biodiversity values is low
- The development site's biodiversity values are low, or not viable
- If the development impacts on a vegetation type that has 10% or less remaining in the catchment management area, the area of land containing this highly cleared vegetation type is less than 4 ha in size (DECC 2008a).

According to the BioMetric Operations Manual (DECC 2008b) definitions for native vegetation in low condition are:

Native woody vegetation is in low condition if:

- *The over-storey per cent foliage is <25% of the lower value of the over-storey per cent foliage cover benchmark for that vegetation type, AND*
- *<50% of vegetation in the ground layer is indigenous species or >90% ploughed or fallow.*

Native grassland or herbfield is in low condition if:

- *<50% of vegetation in the ground layer is indigenous species or >90% ploughed or fallow.*

If native vegetation is not in low condition then it is considered to be in moderate to good condition.

Hence, treeless native pasture derived from a TEC and dominated by native grasses, and trees in woodland formation satisfying the overstorey percent foliage cover over exotic pasture, are considered 'moderate to good' Biometric condition and are red flag areas.

4.1.6 Threatened Flora

A total of 220 vascular flora species were recorded from the study area. A list of the flora species found within each vegetation community is included in Appendix D. No threatened flora species were detected during Survey 1 or Survey 2.

Threatened species database searches returned three trees, three shrubs, four forbs (including one orchid) and two grasses listed as threatened that occur or have the potential to occur within 10 km of the study site. An assessment of the likelihood of occurrence of these species was undertaken. The assessment took into consideration the preferred habitat, including soils, and the current known distributions of the species and communities. Based on these threatened species evaluations (provided in Appendix B) and following the completion of Survey 1, four of these species were considered to have the potential to occur at the site and be impacted by the Project. These species are shown in Table 4-7.

Table 4-7. Threatened flora species considered to have the potential to occur at the site and be impacted by the Project following Survey 1

Species	Status
Small Snake Orchid (*Diuris pedunculata*)	TSC - E, EPBC - E
Dungowan Star-bush (*Asterolasia* sp. "Dungowan Creek")	TSC - E
Queensland Bluegrass (*Dichanthium setosum*)	TSC - V, EPBC - V
Euphrasia arguta	EPBC - CE

Targeted searches were carried out in suitable habitat for these species during Survey 2 (October 2012). Survey timing was considered suitable for the Small Snake Orchid and Dungowan Star-bush and although not optimal, it was also considered suitable for detecting *Euphrasia arguta* given that flowering has been recorded in October and if not flowering, it would have been possible to identify this species in its vegetative state. Targeted surveys did not detect these species and it is considered unlikely that the Small Snake Orchid, Dungowan Star-bush or *Euphrasia arguta* occur within the study area and that they are unlikely to be impacted by the Project.

The survey timing was not considered suitable for detecting Queensland Bluegrass which typically reproduces (and is identifiable) in summer and autumn. One record is known for this species in

Bowling Alley Point Cemetery (recorded in 2003) which is approximately 500 m east of the study site. This location was searched for this species during the spring survey and the species was not detected. However, given the unsuitable timing it is possible that it occurs and was not detected.

Queensland Bluegrass occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas and occurs in disturbed situations (OEH 2012c). Within the Namoi CMA, Queensland Bluegrass is associated with 16 vegetation types within the following vegetation classes:

- North-west Slopes and Northern Tablelands Dry Sclerophyll Forests
- Montane Lakes
- Semi-arid Floodplain Grasslands
- Western Slopes Grasslands
- Floodplain Transition Woodlands
- Western Slopes Grassy Woodlands
- Brigalow Clay Plain Woodlands
- North-west Floodplain Woodlands
- Riverine Plain Woodlands

The soil types at the location of the known record are not the heavy basaltic black soils that this species is typically associated with but consist of a red-brown loam which can also be associated with this species (OEH 2012c). The habitat at the recorded location is Box-gum grassy woodland similar to that of the higher quality areas within the study area. The soil type at the recorded location also appears to be similar to that of the soils within the study area. If Queensland Bluegrass occurs at the Bowling Alley Point cemetery, then it is possible that it also occurs within the study area and that it has the potential to be impacted by the Project.

4.1.7 Weeds and disturbance

Chaffey Dam is situated within a landscape which, apart from steeper slopes in the upper catchment, is predominantly cleared or has been highly modified by past and current agricultural practices. Within the area to be impacted by the Project, remnant treed vegetation is mostly comprised of scattered mature Yellow Box (*Eucalyptus melliodora*), Rough-barked Apple (*Angophora floribunda*) or Blakley's Red Gum (*E. blakelyi*) individuals. Other more dense naturally occurring treed areas consist of mostly younger regrowth vegetation. An exception is the Dulegal Arboretum which contains a variety of mature trees. However, the majority of these species although native, are not indigenous to the area and have been planted.

The majority of the vegetation to be affected by the increased FSL consists of highly disturbed low diversity grassland. Small areas of higher diversity occur on the eastern bank of the dam associated with regrowth woodland vegetation.

In the areas immediately surrounding the affected area, remnant vegetation occurs on the steeper upper slopes of the valley comprising mostly Silvertop Stringybark (*E. laevopinea*) dominated dry forest and White Box (*E. albens*) grassy woodland communities.

Common pasture weeds are prevalent throughout the area surrounding the existing dam including the area to be affected. Noxious weeds listed for the Tamworth Regional Control Area are also

present. Large infestations of Blackberry (**Rubus fruticosus* aggregate) occur around the existing foreshore. Other noxious weeds including Sweet Briar (**Rosa rubiginosa*), Prickly Pear (**Opuntia stricta*), St John's Wort (**Hypericum gramineum*), African Boxthorn (**Lycium ferocissimum*), Willows (**Salix* spp.) and Bathurst Burr (**Xanthium spinosum*) occur commonly as isolated individuals or patches. Blackberry, African Boxthorn, Prickly Pear and Willows (all except *Salix babylonica, S.x calodendron* and *S.x reichardtii*) are listed Weeds of National Significance (WoNS).

4.2 FAUNA

4.2.1 Database Search Results

Forty-two migratory or threatened terrestrial fauna species and/or their potential habitats have been recorded within 10 km of Chaffey Dam (Appendix A). Of these species, 16 are listed under the TSC Act, and 25 under the EPBC Act.

Five of these threatened fauna species and three of the listed migratory species have been recorded within the study area since 1990; the Brown Treecreeper, Speckled Warbler, Little Lorikeet, Border Thick-tailed Gecko, Booroolong Frog, White-bellied Sea-eagle, Rainbow Bee-eater and Great Egret. Being ground dwelling and less mobile than the listed bird species, the Border Thick-tailed Gecko and the Booroolong Frog are therefore more likely to be impacted by the raising of the dam wall and the increased FSL, respectively.

The detailed descriptions and habitat preferences of these communities, along with an assessment of likelihood of occurrence and potential for impact, are provided in Appendix B.2. The assessment was based on the known habitat preferences and distributions of the species, suitability of habitat on the study site, results of previous surveys and results of surveys conducted in 2012 for this report.

4.2.2 Results of Previous Fauna Surveys and Studies

Three terrestrial fauna studies have been conducted at the study site since 1990, recording a total of four threatened and two migratory species:

- Austeco (1990). Chaffey Dam Enlargement Proposal: Impact on Terrestrial Fauna. Report prepared for Department of Water Resources.
- GHD (2008a). Chaffey Dam Upgrade Ecological Assessment.
- NWES (2009a). Flora and Fauna Impact Assessment for the proposed Chaffey Dam Safety Upgrade Options 1 & 2- Addendum report to the GHD Ecological Assessment Report.

Austeco (1990) detected the Little Lorikeet (TSC-V), Brown Treecreeper (TSC-V) and Rainbow Bee-eater (EPBC-Migratory) during their surveys, although the Little Lorikeet and Brown Treecreeper were not yet listed as threatened.

In 2007 GHD conducted flora and fauna habitat assessments, a Peregrine Falcon roost and nest search, and spotlighting surveys for microbats (GHD 2008a). The habitat assessments identified potential habitat for the Squirrel Glider (TSC-V), Yellow-bellied Glider (TSC-V, EPBC-V), and Border Thick-tailed Gecko (TSC-V, EPBC-V). Opportunistic observations included the Brown Treecreeper, Little Lorikeet, White bellied Sea-eagle (*Haliaeetus leucogaster*) (EPBC-Migratory), and Great Egret *(Ardea alba)* (EPBC-Migratory). Surveys were undertaken for microbats in June 2007, however none were recorded and the survey timing was deemed inadequate (GHD 2008a). Platypus habitat

assessments and observations were also conducted (Grant 2007). While not listed as threatened, the Platypus is an iconic species protected under the NPWS Act. Two platypus individuals were observed foraging downstream of the spillway outlet (GHD 2008a). Grant (2007) recorded a further 14 individuals within the 1.5 km reach downstream of the dam. Although not recorded upstream of the dam, Grant (2007) suggested that suitable habitat exists.

In 2008 and 2009 North West Ecological Services (NWES) conducted targeted searches for the Border Thick-tailed Gecko, and found it to be relatively common on the dam wall and in the larger Goat Mountain remnant to the to the immediate northwest of the dam wall. To detect threatened microbats in the area, harp trapping, Anabat detection and mistnetting was conducted. No threatened microbat species were captured or recorded by any of these methods (NWES 2009a). Two call playback surveys were conducted for the Barking Owl (TSC-V), Masked Owl (TSC-V) and Yellow-bellied Glider, however no responses were elicited. Targeted searches for the Booroolong Frog were also conducted both upstream and downstream of Chaffey Dam. A total of 634 individuals were recorded over three surveys at a location approximately 1 km upstream of the existing FSL (all within the new FSL). It is unknown where this population overwinters and it is possible that chytrid impacts the population severely during winter, as low numbers of individuals are normally recorded in early summer (P. Spark, *pers. comm*.). Chytridiomycosis is a fatal disease of amphibians and is caused by the chytrid fungus *Batrachochytrium dendrobatidis* (DECC 2008). Because the species is a very capable breeder, numbers seem to regenerate over summer (P. Spark, *pers. comm*.). Recent surveys conducted by Philip Spark in autumn 2012 indicate that this population is still present (P. Spark, *pers. comm*.).

The Border Thick-tailed Gecko was observed by North West Ecological Services in 2008 on the dam wall (NWES 2009a). This species was also found to be relatively common within the region, recorded many times in shrubby rocky remnants around Woolomin, including Goat Mountain, to the immediate northwest of the dam wall. With the placement of additional rock and associated activities with raising of the dam wall, this species may be impacted by construction (NWES 2009a).

Surveys by NWES (2009b) in 2008 and 2009 found the Booroolong Frog occurring along an estimated 99 km of stream from seven streams in the Namoi catchment between 400 to 700 m above sea level. NWES located a large population of this species upstream of Chaffey Dam on the Peel River (NWES 2009b). A total of 634 individuals were recorded over three surveys at a location approximately 1 km upstream of Chaffey Dam (within the new FSL). A population of this size is presently unknown from anywhere else in the current distribution of the species (P. Spark, *pers. comm*.). A further six individuals were observed approximately 5.8 km upstream of this site (outside the new FSL), and another two individuals a further 2 km upstream (outside the new FSL) (NWES 2009b).

The methodology used at each site for those surveys is detailed below:

- daytime inspection of the sites to be surveyed to identify a suitable 500m transect for spotlight searching. Site selection aimed to incorporate as much potential habitat as possible in the 500m transect.
- completed the proforma recording the description of the section of stream (see Appendix A of NWES 2009 b).
- measured the 500m and recorded the length of the stream into a Garmin GPS for
- downloading into a PC

- began the survey after dusk, recorded the start time, weather conditions, and grid reference for the start point.
- two experienced ecologists conducted spotlighting along the 500m length of the stream using 30 watt hand-held spotlights and low watt head lamps, alternating between using the headlamp to look for frog eye shine and the hand held spotlights which give a brighter beam.
- During the search the call of a male Booroolong frog was played using an MP3 player and speaker. The call used was recorded from the first male Booroolong frog heard calling at Crawney TSR and met the need to use the species' 'local language' on the play back recording. The call was paused regularly for listening periods. Searches were not timed to complete within a set time frame, but were extended for the duration required to thoroughly search the site both in the stream and along both banks of the stream.
- All frog species observed and heard were recorded, as was the presence of fish, yabbies, turtles, water dragons, feral animals (including fish), and any other mammals heard or observed.
- All Booroolong frogs found were captured for weighing, measuring, and swabbing for DNA tissue and chytrid fungus and a detailed description of the location recorded onto the proforma (appendix A). At the Chaffey Dam site a sample of each age class was recorded.
- At the end of each transect the time, grid reference, and weather conditions were again noted, and the water temperature of the stream recorded.
- Each night all the swab samples were labelled and refrigerated for storage.
- Strict adherence to the NPWS 'Hygiene Protocol for the Control of Disease in Frogs' to avoid the spread of chytridiomycosis was practiced.

A very rough (and conservative) population estimation based on the number of Booroolong frogs recorded from the 500 metre survey transects within the 99 km of stream (3 – 4 frogs per 500m) puts the total population between 594-792 frogs (99 x 6 - 8 frogs per km). This calculation excludes the 634 recorded at the Chaffey Dam site which is considered atypical, and assumes that frogs occur along the length of the stream, which could prove to be incorrect. (NWES 2009b).

4.2.3 Fauna habitats

Fauna habitats of the study area and surrounds contained a range of microhabitat features including tree hollows, fallen timber, ground litter layer, riparian and wetland habitats.

A large portion of the study area contains variable (mostly moderate to poor) quality habitat, including large areas of grassland, planted, and exotic habitat. The woodland habitat to be impacted by the Project is patchy and isolated.

Woodlands

Three woodland communities within the study area provide habitat for fauna; Box-gum Woodland (TSC Act and EPBC Act listed), Silvertop Stringybark grassy open forest dominated by Silvertop Stringybark (*Eucalyptus laevopinea*) and Silvertop Stringybark grassy open forest dominated by Ribbon Gum (*Eucalyptus viminalis)* (Figure 4-1). These communities provide habitat for a range of

avifauna recorded during surveys including the Whistling Kite (*Haliastur sphenurus)*, Musk Lorikeet (*Glossopsitta concinna),* and Red-rumped Parrot (*Psephotus haematonotus)* (Appendix E).

Of the habitats present within the study site, these woodland communities are the most likely to provide habitat opportunities for threatened fauna including the Squirrel Glider, Koala, microbats, and woodland birds such as the Hooded Robin (*Melanodryas cucullata)*, Diamond Firetail (*Stagonopleura guttata)*, Speckled Warbler (*Chthonicola sagittata)*, Brown Treecreeper (*Climacteris picumnus)* and Varied Sittella (*Daphoenositta chrysoptera)*. Two of these species, the Brown Treecreeper (TSC-V) and Speckled Warbler (TSC-V) have been recorded during past surveys (GHD 2008a, NWES 2009a). Other threatened species that have been recorded include the Little Lorikeet (*Glossopsitta pusilla*) (GHD 2008a).

The study area was assessed for the presence of Koalas during Survey 1. Two feed tree species, as listed in Schedule 2 of SEPP 44, occur within the new FSL: Ribbon Gum (*Eucalyptus viminalis*) and River Red Gum (*Eucalyptus camaldulensis*). Ribbon Gums occur on the western extent of Chaffey Dam where the Westbank Road is planned for realignment. These individuals will be impacted by the new FSL and the realignment of Westbank Road, however their distribution is not continuous and they are unlikely to provide valuable habitat for Koalas. River Red Gums occur on the eastern foreshore within the Bowling Alley Point recreation area, however these individuals are also isolated and were probably planted. The presence of these two species within the new FSL does not constitute 15% of the total number of trees in the upper or lower strata of the tree component, therefore the study area does not qualify as *potential koala habitat* as defined by SEPP 44. *Core koala habitat* is defined as 'an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population'. No Koalas or signs of Koala presence were recorded during Survey 1. GHD (2008a) also conducted a Koala habitat assessment and found that the study area did not constitute potential koala habitat as defined under SEPP 44. It was therefore considered unlikely that a resident Koala population would occur within the study area.

River Oak Riparian Woodland

Stands of River Oak *(Casuarina cunninghamiana)* occur as isolated patches along the shoreline of the upper reaches of the dam and the Peel River, and also downstream of the dam wall (Figure 4-1). This riparian woodland provides foraging and nesting habitat for small birds such as Thornbills (*Acanthiza* spp.) and the Red-browed Finch *(Neochmia temporalis).* An abundance of Needle-leaf Mistletoe (*Amyema cambagei*) provides foraging habitat for a large diversity of species, including the White-plumed Honeyeater (*Lichenostomus penicillatus)*, Noisy Friarbird (*Philemon corniculatus*), and Mistletoebird (*Dicaeum hirundinaceum)*. These stands of River Oak and their association with water may provide potential habitat for threatened fauna including the Brown Treecreeper, Regent Honeyeater, and Turquoise Parrot (Namoi CMA 2012). The Booroolong Frog, listed as Endangered under both the TSC Act and EPBC Act, is known to occur within the vicinity of this habitat type, upstream of Chaffey Dam on the Peel River. Shading created by the River Oaks along the river provide sub-optimal habitat for the frog by reducing basking sites for adult frogs, and lowering stream temperatures, which may reduce larval growth (Bevitt *et al.* 1998).

Disturbed Lands

Disturbed lands include those vegetation communities listed as 'Planted non-indigenous native vegetation' and 'Exotic non-native vegetation' (Section 4.1.2 and Figure 4-1). These areas are subject to disturbance from recreational or grazing pressures and heavy infestations of weeds such as

Blackberry (**Rubus fruticosus* aggregate). These areas provide habitat for rabbits and foxes as well as habitat for small birds such as Superb Fairy-wrens (*Malurus cyaneus).* Around the dam wall, Coolatai Grass (**Hyparhenia hirta*) forms almost pure stands. This grass species is one of the main threats to the Border Thick-tailed Gecko, which occurs on the dam wall and in the Goat Mountain remnant at the northern extent of Chaffey Dam (NWES 2009a).

Grassland

Grasslands include the EEC listed as White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived grassland (Section 4.1.2) which has resulted from the clearing of Box-gum grassy woodland vegetation. This community occurs extensively as native pasture at the study site (Figure 4-1). This habitat is degraded, however it provides potential habitat for threatened species including the Diamond Firetail, Hooded Robin, and Little Eagle. Evidence of rabbits in these areas was high, and the grassland provides ample foraging opportunities for foxes and raptors.

Hollow-bearing Trees

Fifty-seven hollow-bearing trees were recorded within the new FSL during Survey 1 (Figure 4-10). These trees ranged in height from 8 to 20 m, with a diameter at breast height (DBH) ranging from 30 to 150 cm. An even proportion of trees contained small and medium-sized hollows, with only seven trees observed to have large hollows. Clusters of hollow-bearing trees, particularly along the eastern foreshore, provide potential habitat for arboreal fauna including the Squirrel Glider (TSC-V).

Spotlighting conducted in areas with clusters of hollow-bearing trees (Figure 4-10) did not detect any threatened fauna species.

Figure 4-10. Hollow-bearing trees within the study area

Riparian Zones and Reservoir

The riparian zone often includes a diverse range of habitats, which in the study area, includes the Chaffey reservoir, Peel River, creek banks and drainage lines, narrow bands of aquatic vegetation, tree lined River Oak Woodland, some patches of Eucalypt woodland, and grassland along the reservoir foreshore.

Common species observed in these areas include the Pacific Black Duck (*Anas superciliosa),* Little Pied Cormorant (*Microcarbo melanoleucos),* Little Black Cormorant (*Phalacrocorax sulcirostris),* Eurasian Coot (*Fulica atra),* Black Swan (*Cygnus atratus),* Australasian Grebe (*Tachybaptus novaehollandiae),* and Australasian Darter (*Anhinga novaehollandiae).* Less common observations included the Azure Kingfisher (*Alcedo azurea)* and White-bellied Sea-eagle *(Haliaeetus leucogaster).* Other fauna that are likely to use these habitats include a range of reptiles, amphibians and mammals. The Platypus (*Ornithorhynchus anatinus)* has been recorded within the spillway channel and further downstream of the dam (Grant, 2007).

Some of these areas provide known habitat for the Booroolong Frog and are likely to be an important foraging resource for microbats.

4.2.4 Fauna Survey Results

A total of 104 fauna species were recorded within the study area during both Survey 1 and Survey 2. Native fauna comprised 75 bird, 17 mammal, four reptile, two amphibian, and three aquatic species. Of these, three threatened species were detected including one mammal, one amphibian and one reptile. One migratory species was also recorded. Introduced species included one bird and two mammals.

A full species list is provided in Appendix E. Results for each fauna group are provided below.

Threatened and migratory birds

One migratory species listed under the EPBC Act, the White-bellied Sea-eagle, was recorded opportunistically during both Survey 1 and Survey 2. No threatened bird species were observed during the dedicated bird surveys or opportunistic observations.

Microbats

One species of threatened bat was recorded during Survey 2. The Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis)*, listed as Vulnerable under the TSC Act, was recorded as 'confident' from the Anabat located at the top of the dam wall. This species roosts in caves, derelict mines and man-made structures. It is likely that this species is roosting in the rocky habitats available on the upper slopes in the locality surrounding the dam, using Chaffey Dam primarily as foraging habitat.

Booroolong Frog

A total of 836 m was assessed within the new FSL where eleven potential and known Booroolong Frog habitat locations were identified (Figure 4-12 and Appendix H). These 11 locations total approximately 506 m (2721 m^2) of Booroolong Frog habitat within the FSL and will be impacted by the Project. A further 1.7 km was assessed upstream of the FSL (an additional 16 locations), and 932 m (5294 m^2) of this provides potential habitat for the Booroolong Frog (Figure 4-12 and Appendix H).

Potential habitat, both within and outside the new FSL, is not necessarily optimal habitat, with some areas negatively impacted by shading, depth and substrate (Table 4-8 and Figure **4-11**). Areas shaded by riparian overstorey vegetation along the Peel River provide sub-optimal habitat for the frog by reducing basking sites for adult frogs, and lowering stream temperatures, which may reduce larval growth (Bevitt *et al.* 1998). Shading is predominantly created by River Oaks along the Peel River. Approximately four sites within the new FSL and four sites outside the new FSL provide optimal habitat for the Booroolong Frog with full sun conditions. The majority of locations were partially shaded (Table 4-8) depending on the time of day.

Table 4-8. Summary of Booroolong Frog habitat assessment

Locations within FSL			Locations outside FSL		
Sun	**Partial Shade**	**Shade**	**Sun**	**Partial Shade**	**Shade**
4	6	1	4	11	1


Figure 4-11 Comparison of suitable Booroolong Frog habitat in sun (left) and shade (right)

One Booroolong Frog was recorded upstream of Chaffey Dam on the Peel River during Survey 2 (Figure 4-13). Low numbers are expected at this time of year as the growth rate of chytrid fungus increases in colder temperatures, resulting in population declines and mass mortality events over winter (NWES 2009). Hunter (2001) found that annual survival for this species is relatively low, with 10% annual survival for adult males and 20% annual survival for adult females (NSW OEH 2012). European Carp *Cyprinus carpio* were also observed upstream of the dam (outside of the FSL). This species is predatory and may have a significant adverse impact on Booroolong Frog populations by preying on eggs and tadpoles (DSE 2003; Gillespie and Hero 1999).

Border Thick-tailed Gecko

Three Border Thick-tailed Geckos were recorded on the crest of the dam wall (on the northern side) and one on Goat Mountain during Survey 2 (Figure 4-13). Suitable habitat for the Gecko is extensive on Goat Mountain and most likely in rocky surrounding areas. The artificial rocky surface area of the downstream dam wall currently provides approximately 50,000 m^2. The upstream face of the dam wall above the FSL provides approximately an additional 6,000 m^2 of suitable rocky habitat. NWES (2009a) found the geckos to be relatively common within the locality and the region within woodland remnants, dry open forests with a patchy and continuous shrub layer.

4.2.5 Exotic Fauna Species

Evidence of European Rabbits (*Oryctolagus cuniculus*) was abundant across the study area. Densities were particularly high on the island in the middle of the dam. The Red Fox (*Vulpes vulpes*) was found to be abundant across the study area, and was observed during spotlighting, diurnal surveys, and as road kill.

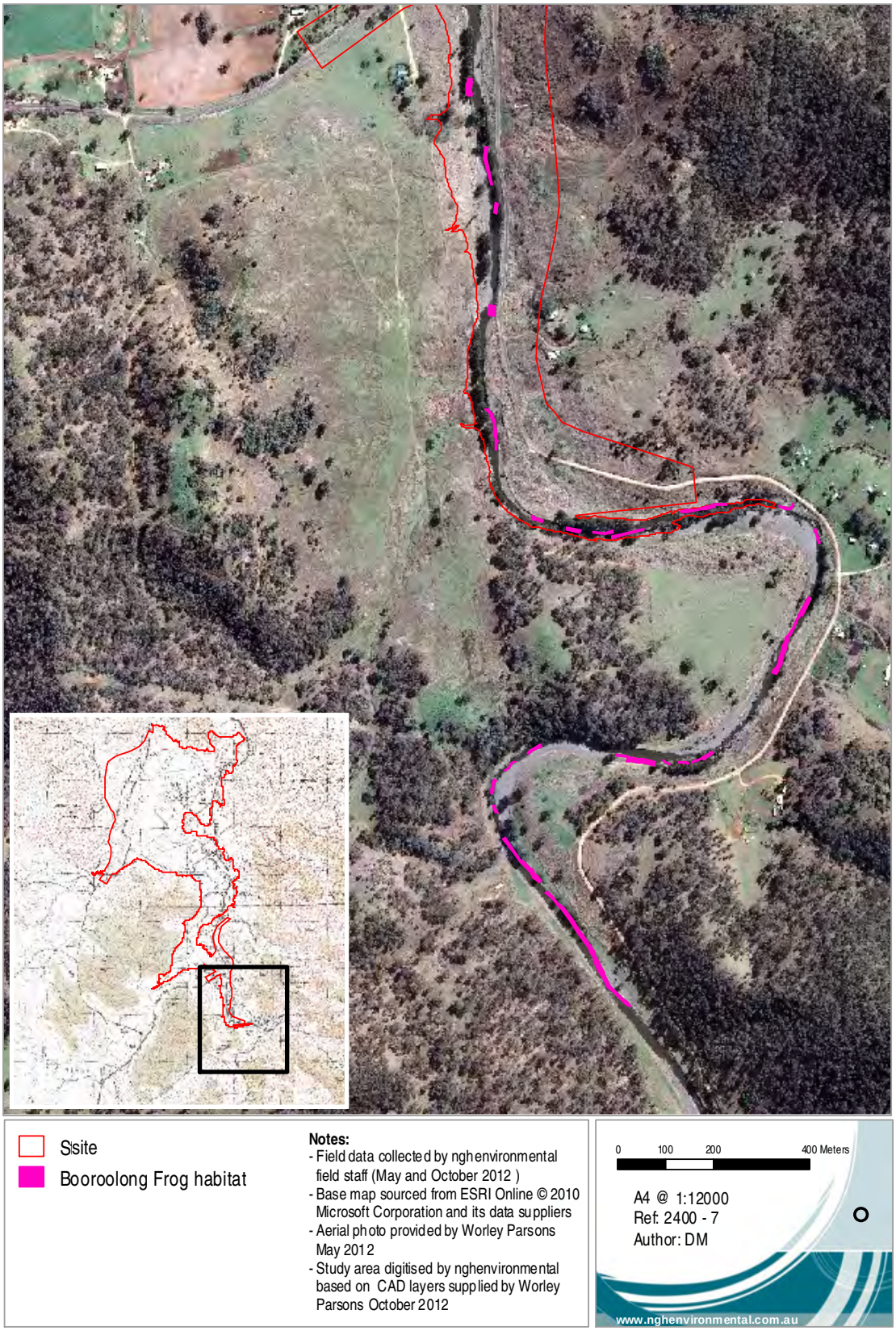


Figure 4-12. Booroolong Frog habitat upstream of Chaffey Dam

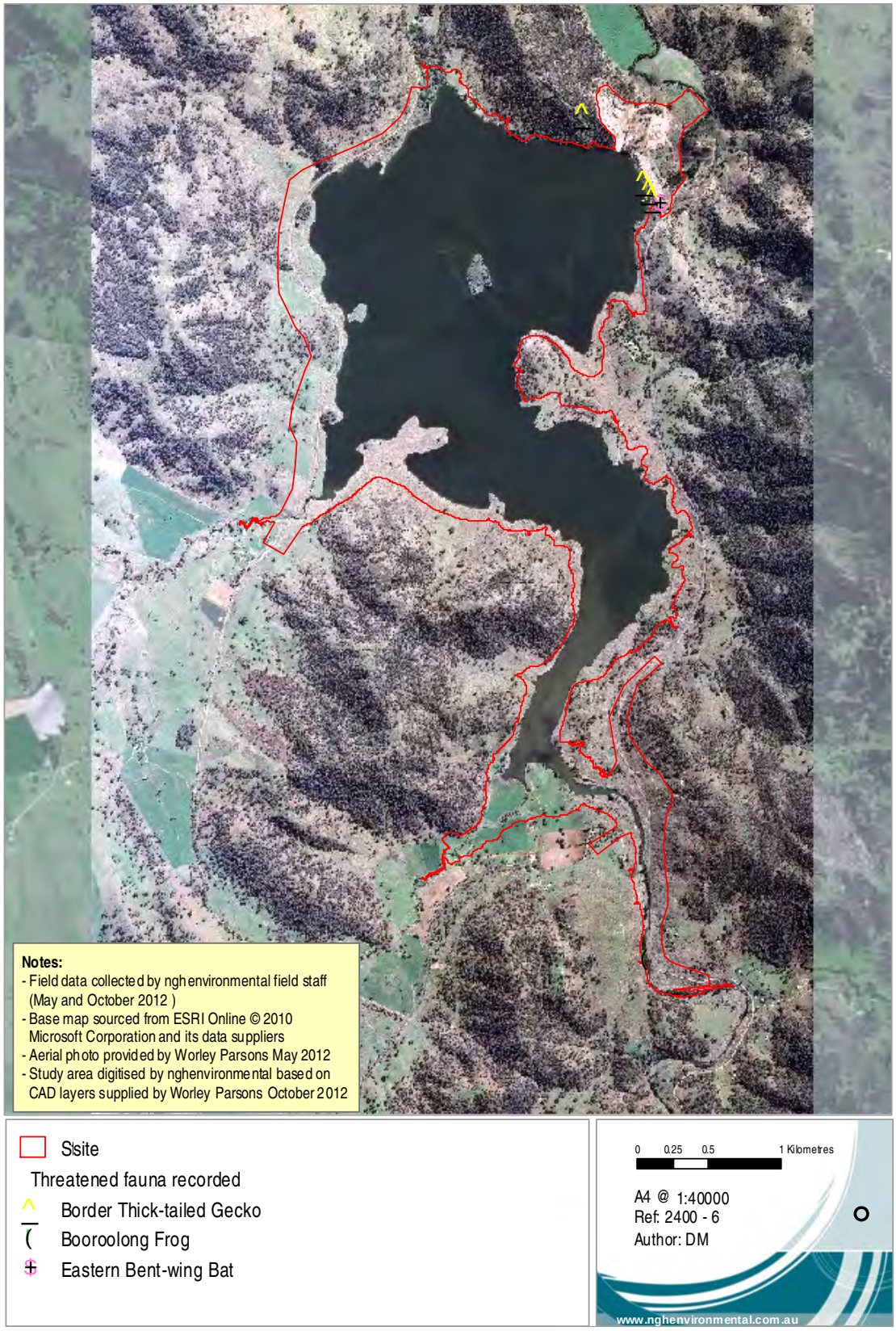


Figure 4-13. Threatened species recorded in the study area during Survey 1 and Survey 2

4.3 AQUATIC

4.3.1 Chaffey Dam and the Peel River

Chaffey Dam is located within the upper reaches of the Namoi Catchment along the Peel River approximately 45 km south west of Tamworth. Chaffey Dam currently regulates 41 per cent of all inflows in the Peel River compared to Split Rock Dam and Keepit Dam, which regulate 93 per cent and 77 per cent of all inflows in the Namoi River respectively (CSIRO, 2007).

Chaffey Dam supplies water for domestic, stock and irrigation purposes, as well as environmental flows. The dam provides water supplies and drought security to Tamworth and significant irrigation along the Peel Valley, used for the production of cotton, wheat, lucerne, vegetables, fruit trees, oil seeds and fodder as well as pastures for sheep and cattle (State Water 2009).

The Water Sharing Plan for the Peel Regulated, Unregulated, Alluvial and Fractured Rock Water Sources (Peel Water Sharing Plan) commenced on 1 July 2010 and applies until 30 June 2020 (NOW 2010). The current environmental water rules require a 'stimulus flow' of up to 1,600 ML to be provided if the Chaffey storage exceeds 50,000 ML at the start of the water year. The purpose of a stimulus flow is to achieve environmental benefits by stimulating the ecosystems downstream of the dam. There are also provisions for a stimulus flow if the storage is less than 50,000 ML at the start of the water year. The plan also has rules for when Chaffey Dam is enlarged which involves the creation of up to a 5,000 ML of environmental contingency allowance. Furthermore, under both current and augmented conditions, a minimum daily release that is equal to 3 ML is required except when a release of greater than 3 ML per day is required to meet basic landholder rights and access licence extractions or when a release is being made under stimulus flow or environmental contingency allowance rules.

4.3.2 Aquatic habitats

The Peel River, as part of the Namoi catchment, supports various sedges, rushes and reeds. Riparian vegetation includes River Oaks (*Casuarina cunninghamiana*,) Rough-barked Apple (*Angophora floribunda)*, River Red Gum*, Callitris sp.*, and *Lomandra sp*. The area downstream of the confluence of the Cockburn River is characterised by a well-formed floodplain and the formation of an anabranch system directly downstream of Tamworth. The unregulated Peel anabranch is highly degraded due to long-term gravel extraction operations.

Lampert and Short (2004) provide a detailed assessment of the river styles and condition of the Namoi catchment. The River Style analysis, which assessed around 10,000 km of stream, found 23 different River Styles in the Namoi catchment. The determination of River Style and indicative condition of assessed streamlines in the Namoi catchment provided a geomorphic basis for prioritising river conservation and rehabilitation efforts (Lampert and Short 2004). Unlike large wetland complexes, such as those found in the Gwydir, Macquarie and Lachlan catchments, where duration and total flow volumes over weeks or months are important, the Namoi water-dependent ecosystems are largely driven by the daily (or even instantaneous) flows that link the benches, cut-off channels, anabranches and floodplains. The Namoi ecological assets are linked to reaches and are based on maintaining the processes for river health such as organic carbon transfer and nutrient cycling, as well as direct impact on vegetation condition and habitat availability.

Prior to the commencement of the Peel Water Sharing Plan, Foster (2003) and Foster and Lewis (2009) described the Peel River downstream of the dam as follows:

"The Peel River, directly downstream of Chaffey Dam, is a confined channel that is narrowing and becoming invaded by riparian vegetation due to the lack of high velocity flows. The lack of high velocity flows has also resulted in instream gravel becoming immobile and encrusted with filamentous algal mats and biofilms during summer.

Riverine vegetation supported by the Peel River includes emergent aquatic plants and river oaks, rough-barked apple and river red gum. Straw-necked ibis are often observed on floodplain areas in this zone.

A more natural flow regime which includes variability, frequency and magnitude downstream of Chaffey Dam is likely to improve instream foodwebs and physical channel habitats. This could be achieved by better management of regulated irrigation release or by the application of a stimulus flow rule. However, due to the outlet capacity restrictions of the dam, high velocity and increased volumes are difficult to achieve. Rules such as dam translucency and/or transparency may achieve some benefit without compromising irrigator reliability."

Additional description of the Peel River downstream of the dam can be found in Barma Water Resources *et al.* (2012) which states:

"Features include instream benches and gravel point bars. The features in the zone between the dam wall and the Cockburn River are generally in good condition with some grazing impacts. This area also provides a good source of litter and organic matter.

Extensive instream pool habitats are also contained in this area [The river channel in the zone downstream of Chaffey Dam to below the confluence of Dungowan Creek].

The area around Piallamore Anabranch to upstream of the confluence with the Cockburn River features a wide floodplain. The Piallamore Anabranch, on the eastern side of the floodplain, runs for many kilometres. This anabranch is filled during high flows, however, water levels are mostly replenished by overland flows derived from adjacent hills. The channel is wider and deeper and riparian vegetation condition has suffered from grazing pressure and clearing. Lateral erosion of the banks through channel migration and avulsion may also have contributed to the reduction of vegetation in this area. More willows appear in these downstream reaches and these often cause stream blockages which results in bank erosion".

A basin wide river health assessment was also undertaken as part of the Sustainable Rivers Audit program which was based on observations of fish, macroinvertebrates and hydrology between 2004 and 2007. The Namoi catchment was reported to have an overall poor health. It rated as poor in terms of its fish and macroinvertebrate communities and good in terms of its hydrological condition (Davies *et al.* 2008).

The following aquatic habitat descriptions for Chaffey Dam and upstream and downstream reaches within the study area are summarised from Grant (2007), GHD (2008b) and site surveys undertaken by **ngh**environmental in 2012 (Survey 1 and Survey 2). A full description of each site surveyed can be found in Appendix F.

Chaffey Dam

The aquatic habitat of Chaffey Dam is open water with limited fringing and aquatic vegetation present. The minimal fringing and aquatic vegetation is likely due to the frequent fluctuations in the dam water level which may prevent the establishment of these habitats (Figure 4-14).

The Chaffey Dam reservoir is classified as a Key Fish Habitat in accordance with the DPI (Fisheries) definition and mapping (Figure 4-20).

Figure 4-14. Chaffey Dam reservoir and banks

Peel River and its tributaries upstream of the dam (US 1-7) (refer to Figure 3-3 and Table 3-5 for locations)

At the time of the survey, the Peel River, at US2 and upstream, consisted of a series of pools separated by boulder or bedrock riffles. Downstream of US2 the river was a run habitat with no riffles observed. The riparian zone is generally cleared of vegetation or less than 10 m wide. Where present, riparian vegetation includes grassy ground cover and banks are generally consolidated by River Sheoak (*Allocasuarina cunninghamiana*). Boulder substrates were also present. River banks were in some areas disturbed by road crossings and or stock access. No macrophytes were recorded by Grant (2007a) and large woody debris was observed to be at flood level rather than in the stream itself. Grant (2007a) found turbidity to be very low, with the substrate visible even in the deeper pools. This was also the case during surveys 1 and 2 (Figure 4-15, Figure 4-16).

Figure 4-15 Peel River at location US1

Figure 4-16 Peel River at US2

Cannes Creek includes a series of pools separated by narrow channels including reeds and rushes. The creek is generally degraded as a result of stock access and channel crossing and riparian vegetation was sparse and included willows (*Salix* sp.) and poplars (*Populus* sp.). Instream habitats included some sparse aquatic vegetation and large woody debris (Figure 4-17).

Hydes Creek includes small pools separated by channels which are prone to becoming dry during periods of low flow or when the dam is not at full supply level. Reeds and rushes are present in various sections of the creek. As per other upstream reaches, riparian vegetation is limited (Figure 4-18).

Figure 4-17 Cannes Creek at US3

Figure 4-18 Hydes Creek at US5

The Peel River upstream of Chaffey Dam and other upstream tributaries of the dam include around 260 km of lotic (riverine) environment classified as a Key Fish Habitat in accordance with the DPI (Fisheries) definition and mapping (Figure 4-20).

Sites assessed along the Peel River upstream of the dam, as well as the site at Silver Gully (US6), were considered Class 1 Waterway Types (Major Fish Habitat) in accordance with the classification scheme of Fairfull and Witheridge (2003). Sites at Hydes Creek (US5), Cannes Creek (US3 and US4) and Sheep Station's Creek (US7) upstream of the dam were considered Class 2 Waterway Types (Moderate Fish Habitat).

Peel River downstream of the dam (DS1-3) (refer to Figure 3-3 and Table 3-5 for locations)

Grant (2007) and GHD (2008c) provide a description of the riparian and instream habitats within a 1.5 km reach of the Peel River downstream of the dam.

"Within this largely incised reach, the narrow stream bed consists of a series of pools, predominantly enclosed by riparian vegetation, and separated by cobbled riffles. Banks are mainly low (less than one metre high adjacent to the stream but higher behind), consisting of earth consolidated by roots of River Sheoak and willow trees (Salix sp). Some riparian shrub layer is present but mainly consists of weed species (e.g., blackberry) and cleared areas of bank support pasture grasses and other weeds such as cobbler's peg (Bidens pilosa). Two species of submerged macrophytes (Potamogeton crispus and Myriophyllum sp) occur in the riffles but appear to be absent from the turbid pools. The macrophytes were covered with fine sediment, which also coated the rocks in the riffles. Emergent

*macrophytes comprising cumbungi (Typha orientalis), spike rush (Eleocharis sphacelata) and rushes (Juncus sp) also characterise the instream vegetation. Riffles were observed to be less than 10 cm deep in most places and the larger pools one to two metres deep, with the exception of the dissipater pool at the base of the dam, which was four to seven metres deep. Large woody debris occurs in most pools. Some stock damage and slumping of unconsolidated banks were noted" (*Figure 4-19*).*

Figure 4-19 Peel River downstream of the dam at DS1

The Peel River and its tributaries downstream of the dam (DS1-3) are classified as a Key Fish Habitat in accordance with the DPI (Fisheries) definition and mapping (Figure 4-20).

DS1 and DS3 along the Peel River assessed downstream of the dam were considered Class 1 Waterway Types (Major Fish Habitat) in accordance with the classification scheme of Fairfull and Witheridge (2003). The unknown tributary, site DS2, was considered Class 2 Waterway Type (Moderate Fish Habitat).

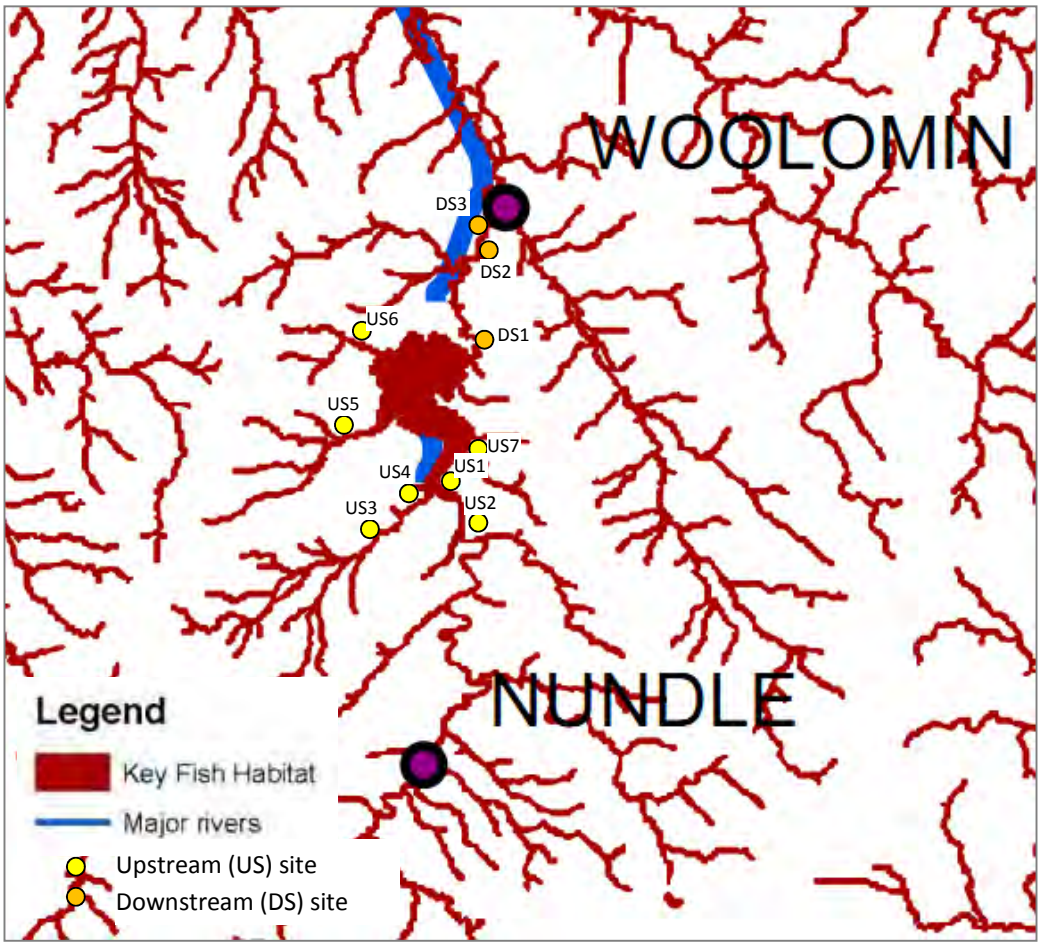


Figure 4-20 Key Fish Habitat mapping of the survey area (source: modified from NSW DPI (Fisheries) n.d.; not to scale).

4.3.3 Fish barriers

NSW Department of Primary Industries (2006) reports on the barriers to fish passage in Class 1 Waterway Types (Major Fish Habitat) and Class 2 Waterway Types (Moderate Fish Habitat) (in accordance with the classification scheme of Fairfull and Witheridge, 2003) of the Namoi Catchment. A total of 162 structures, including but not limited to weirs, water gauges, bridges and causeways were identified as potential barriers to fish passage within the Namoi Catchment. Thirty one are considered high priority (requiring immediate remediation) including five along the Peel River and/or its tributaries. Chaffey Dam is considered a high priority fish barrier with the next closest located in Tamworth around 45 km downstream of the dam. There are currently no plans to reinstate fish passage at the dam.

It should be noted that other fish barriers of lower priority (less in need of remediation) occur within the study area. Furthermore, instream vegetation or large woody debris may impact fish passage, especially during low flows and in smaller streams.

4.3.4 Aquatic Fauna

The Sustainable Rivers Audit program (Murray-Darling Basin Commission 2008) identified the Namoi catchment fish community as being in poor condition, though the upland zone (which includes the Peel River and Chaffey Dam) was in good condition. Twelve native species (80% of expected) were recorded in the Namoi catchment. Five exotic species were abundant, constituting 61% of biomass and 37% of individuals (Davies *et al.* 2008).

Based on the literature review completed for the Project, fish species previously recorded within the study area are provided in Table 4-9.

Table 4-9. Fish species previously recorded in Chaffey Dam and in downstream and upstream reaches

Species	Native (N)/Exotic (E)	Conservation Status
Silver Perch *Bidyanus bidyanus*	N	FM-V
Golden Perch *Macquaria ambigua*	N	N/A
Murray Cod *Maccullochella peelii peelii*	N	EPBC-V
River Blackfish *Gadopsis marmoratus*	N	N/A
Eel tail Catfish *Tandanus tandanus*	N	FM-EP
Carp gudgeon *Hypseleotris* spp	N	N/A
Australian Smelt *Retropinna semoni*	N	N/A
Mountain Galaxias *Galaxias olidus*	N	N/A
Bony Bream *Nematalosa erebi*	N	N/A
Hardyhead *Craterocephalus eyresii*	N	N/A
Spangled Grunter *Leiopotherapon unicolor*	N	N/A
Rainbow Trout *Oncorhynchus mykiss*	E	N/A
Brown Trout *Salmo trutta*	E	N/A
Carp *Cyprinus carpio*	E	N/A
Redfin Perch *Perca fluviatilis*	E	N/A

EPBC-V – Vulnerable species under the Environment Protection and Biodiversity Conservation Act 1999
FM-EP – Endangered population under the Fisheries Management Act 1994
FM-V – Vulnerable species under the Fisheries Management Act 1994

The Namoi Valley macroinvertebrate community has been assessed as being in poor condition. Seventy-two percent of families expected to occur in the Namoi Valley were recorded. Six common families included freshwater shrimp, long-horned and ecnomid caddisflies and velvet water bugs. Five rare families included hawker and emerald dragonflies and midges (Davies *et al.* 2008).

4.3.5 Significant Aquatic Species and ecological communities

Table 4-10 lists the threatened aquatic species and ecological communities known to occur or having the potential to occur within the study area based on habitat requirements. Refer to Appendix B for a detailed assessment of all listed aquatic species and ecological communities for the Namoi catchment.

Table 4-10 Threatened aquatic species and ecological communities known to occur or with the potential to occur within the study area.

Species / Ecological Community	Status	Occurrence
Bidyanus bidyanus **Silver Perch**	FM-V	Known to occur
Maccullochella peelii **Murray Cod**	EPBC-V	Known to occur
Notopala sublineata **River snail**	FM-E	Potential to occur
The Murray Darling Basin population of the eel-tailed catfish	FM-EP	Known to occur
Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River (Darling River EEC)	FM-EEC, TSC-EEC	Known to occur

4.4 CRITICAL HABITAT

Critical habitats are areas of land that are crucial to the survival of particular threatened species, populations and ecological communities (OEH 2012). No areas of critical habitat have been declared under either the EPBC Act or TSC Act within or near the study area.

4.5 CORRIDORS

Corridors can provide habitat linkages and important refuges for rare and threatened species, especially in landscapes where natural vegetation has been removed, or where linkages are the last remnants of vegetation types that have been selectively cleared (Bennett 1998, 2003). Areas of both Box-gum woodland and Stringybark forest remain outside of the FSL and extend to the upper slopes and ridge tops. These areas provide connectivity for fauna, as they have been less impacted by agricultural and grazing practices around the dam. Specifically, these areas include Goat Mountain at

the northern extent of the dam, and vegetation adjacent to the south-western foreshore. Both of these areas are located outside of the new FSL.

A planted corridor was created in late 2011 and early 2012 with the aim of linking Goat Mountain with the Peel River and habitat areas to the east. Once established, it is likely this will provide habitat for a range of native species protected under both State and Commonwealth legislation, particularly the Border Thick-tailed Gecko. It will take some years for the vegetation to become established and mature to the point where it would function as an effective wildlife corridor, and in its current state does not provide habitat connectivity and is susceptible to weed invasion due to the high levels of disturbance.

The Peel River also acts as a natural corridor. Despite the degraded quality of the riparian habitats both upstream and downstream of Chaffey Dam, their connectivity makes them a critical landscape component, particularly in maintenance or restoration programmes (Fisher and Goldney 1997).

5 POTENTIAL IMPACTS OF THE PROJECT

5.1 IMPACT ASSESSMENT PROCESS

The tables in Appendix A present the habitat evaluation for threatened species, ecological communities and endangered populations listed as occurring or with the potential to occur within 10 km of the study area. The likelihood of occurrence is based on presence of habitat, proximity of nearest records, field survey results, and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence. Those threatened species, populations and ecological communities which may be affected directly or indirectly by the proposed action have therefore been considered further in accordance with Section 5a of the EP&A Act. The assessment of significance (known as a Seven Part Test) is used to improve the standard of consideration afforded to threatened species, populations and ecological communities, and their habitats through the planning and assessment process.

Three threatened species and two threatened ecological communities were assessed as having the potential to be impacted by the Project.

5.1.1 EPBC Act Referral Process

On the 5th July 2012, a meeting was held with the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC), WorleyParsons and **ngh**environmental to discuss the referral process and threatened species and communities listed under the EPBC Act that have the potential to be impacted by the Project. A referral was prepared and submitted to the Australian Government Minister for the Environment, Heritage and the Arts (the Minister) on the 30th August 2012. On the 28th September 2012 SEWPaC notified the relevant parties that the proposed action (the Project) is a controlled action. As such, the project requires assessment and approval under the EPBC Act before it can proceed. On the 19th October 2012, State Water received the supplementary DGRs from the NSW Department of Planning and Infrastructure (NSW DP&I).

5.2 PROJECT OVERVIEW

The Project, comprising the augmentation and safety upgrade of the existing Chaffey Dam, will take approximately 24 months to complete. Following construction of the Project, the timeframe in which inundation from the current FSL to the augmented FSL will be dependent on climatic conditions and rainfall events. Based on simulated 100 year dam volumes, the minimum duration over which the additional inundation will occur is expected to be between eight and 21 weeks, although inundation to the new FSL could take up to several years.

The Project has been divided into two components: construction (which includes the raising of the dam wall and associated works, and the enlargement of the Chaffey Dam reservoir to the new FSL, Section 5.3) and, operational (which includes any flooding outside of the FSL that occurs once Chaffey Dam has reached full capacity, Section 5.4).

5.3 CONSTRUCTION – RAISING OF THE DAM WALL, ASSOCIATED WORKS, AND ENLARGEMENT TO THE NEW FSL

5.3.1 Flora

Clearing of vegetation

Raising the dam wall will require rock fill to be placed in areas that are currently vegetated. The majority of the vegetation that would be impacted around the existing wall is either colonising exotic grasses or was planted following the construction of the original wall. A small area of Stringybark forest occurs immediately north of the wall and this may also be impacted. This vegetation is a common vegetation type, has already been highly disturbed and was isolated from other areas following the construction of the auxiliary spillway. Impacts to this small patch of fragmented vegetation are unlikely to greatly contribute to the overall impacts of the Project.

The raising of the FSL will necessitate the realignment of existing roads along the western and eastern foreshore, and the relocation of the South Bowlo Fishing Club. The establishment of new road alignments will require the clearing of Box-gum grassy woodland, derived grassland and Silvertop Stringybark grassy open forest vegetation. Approximately 16 ha, 47 ha and 5 ha respectively of these vegetation types occur within the works areas for the new road realignments (outside of the new FSL). Areas of Box-gum grassy woodland and derived grassland to be impacted fall within the definition of the Box-gum Woodland EEC listed under the TSC Act. Approximately 4 ha of Box-gum grassy woodland that would meet the criteria for the EPBC listed community occurs within the study area for the road works on Tamworth-Nundle Road.

Clearing of vegetation within the works areas will be minimised. The estimates of vegetation impacted are likely to be a gross overestimate of the actual impacts of the Project however, they are included here as a worst case scenario.

An Assessment of Significance completed for this community concluded that a significant impact on TSC and EPBC listed Box-gum grassy woodland is unlikely to occur as a result of the Project.

Inundation of vegetation

The proposed works would increase the FSL of the dam which would increase the surface area of the dam, inundating the vegetation that occurs immediately adjacent to the existing FSL. The

approximate areas of each vegetation type that would be inundated and the approximate extent of vegetation in a one kilometre radius around the study site (outside the new FSL) are presented in Table 5-1.

Table 5-1 Areas to be inundated by the raised FSL and within a 1 km radius of the study site by vegetation type.

Regional Vegetation Community (RVC)	Area to be inundated (ha)	Area within a 1 km radius (ha)
Box–gum grassy woodlands, Brigalow Belt South and Nandewar (RVC 17)	30	1014
Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)	87	293
Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (RVC 39)	3	892
River Oak Riparian Woodland, eastern NSW (RVC 71)	6	15
Wetlands and marshes, inland NSW (RVC 70)	0.25	0
Planted non-indigenous native vegetation (no RVC)	9	21
Exotic non-native vegetation	45	276
TOTAL	**180.25***	**2510**

*This total area does not include existing cleared and disturbed areas

Impacts resulting from periodic or semi-permanent inundation would be likely to substantially change the species composition of all vegetation communities within the study area. Associated erosion and sedimentation impacts may also exacerbate this impact. It is an assumption of this assessment that all areas of the community within the new FSL will be modified to the extent as to be effectively cleared by the Project. This includes 117 ha of TSC listed White Box – Yellow Box Blakely's Red Gum woodland (30ha woodland, 87 ha derived grassland). Within that 117 ha is 6 ha of EPBC listed White Box – Yellow Box Blakely's Red Gum woodland and derived native grasslands. The majority of the vegetation to be impacted is in poor to moderate condition with characteristics that fall below the ecological benchmarks for the relevant vegetation type (refer to Section 4.1.2). Exceptions include areas of Box-gum grassy woodland in good condition and Silvertop Stringybark grassy open forest, however only relatively small areas (approximately 6 ha and 3 ha respectively) would be inundated.

Field surveys conducted within the area surrounding the study site (one kilometre buffer) and subsequent GIS mapping indicate that there are extensive areas of the community in similar or better condition within the locality immediately adjacent to the study site (Table 5-1). This includes approximately 1300 ha of Box-gum woodland EEC, of which approximately 506 ha meets the criteria for the EPBC listed community. These areas will not be impacted by the Project.

An Assessment of Significance completed for the Box-gum woodland EEC concluded that a significant impact is unlikely to occur as a result of the Project.

Dulegal Arboretum

The Dulegal Arboretum contains a collection of planted native trees and shrubs from all around Australia. In terms of ecological function, this community provides limited habitat resources to

locally native flora and fauna due to its highly modified nature and the fact that the majority of species are not indigenous to the area.

Approximately 3 ha of the arboretum (totalling approximately 10 ha) will be inundated by the raised FSL. A list of species to be impacted by the enlargement of the dam (compiled by Barbara Graham in 1990 and transcribed by Joyce Webster in 2012) (Webster 2012) shows 142 native species will be lost[3] (an untitled list by Barb Graham in 1990 lists 232 species within the arboretum however, there may be more). This list includes the following species currently listed as threatened in NSW.

- Pygmy Cypress Pine (*Callitris oblonga*)
- Spiked Rice-flower (*Pimelea spicata*)
- Silver-leafed Gum (*Eucalyptus pulverulenta*)
- Wallangarra Gum (*Eucalyptus scoparia*)

None of the above threatened species are recorded as naturally occurring in the region around the dam. None of these species were recorded in the study area surrounding the arboretum. The loss of these species is not considered to be important in terms of maintaining the natural distribution and occurrence of these species.

Further scientific, aesthetic and social values associated with the arboretum are not considered within this report.

Potential introduction and spread of weeds

The site carries noxious weeds (refer to Section 4.1.7) which will require control before and after the proposed works in areas where construction works are to occur and within the area to be inundated. It is likely that the impounded waters of Chaffey Dam and the currents that occur within it, currently act as a medium of dispersal for these weed species. This is evidenced particularly by the widespread nature of Blackberry at a large number of locations immediately adjacent to the water's edge. Rising waters will have the potential to inundate and kill some of these infestations however there is also the potential to dislodge and transport both reproductive and vegetative material from weed species to other areas around the foreshore which are currently weed free. Coolatai Grass is abundant within the study area and while it is not listed as noxious under the control area of Tamworth Regional Council, in many parts of NSW it is declared a Class 3 noxious weed under the NSW *Noxious Weeds Act 1993*. Good weed hygiene will be required to prevent the movement of weeds around and off the site, and prevent the introduction of any new weeds. Safeguards (Section 6.1.1) have been included to ensure weeds are adequately controlled at the site. A Vegetation Management Plan would be prepared for the project.

With the appropriate implementation of weed controls during and following construction, weed impacts within and off the subject site are not expected to be significant.

Indirect impacts

Vegetation surrounding the development footprint may be affected by vehicle access and parking, materials laydown and spoil deposition and retrieval. Peripheral impacts may include soil compaction, soil erosion and sedimentation. These impacts are considered manageable and would be addressed in the relevant construction management plans for the project.

[3] This information was current as of 1990 and is not reflective of the currently proposed FSL.

5.3.2 Fauna

Removal of fauna habitat

The Border Thick-tailed Gecko is known to occur on the dam wall. Artificial habitat for the gecko that is provided by the large rocks of the existing dam wall will be removed during construction of the new dam wall. The removal will be gradual and will allow some opportunity for capture and relocation of geckos. There is ample suitable habitat on Goat Mountain to relocate the geckos. Thus the habitat loss is considered to be temporary. It is likely that the Border Thick-tailed Gecko will recolonise the wall post-construction, as the raised wall will comprise rocks of the same type and size as the existing wall. The existing habitat on the upstream face of the dam wall will not be impacted. NWES (2009a) found the species to be relatively common within the region, recording it many times in shrubby rocky remnants around Woolomin, including Goat Mountain, to the immediate northwest of the dam wall. The geckos on the wall are likely to be part of a much larger population in the remnant habitat of Goat Mountain (NWES 2009a). Once established, the wildlife corridor planted in late 2011 and early 2012 between Goat Mountain and the dam wall will facilitate movement of this species.

The removal of bridges has the potential to impact on roosting microbat species, however inspection of the Bowling Alley Point Bridge and Hydes Creek Bridge gave no indication that bat species utilised these structures. The Eastern Bentwing-bat, listed as vulnerable under the TSC Act, was recorded during Survey 2 at the top of the dam wall. This species roosts in caves, derelict mines and man-made structures. It is likely that this species is roosting in the rocky habitats available on the upper slopes in the locality surrounding the dam, using Chaffey Dam primarily as foraging habitat.

Booroolong Frog

The population of Booroolong Frogs approximately 1 km upstream of Chaffey Dam (within the new FSL) is likely to be impacted by the increased FSL through inundation of suitable habitat. The area of inundation (i.e. the extent of the new FSL) extends approximately 700 m upstream of this known population. Inundation to the new FSL will be gradual (from a minimum of eight weeks up to several years based on 100 year simulated dam volumes) and occur over a period of time that may allow upstream migration of the frogs.

Survey 2 (October 2012) aimed to quantify and describe the area of suitable Booroolong Frog habitat to be impacted by the new FSL and the amount of suitable habitat that exists upstream, outside of the FSL. Approximately 506 m (2721 m^2) of potential and known Booroolong Frog habitat is within the FSL and will be impacted by the Project. Within a further 1.7 km of the Peel River (upstream of the new FSL), approximately 932 m (5294 m^2) of potential habitat for the Booroolong Frog is available (Figure 4-12 and Appendix H). Some of this habitat, both within and upstream of the new FSL, is sub-optimal due to shading from riparian overstorey vegetation. Existing information suggests there is at least 12 km of suitable habitat for the species upstream of Chaffey Dam including the area of known Booroolong Frog habitat that is located within the FSL (Anna Cronin Namoi CMA *pers. comm.*). However, it is unknown where this population overwinters and it is a possible that chytrid fungus has a severe impact on the population during winter, causing large declines, as low numbers of individuals are normally recorded in early summer (P. Spark, *pers. comm.*). Because the species is a very capable breeder, numbers seem to regenerate over summer (P. Spark, *pers. comm.*).

The large population of Booroolong Frogs that has been recorded within the new FSL (where a Booroolong Frog was observed during Survey 2) is conservatively estimated to be between 600 and

800 frogs (Namoi CMA quoted in Molino Stewart 2011). NWES (2009b) found there to be a large recruitment of frogs between January 2009 and February 2009, with hundreds of metamorph and juvenile frogs emerging from the Peel River at its junction with Chaffey Dam. Such an abundance may be partly due to two floods which occurred in November and December 2008, washing eggs, and possibly young tadpoles, downstream (NWES 2009b). It is also possible that the site simply provides optimal habitat for Booroolong Frogs, capable of supporting large numbers of frogs and mass breeding events (NWES 2009b). A population of this size is presently unknown from anywhere else in the current distribution of the species (P. Spark, *pers. comm.*). Surveys by NWES in 2008 observed six individuals approximately 5.8 km upstream of this site (outside the new FSL), and another two individuals a further 2 km upstream (outside the new FSL) (NWES 2009b). Namoi CMA will be conducting surveys in summer 2012/2013 within the Namoi Catchment to make a comparison of the Booroolong Frog's distribution and abundance with those of the 2008/2009 surveys. It is recommended that surveys are coordinated with Namoi CMA in summer 2012/2013 to gain an understanding of the present status of Booroolong Frog populations on the Peel River, upstream of Chaffey Dam, and provide information to further tailor appropriate mitigation measures for the species.

Given the large number of individuals that may be impacted by inundation to the new FSL, the impact assessment has concluded that given the potential loss of approximately 600 individuals the Project is likely to have a significant impact on the population of the endangered Booroolong Frog that currently occurs immediately upstream of Chaffey Dam on the Peel River. However, this impact will be localised and the impact to the species across its range is unlikely to be significant.

5.3.3 Aquatic

Temporary reduction of dam water level for construction purposes

Construction activities may require the dam water level to be lowered. This would only be required if the dam is at or within 2 m of the FSL during the construction period. This will likely be required during construction works on the morning glory spillway. Depending on timing and quantity of water released this may result in a number of potential downstream impacts including:

- Cold water pollution is discussed further below. The quantity and timing of water to be released would depend on construction activities and level of the dam at the time when these need to be undertaken. Cold water pollution impacts would be higher during summer periods when water temperature stratification occurs. Timing of water releases for construction purposes would therefore need to be carefully considered in the construction staging and relevant construction management plans. Chaffey Dam has a multi-level offtake (i.e. intake) tower that can be configured to extract water from a range of reservoir depths to control the temperature of the released waters (see below for further information).
- Other water quality impacts through release of water downstream. This may include the release of anoxic water with high nutrient and/or metal concentrations during seasonal stratification. This is further discussed below. As per cold water pollution, timing of water releases for construction purposes would need to be carefully considered in the construction staging and relevant construction management plans.
- Increased flows and water levels. Numerous aquatic species, including threatened species, rely on increased flows and water levels as triggers to migrations or

spawning. Timing and quantity of water released downstream has the potential to impact on the migration and breeding patterns of various species.

Earthworks and other construction activities

Extensive earthworks will be required as part of the proposed upgrade. Most of these would be undertaken in close proximity to the Chaffey Dam reservoir and/or its tributaries, sometimes within the waterways themselves. Works with the potential to disturb soils and sediments and potentially increase sedimentation of waterways include:

- Raising of the dam wall
- Raising the morning glory spillway
- Reconfiguration of the auxillary spillway fuseplug
- Realignment of roads and bridges

These activities would include, but would not be limited to the excavation and stockpiling of rock and soil; vegetation clearing, construction of roads and bridges. Most of these activities would be undertaken at or immediately downstream of the dam wall except for the realignment of roads and bridges around the Chaffey Dam reservoir. Use of a barge may also be required for the raising of the morning glory spillway.

Impacts on aquatic habitats and aquatic flora and fauna as a result of potential erosion and sedimentation of waterbodies could include:

- Reduction of water quality such as increased turbidity and/or increased nutrient levels
- Reduction of light penetration (as a result of increased turbidity) and subsequent reduction of aquatic macrophytes (loss of habitat)
- Increased potential for algal growth with potential for toxic algal blooms (as a result of increased nutrients) resulting in negative impacts on aquatic fauna
- Potential sedimentation of aquatic habitats including but not limited to rocky areas, riffles and macrophytes (loss of aquatic habitats)

These impacts have the potential to impact downstream areas as well as areas close to the earthworks or construction activities.

Proposed works also have the potential to impact water quality through accidental chemical spills (e.g. hydrocarbons, concrete). Potential pollution sources may include but not be limited to:

- Compound sites
- Barges and boats
- Construction plant

Upstream Impacts

The proposed works would increase the full supply level of the dam which would increase the surface area covered by the dam and inundate sections of the upstream reaches of the Peel River and its tributaries. The Chaffey Dam reservoir is classified as a key fish habitat by DPI (fisheries). The area of potential key fish habitat will increase by 185 hectares and 40 GL as a result of the increased dam capacity.

The inundation would flood any fringing aquatic habitat currently present. This loss of habitat is likely to be temporary as new similar habitat would become available along the new perimeter of the reservoir. Furthermore, the impact would be minor considering the currently limited availability of

this type of habitat around the dam, most likely a result of the existing fluctuations in the dam water level.

Some riparian vegetation would also be lost along the edges of the reservoir and upstream reaches. Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions:

- Provide bed and bank stability and reduce bank and channel erosion
- Protect water quality by trapping sediment, nutrients and other contaminants
- Provide a diversity of habitat for terrestrial, riparian and aquatic flora and fauna species
- Provide connectivity between wildlife habitats
- Allow for conveyance of flood flows and control the direction of flood flows
- Provide an interface between developments and waterways.

Riparian zones are currently limited around the reservoir and in upstream and downstream reaches. The Peel River would be considered an order 3 waterway with its upstream and downstream tributaries order 1 or 2 in accordance with the Strahler (1969) stream classification. According to riparian zone management guidelines, order 3 or above waterways warrant a 40 m wide core riparian zone, while order 1 and 2 waterways warrant riparian zones of 10 m and 20 m respectively. The width of the current riparian zones is generally below 10 m along most sections of the waterways. The loss of riparian areas through the increased full supply level would increase the impact of a key threatening process under the *Fisheries Management Act (1994)*: the degradation of native riparian vegetation along New South Wales water courses. The loss of riparian vegetation may increase bank and channel erosion, impact water quality, change the hydrology of the waterways. This loss cannot be avoided but there are opportunities to rehabilitate the riparian zone along the new full supply level as part of the proposed works. The inundation of the riparian zone has the potential to increase the availability of some important aquatic habitat sources such as large woody debris.

The Peel River and its tributaries upstream (and downstream) of the dam are also classified as key fish habitat by DPI (Fisheries). These areas provide various habitat types, including some exclusively found in riverine environments such as riffles and rapids, which are important habitat components used by various aquatic species for foraging, refuge or breeding. The proposed works would impact (at full supply level) approximately 2.5 km of 260 km of riverine key fish habitat which would account for around one per cent of the riverine key fish habitat upstream of the dam. This is unlikely to have a major impact on the availability of habitat in the upstream reaches.

Other water quality impacts

Heavy summer rainfall events and the steep, sparsely vegetated catchment, agricultural and recreational uses create high rates of sediment erosion in the region. Sediments and associated nutrients and contaminants end up in waterways and ultimately Chaffey Dam, which acts as a sediment basin. In terms of nutrients, elevated levels of total nitrogen and total phosphorous were recorded just below the dam compared to the upstream reaches and at Tamworth. This seems to indicate the dam acts as a nutrient source. Phosphorous is generally accepted as the most significant nutrient input into the Chaffey Dam reservoir (GHD 2008b).

The primary water quality issues of concern for the downstream aquatic ecosystem include oxygen content, temperature, nutrient levels and metals concentrations. Management of downstream water quality requires consideration of large scale reservoir activities to manage nutrients and algal blooms, as well as withdrawal management to control oxygen levels and water temperatures.

The current and proposed multi-level offtake tower of Chaffey Dam provides scope to manage the water quality of downstream releases as previously discussed. Changing the withdrawal depths throughout the year to satisfy downstream environmental requirements can be undertaken. For example, epilimnetic (i.e. warm surface waters) withdrawal avoids the release of anoxic water with high nutrient and metal concentrations during seasonal stratification (spring and summer periods). In contrast, withdrawals from deeper waters during algal blooms will be prudent in the event of cyanobacterial blooms. Furthermore, withdrawal from the lower waters during winter can avoid the release of higher nutrient concentrated water sourced from the upstream catchment.

The proposed upgrade would inundate approximately 185 ha of mostly grassed and agricultural land. This has the potential to have a short to medium term impact on water quality through the decomposition of organic matter as inundation takes place. This could increase nutrient loadings and cause algal blooms.

Creek crossings

The proposed works would require the construction of two bridges which would conform to the crossing types recommended in Fairfull and Witheridge (2003) for class 1 waterways.

The location of the Bowling Alley Point Bridge along Nundle Road would be altered, with the eastern end of the new bridge located around 10 m from its existing location. The western end of the bridge would remain in the same location. The new bridge would be approximately 174 m in length, with six spans and two lanes. The deck level of the bridge would be at 529.30 mAHD to provide adequate clearance above the 1 in 100 AEP flood level. This bridge is unlikely to impact fish passage.

Construction of a new two span, single lane, 60 m long bridge at Hyde's Creek along Western Foreshore Road would also be undertaken. This bridge is unlikely to impact fish passage.

5.4 OPERATIONAL – FLOODING ABOVE THE NEW FSL AND FLOW RELEASES

Flooding

The existing auxiliary spillway fuseplug would be modified to a two-bay design to enable a staged trigger of the fuseplug, at the 1 in 10,000 and 1 in 20,000 annual exceedance probability (AEP) events. These extreme events are likely to cause extensive flooding downstream of the dam as well as severe erosion and sedimentation which would impact instream habitats, flora and fauna, riparian zones and surrounding floodplains. However, significant impacts would occur in 1 in 10,000 AEP or above events regardless of the change to the existing auxiliary spillway fuseplug. Furthermore, the proposed safety works would improve the current condition and minimise potential flooding impacts. Based on observations made during the field survey, there appears to be no lasting detrimental effects on the vegetation communities surrounding the dam from past flooding events. Increasing the capacity of the dam would in fact, increase the ability of the facility to absorb and manage flood waters.

Aside from minor sedimentation and erosion, no significant impacts to terrestrial and aquatic biodiversity are likely in the event of flooding above the new FSL.

Flow Releases

Numerous fish species respond to rises in water levels to initiate breeding migrations. The regulated Peel River is currently impacted by controlled releases of water. Without implementation of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, data analysis suggests that annual average flows in the Peel River immediately below the dam would decrease by about two per cent compared to existing conditions as a result of the raising of the dam wall and increase in full supply level (GHD 2008c). More specifically, the proposed augmentation is likely to increase the volumes of low flows while reducing the flow volumes for high flows during summer. Compared to the percentage changes in summer flows, the impact of the proposed augmentation on winter flows would be more pronounced. Furthermore, low flow volumes appear to have increased, while mid and high flow volumes decreased. The degree of impact diminishes further downstream on approach to Tamworth. While these changes have the potential to have geomorphic impacts as well as ecological impacts, impacts are unlikely to be significant considering an overall decrease of two percent (GHD 2008c). It is therefore unlikely to substantially increase the impact of the key threatening process 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams' under the Fisheries Management Act 1994.

The release of water is governed by the Water Sharing Plan for the Peel Regulated, Unregulated, Alluvial and Fractured Rock Water Sources which commenced on 1 July 2010 and applies until 30 June 2020 (NOW 2010). The current environmental water rules of the plan require a 'stimulus flow' of up to 1,600 ML to be provided if the Chaffey storage exceeds 50,000 ML at the start of the water year. The purpose of a stimulus flow is to achieve environmental benefits by stimulating the ecosystems downstream of the dam. There are also provisions for a stimulus flow if the storage is less than 50,000 ML at the start of the water year. The plan also has rules for when Chaffey Dam is enlarged which involves the creation of up to a 5,000 ML of environmental contingency allowance (ECA). The ECA is likely to be used as a stimulus flow over seven days with a day 2 peak of 1,200 ML/day, although it has the flexibility to be used for any purpose at the discretion of the NSW Environmental Water Manager. This flexibility would ensure that the ECA water is used to maximise environmental outcomes in this water source.

Environmental Water Delivery: Namoi River (Barma Water Resources *et al*. 2012) provides information on the environmental assets and potential options for environmental water use in the Namoi catchment including at Chaffey Dam. The document provides recommendations on water uses to best meet desirable ecological outcomes for the Peel River and monitoring requirements.

Cold water pollution

Between spring and autumn, the water stored in large dams, generally where water depths are greater than 15 m, can form two layers: a warm surface layer overlying a cold bottom layer (New South Wales 2006). Cold water pollution is caused by cold water being released into rivers from large dams during warmer months Figure 5-1.

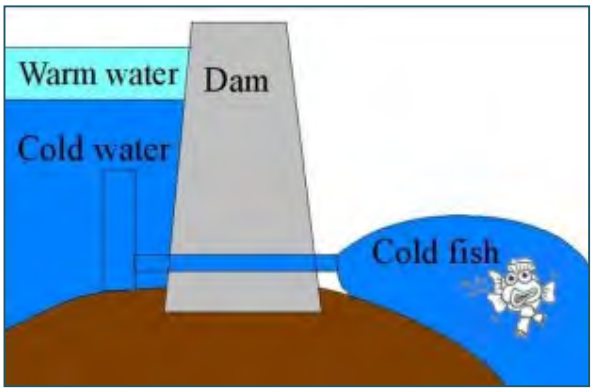


Figure 5-1 Cold water pollution by bottom release from dams (Source DPI (Fisheries) website 2012)

Cold water pollution is one of the key factors behind the reduction in the range and abundance of native freshwater fish species in NSW (Astles *et al*. 2003, Lyon *et al*. 2007, Rutherford *et al.* 2009, Sherman *et al.* 2009). It can affect temperatures in river systems many hundreds of kilometres downstream from the storage. Native fish and other ectothermic animals, such as turtles and frogs, depend on the temperature of their environment for their survival, growth and reproduction.

Cold water pollution can reduce the growth of fish and even reduce their chance of survival and breeding success. Fish will not breed if conditions are unfavourable. Even in the right season for breeding and with appropriate rises in the river, breeding may not occur if seasonal temperature changes and thresholds are not reached(Figure 5-2). As a result of cold water pollution, native warm-water fish may fail to breed, they may breed late in the season, fish eggs may fail to hatch or the young may die or develop more slowly.

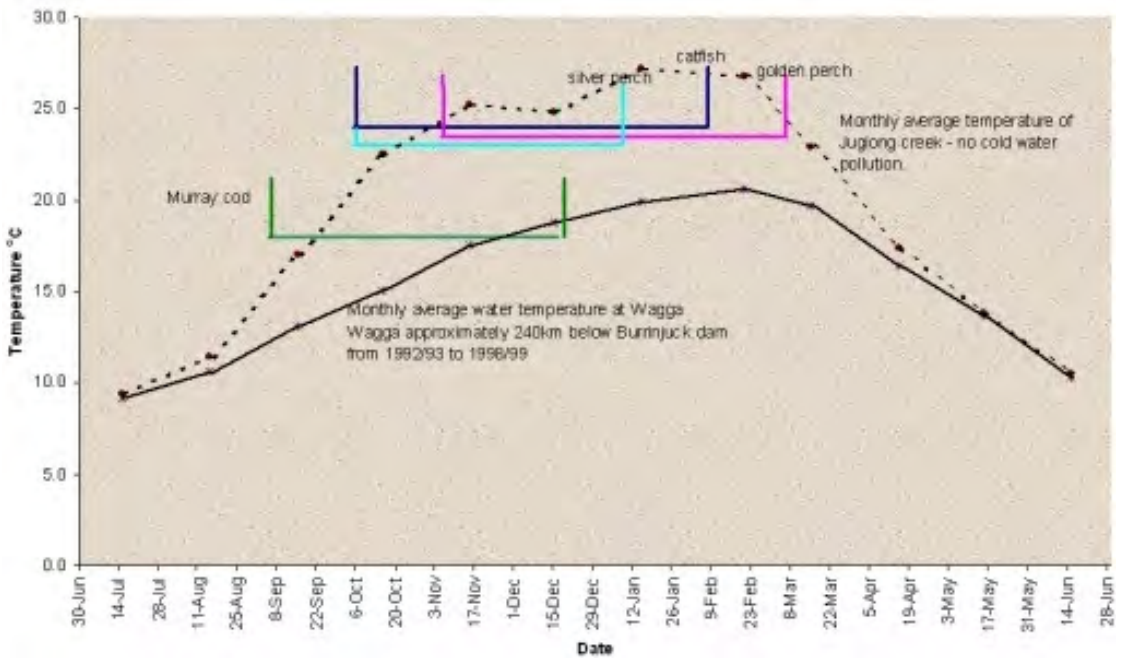


Figure 5-2 Observed water temperature of the Murrumbidgee River at Wagga Wagga and Juglong Creek at Juglong in comparison to fish spawning envelopes (Source DPI (Fisheries) website 2012).

Furthermore, young fish depend on zooplankton blooms as a food source. Low water temperatures can delay or prevent the development of these blooms, eliminating an important food source.

Some examples of the effects of cold water releases on native fish in NSW include:

- Elimination of Trout Cod, Macquarie Perch and Freshwater Blackfish from large sections of the Murrumbidgee River downstream from Blowering Dam
- Loss of Trout Cod, Macquarie Perch and Freshwater Catfish from the Murray River downstream from Hume Dam
- Loss of Silver Perch, Murray Cod, Rainbowfish and Bony Herring from the Macquarie River for up to 300 km downstream from Burrendong Dam. Results showed 100% survival in the warm channels (18 to 24^{o}C) compared to 25% survival in the cold channels (12 to 14^{o}C)
- Growth and weight responses were similar to those for survival, with fish in the warmer channel growing significantly better
- Suppressed breeding of native fish, particularly Silver Perch, in the Namoi River as far as 100 km downstream of Keepit Dam
- 50 per cent of juvenile Silver Perch killed after only 30 days of exposure to cold water in a study conducted by NSW Fisheries

The lack of seasonal temperature variation has also been found to reduce the numbers of macroinvertebrate species that would normally be expected in the warm summer period. Studies show that eggs of mayflies do not develop if temperatures are too low (Koehn *et al.* 1997).

A desktop assessment of New South Wales dams ranked Chaffey Dam as a low priority in terms of cold water pollution potential to downstream environments because of small discharge volumes and predominately an extraction from shallow depths (and hence warm temperatures) (Preece 2004). Cold water releases from Chaffey Dam were predicted by IESC Pty Ltd (1974) to lower the downstream temperature by 6 to 10°C with the potential for resultant fish kills. Bishop and Harris (1990) reported lower water temperatures later into summer and depressed temperatures for up to 50km downstream of Chaffey Dam. Differences in water temperatures of the Peel River upstream and downstream of Chaffey Dam were simulated with a reservoir water quality model over two periods from 1995-1997 and 2005-2007. The simulated water temperature is often up to 10°C cooler during January and February because of extraction of hypolimnetic cool waters as shown in Figure 5-3. (GHD 2008b). Cold water pollution therefore does occur at Chaffey Dam.

Chaffey Dam has a multi-level offtake (i.e. intake) tower that can be configured to extract water from a range of reservoir depths. In particular water from the reservoir can be extracted from two different depths simultaneously through the multi-level intake. Hence, there is opportunity to control the temperature of the released waters during the period of thermal stratification through extraction of cooler deep (hypolimnetic) waters, warmer surface (epilimnetic) waters or a blend. While the multi-level offtake tower is typically positioned within the thermocline there is some release from the hypolimnion and surface waters (Preece 2004).

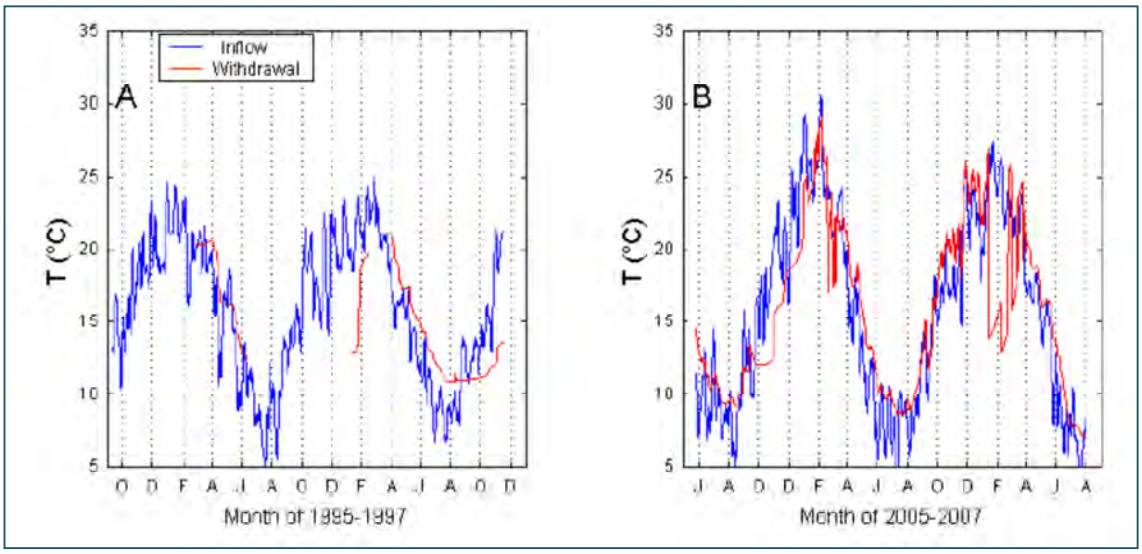


Figure 5-3 Modelled differences in water temperatures of the Peel River upstream and downstream of Chaffey Dam (GHD 2008b)

Mitigating cold water pollution is an identified outcome under Objective 2 (monitoring water quality and manage operational impacts on aquatic habitat) of State Water's Environmental Management Plan (EMP 2011-2016). The multi-level offtake tower would be raised as part of the proposed works and therefore the potential to control the temperature of released waters would be maintained. However, it should be noted that management of cold water pollution has the potential to conflict with algal management (which requires the release of water below the algal bloom, potentially requiring release of colder waters).

Therefore, cold water pollution downstream of the dam has the potential to occur following the dam upgrade. The Stage 1 of the NSW Cold Water Pollution Strategy (NSW Cold Water Pollution Interagency Group, 2012) has cold water mitigation actions including the implementation of improved operating protocols (including monitoring) and structural modifications recommended by the NSW Environmental Trust Project for the priority dams that already have selective off-take capability. This includes Chaffey Dam.

For Chaffey Dam, NSW Cold Water Pollution Interagency Group (2012) provides the following suggestions to meet the requirement of the *Water Management Act 2000* in regards to cold water releases:

- The licence holder is to prepare and submit an approved operating protocol for the management of cold water pollution in accordance with the Guidelines for managing cold water releases from high priority dams (NOW, 2011).
- The licence holder is to use its best endeavours to operate the dam according to the operating protocol.
- The licence holder will provide within three months of the end of each year or annually on agreed date a report to Office of Water detailing its performance against the protocol, including instances of and reasons for departure from the operating protocol, outcomes achieved (in accordance with NOW 2011) and proposals for improvement in performance.

The current operating protocol for Chaffey Dam, which includes cold water and algal management, may need to be reviewed and possibly improved following the upgrade of the dam so these are in line with requirements from the Guidelines for managing cold water releases from high priority dams (NOW 2011) and to meet the requirements of the *Water Management Act 2000*.

5.5 SUMMARY OF POTENTIAL IMPACTS ON THREATENED SPECIES, POPULATIONS AND ENDANGERED ECOLOGICAL COMMUNITIES

Table 5-2. Summary of potential Impacts to flora and faunaprovides a summary of the impacts to flora and fauna that may result from the project.

Table 5-2. Summary of potential Impacts to flora and fauna

Species or Community	**Extent of impact from inundation (inside FSL)**	**Extent of impact from construction (outside FSL)**	**Total**
Booroolong Frog	Approximately 600 individuals (may be revised following surveys in January 2013).	None	Approximately 600 individuals (may be revised following surveys in January 2013).
Booroolong Frog Habitat	Approximately 2721 m^2 of known and potential Booroolong Frog habitat on the Peel River.	None	Approximately 2721 m^2 of known and potential Booroolong Frog habitat on the Peel River.
Border Thick-tailed Gecko	None	Unknown number of individuals living within the artificial habitat of the dam wall.	Unknown number of individuals living within the artificial habitat of the dam wall.
Border Thick-tailed Gecko Habitat	2,600 m^2 (area of upstream face of dam wall to be inundated).	50,000 m^2 (area of downstream face of dam wall).	52,600 m^2
Queensland Bluegrass	Extent of Impact (if any) to be determined in January 2013 surveys. Potential habitat for the Bluegrass of approximately 6 ha of high quality box gum woodland will be impacted.	Extent of Impact (if any) to be determined in January 2013 surveys. Potential habitat for the Bluegrass of approximately 4 ha of high quality box gum woodland will be impacted.	Extent of Impact (if any) to be determined in January 2013 surveys. Potential habitat for the Bluegrass of approximately 10 ha of high quality box gum woodland will be impacted.

Species or Community	Extent of impact from inundation (inside FSL)	Extent of impact from construction (outside FSL)	Total
White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland (EPBC Act CEEC) (high quality)	6 ha	4 ha	10 ha
White Box-Yellow Box-Blakely's Red Gum Woodland (TSC EEC) (low to moderate quality)	117 ha	63 ha	180 ha

5.5.1 Flora

Impacts were considered likely and Assessments of Significance undertaken for the threatened flora species Queensland Bluegrass and the Endangered Ecological Community White Box-Yellow Box-Blakely's Red Gum Woodland. The results of these assessments are presented below.

Queensland Bluegrass

It is currently unknown as to whether a population of this species occurs within the area to be impacted by the Project. Given that there is a known record (from 2003) in close proximity to the study area and that similar habitat occurs within the area to be impacted, without further information it must be assumed that a population could exist and be impacted by the Project. If a population was to occur only within the area to be impacted then a significant impact to this species would be likely. Given that suitable habitat extends beyond the area of impact around the dam it is also likely that should a population occur, that it would also extend beyond the area of impact. Without further information obtained from surveys during the suitable time for this species (i.e. when the species is identifiable - exhibiting reproductive material from summer - autumn), employing the precautionary principle it must be assumed that there is the potential for an impact to Queensland Bluegrass as a result of the Project. Surveys are to be conducted in January 2013 and may conclude that impacts to this species are unlikely to be significant.

White Box-Yellow Box-Blakely's Red Gum woodland

Up to 117 ha of TSC listed White Box-Yellow Box-Blakely's Red Gum woodland and derived grassland in mostly poor to moderate condition would be effectively cleared (inundated) by the Project. This includes 6ha of EPBC listed White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived native grassland (EPBC Act). Extensive areas of this community in similar or better condition occur immediately adjacent to the area to be impacted and within the locality (including approximately 506ha that would meet the criteria for the EPBC listed community). The effective clearing of the community within the study area is unlikely to result in the extinction of the community in the locality. Although clearing of this community is not consistent with the draft national recovery plan,

it is a recommendation of this report that offsets be established in areas containing the community around the dam that would result in the long term management and security of the community in the locality. As such, a significant impact is considered unlikely and that a net positive 'maintain or improve' outcome can be achieved.

5.5.2 Fauna

Two species listed under the EPBC Act and TSC Act are likely to be impacted by the Project. Assessments of significance were prepared for these species and the results are provided below.

Booroolong Frog (EPBC-E, TSC-E)

Surveys conducted in spring 2012 recorded approximately 2721 m^2 of potential and known habitat for the Booroolong Frog within the FSL that will be impacted by the Project. Approximately 5294 m^2 of potential habitat exists outside the FSL within a 1.7 km section of the Peel River. Previous surveys indicate that approximately 12 km of potential and known habitat exists upstream of Chaffey Dam. This habitat will be further described and mapped during surveys conducted by Namoi CMA over summer 2012/2013.

Given the large number of individuals (approximately 600) that may be impacted by inundation to the new FSL, the impact assessment has concluded that the Project is likely to have a significant impact on the population of the endangered Booroolong Frog that currently occurs immediately upstream of Chaffey Dam on the Peel River. However, this impact will be localised and the impact to the species across its range is unlikely to be significant. Further, with the implementation of extensive mitigation and offset measures, the magnitude of this impact would be substantially reduced and may result in the removal of threatening processes for the broader population, resulting in positive long term impacts. These measures would be developed in consultation with species experts and the Namoi CMA and would include a relocation program to move juvenile frogs to areas of suitable habitat upstream and offset measures to improve the habitat available for the species outside of the FSL.

Border Thick-tailed Gecko (EPBC-V, TSC-V)

Surveys in October 2012 confirmed the presence of this species on the dam wall (four individuals).The Border Thick-tailed Gecko has been found to be relatively common within the Nandewar bioregion, and has been recorded many times in shrubby rocky remnants around Woolomin, including Goat Mountain, to the immediate northwest of the dam wall. The Border Thick-tailed Gecko individuals present on the dam wall are likely to be part of a much larger population that occupies this larger remnant on Goat Mountain. With the placement of additional rock and associated activities for raising of the dam wall, this species may be impacted by construction. A planted corridor was created in late 2011 and early 2012 with the aim of linking Goat Mountain with the Peel River and habitat areas to the east. This corridor in its current state of growth is not yet suitable as a wildlife corridor, but may facilitate movement of Border Thick-tailed Geckos between Goat Mountain and the dam wall in the future. Coolatai grass has been identified as a key threatening process for this species and as such, is an important consideration in maintaining suitable habitat for the Border Thick-tailed Gecko. The rock used for raising of the dam wall will be consistent with that currently inhabited by the species and it is likely that the Border Thick-tailed Gecko will recolonise the dam wall following completion of construction. Considering that the disturbance to the population on the dam wall is temporary and that the appropriate mitigation measures provided in Section 6.1.2 are followed, a significant impact to this species is considered unlikely.

5.5.3 Aquatic

One threatened aquatic ecological community has the potential to be impacted by the Project, the 'Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River' (Darling River EEC). The results of the assessment of significance prepared for this community is provided below.

Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River (FM-EEC)

Without implementation of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, impacts to the Darling River EEC located downstream of the dam would include a reduction of annual flows by an average of two per cent. Cold water pollution may also result. Impacts due to modified flow regime and cold water pollution currently occur as a result of operation of the dam and the changes resulting from augmentation of the dam are unlikely to significantly increase these impacts. Current operating protocols to minimise cold water pollution would be adapted to continue minimising this impact. Furthermore, 5,000 ML of environmental contingency allowance (ECA) would be created following the dam augmentation. The ECA is likely to be used as a stimulus flow over seven days with a day 2 peak of 1,200 ML/day, although it has the flexibility to be used for any purpose at the discretion of the NSW Environmental Water Manager. This flexibility would ensure that the ECA water is used to maximise environmental outcomes downstream of the dam. With adequate management, significant impacts to the Darling River EEC are unlikely.

5.5.4 Key Threatening Processes

There are six key threatening processes of relevance to the Project, with two listed under the TSC Act only, one listed under the TSC Act and EPBC Act, two listed under the FM Act and one listed under the TSC Act and FM Act.

Infection of amphibians with chytrid fungus resulting in chytridiomycosis (TSC Act, EPBC Act)

Chytridiomycosis is a fatal disease of amphibians and is caused by the chytrid *Batrachochytrium dendrobatidis.* High altitude (>400m) populations are more severely affected by chytridiomycosis. Stream-associated frog species are more likely to be infected because the pathogen is waterborne. In NSW chytridiomycosis has been reported from the Booroolong Frog. Through the implementation of a management plan for *Litoria booroolongensis*, the control and spread of chytrid will be appropriately managed by adoption of the protocols for persons, vehicles and equipment as detailed the 'Hygiene protocol for the control of disease in frogs' (DECC, 2008).

Land clearance (EPBC Act) and clearing of native vegetation (TSC Act)

Land clearing consists of the destruction of the above ground biomass of native vegetation and its substantial replacement by non-local species or by human artefacts. Native vegetation is defined as vegetation in which native species constitute more than 70% of the plant cover, or other vegetation containing populations of species listed under the EPBC Act. Substantial replacement by non-local species or human artefacts is defined as the achievement of more than 70% of the total cover by species or human artefacts that did not occur previously on the site.

Clearing of native vegetation refers to the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation.

Vegetation will be lost as a result of the increased FSL and the realignment of roads and bridges. Appropriate sites will be chosen to offset the residual impacts of the Project (See Section 6.2).

Loss of hollow-bearing trees (TSC Act)

The distribution and abundance of hollow-bearing trees in NSW has been reduced and fragmented by extensive clearing of native vegetation during the past two centuries, primarily for agriculture. The density of hollow-bearing trees required to sustain viable populations of vertebrates is controlled by the diversity of competing fauna species at a site, population densities, number of hollows required by each individual over the long-term, and the number of hollows with suitable characteristics occurring in each tree. The presence, abundance and species richness of hollow-using fauna are correlated with the density of hollow-bearing trees; suggesting that the availability of hollows is often a limiting environmental factor.

Fifty-seven hollow-bearing trees were recorded within the study area containing predominantly small and medium-sized hollows, and seven trees observed with large hollows. Clusters of hollow-bearing trees, particularly along the eastern foreshore, provide potential habitat for arboreal fauna. No threatened hollow-dependent fauna were observed during surveys, however appropriate offsets may be required in order to account for the loss of this important resource and will be assessed as part of the Offset Strategy (See Section 6.2).

Invasion of native plant communities by exotic perennial grasses (TSC Act)

Exotic perennial grasses are those that are not native to NSW and have a life-span of more than one growing season. More than a hundred species of exotic perennial grasses occur in New South Wales. A relatively small number of these perennial grasses threaten native plant communities, and it is these species which are of concern. Exotic perennial grasses of special concern include Coolatai grass *(Hyparrhenia hirta*) which is abundant at Chaffey Dam. White Box-Yellow Box-Blakelys Red Gum woodland and the Border Thick-tailed Gecko are both threatened by Coolatai grass.

Degradation of native riparian vegetation along New South Wales water courses (FM Act)

Riparian vegetation is vegetation on land that adjoins, directly influences or is influenced by, a body of water. Riparian vegetation is found alongside creeks and rivers, areas around lakes, wetlands and on river floodplains. It is part of a healthy functioning ecosystem and has numerous ecological benefits. Riparian vegetation is degraded by the complete removal or modification of native plants by processes such as clearing, gravel extraction, cropping, livestock grazing, trampling and introduction of, or invasion by, non-native species.

The loss of riparian areas through the increased FSL would increase the impact of this key threatening process by increasing bank and channel erosion, impacting water quality, and changing the hydrology of the waterways. This loss cannot be avoided but there are opportunities to rehabilitate the riparian zone along the new full supply level as part of the proposed works.

Removal of large woody debris from New South Wales rivers and streams (FM Act)

Large woody debris provides important habitat and shelter for native fish in the rivers of NSW. Snags are often used for breeding and resting locations and they provide shelter from predators. Snags also support other aquatic organisms that fish species use as a food source. The removal of large woody debris adversely affects several threatened species.

The Project may require the removal of large woody debris during construction should these be located within the construction zone. Appropriate management measures such as lopping or relocating woody debris instead of removal would be put in place to minimise any potential impacts.

The augmentation of the dam would inundate the riparian zone which may provide additional habitat in the form of large woody debris.

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands (TSC Act) and Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams (FM Act)

Instream structures that modify natural flow may include dams, weirs, culverts, flow regulators, erosion control structures and causeways. Mechanisms that alter natural flow regimes include the operation of the above structures as well as water abstraction, pumping and diversion. Alteration to natural flow regimes can occur by reducing or increasing flows; altering the seasonality of flows; changing the frequency, duration, magnitude, timing, predictability and variability of flow events; altering surface and subsurface water levels; changing the rate of rise or fall of water levels; and by altering water temperatures.

Chaffey Dam currently impacts natural flows along the Peel River below the dam wall. Without implementation of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, the Project would impact downstream flows to a minor degree by reducing current average flows by around two per cent. This is unlikely to increase the impact of this key threatening process that it would substantially affect the Darling River EEC and other downstream environments. Following completion of the upgrade, a permanent environmental contingency allowance would become available for environmental flow releases. These releases have the potential to modify or remove habitat community if not adequately managed (appropriate timing and quantities). The impact of these releases has been assessed and approved in the development of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010.

6 RECOMMENDATIONS AND MITIGATION MEASURES

6.1 GENERAL

6.1.1 Flora

- Further surveys are recommended to determine the presence or absence of Queensland Bluegrass (*Dichanthium setosum*) within the study area to accurately determine the potential for a significant impact to this species.
- Disturbed areas will be identified and used preferentially for vehicle and machinery access, materials laydown, stockpiling of cleared vegetation and the deposition and retrieval of spoil whenever practicable, to minimise the footprint of the development on intact native-dominated areas.
- Excavation works and use of heavy machinery on areas that are outside of the area of direct impact will be avoided during, and immediately following heavy rainfall events to protect soils from compaction.
- Protocols will be developed to ensure hydrocarbon and chemical spills are contained and treated immediately should they occur. Protocols should aim to ensure no soil or water contamination occurs, with any contaminated material removed and treated/disposed of appropriately.
- A weed management plan will be developed for the site including but not limited to the following outcomes:
    - The control of noxious weeds recorded on the site (refer Section 4.1.7) prior to works commencing.
    - The management of Coolatai Grass around the dam wall and planted wildlife corridor.
    - Preventative measures for the spread or introduction of weeds. The Plan should aim to ensure no weeds are spread or introduced as a result of the Project. Any increase in weed infestations should be managed to eliminate/reduce weed infestation.
    - Monitoring of measures and ongoing adaptive management to control weeds throughout the construction and operation of the project.
- Weed control measures employing chemicals would ensure that they are conducted in a manner that does not impact on water quality within the dam.
- Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds.
- Sediment control materials should be weed free such as weed free hay bales or geotextiles.
- Imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or diseases that may be harmful to native vegetation. Should any

imported materials result in the occurrence of weeds, the weed management plan referred to above should be implemented to eliminate the weeds before they have the opportunity to spread.

- Weed management would be ongoing as per the weed management plan particularly focusing on the noxious weeds identified in Section 4.1.7 and Coolatai Grass infested areas around the dam wall and planted wildlife corridor.

6.1.2 Fauna

- A management plan will be developed and implemented for the Booroolong Frog population on the Peel River that will include provision for:
    - Relocation of juvenile frogs within the FSL to suitable habitat upstream on the Peel River, or elsewhere in the catchment to be decided in consultation with Namoi CMA and Philip Spark (or other suitable frog expert) .
    - The relocation program should aim to sustain a viable local population. Should this at any time be unlikely to be met, alternative strategies should be developed.
    - Remediation and threat mitigation as required in receiving sites (e.g. stock exclusion, weed removal, removal of exotic shading vegetation, protection from fossicking, removal of Carp).
    - A pre-construction monitoring program which includes frog surveys in summer 2012 and 2013 to ascertain the current numbers of frogs and to inform the relocation strategy.
    - Post-construction monitoring for a minimum of two years to monitor the success of relocation. This will be dependent on the rate of inundation and consultation with the relevant parties (e.g. Namoi CMA).
- To avoid impacts to the Border Thick-tailed Gecko during the construction phase, works will follow a staged and strategic plan for the clearing and excavation. A fauna management plan will be prepared and implemented to guide the construction phase activities including the following considerations:
    - It is recommended that an ecologist be engaged to locate and remove all fauna found to a safe location in the Goat Mountain remnant prior to construction works on the dam wall. The timing of the relocation needs to occur as close as possible to the commencement of excavation works to minimise the chance of animals recolonising the works site.
    - Clearing and rock removal will begin from the south-eastern end of the wall and work northwest along the ridge to enable all fauna in the impact area to escape along the ridge to the wildlife corridor.
    - Any individuals found during construction will be relocated by an ecologist to the wildlife corridor or Goat Mountain.
    - The materials used to raise the dam wall will be the same as those currently present on the wall.

- The wildlife corridor was designed as a movement corridor for fauna, but is currently adversely impacted by stock and weeds.
    - A stock management plan will be prepared as part of the fauna management plan. As part of this stock management plan stock will be prevented from entering the wildlife corridor area and the habitat between the dam wall and Goat Mountain.
    - Weed management would be ongoing as per the weed management plan particularly focusing on Coolatai Grass infested areas around the dam wall and planted wildlife corridor.

6.1.3 Aquatic

Should large woody debris need to be removed for any construction activities the following management guidelines would be followed in accordance with the *Key Threatening processes in NSW Removal of large woody debris from NSW rivers and streams prime fact 11* (DPI 2005):

- Lopping (trimming) should be considered as a first option.
- Instream realignment should be considered as the next option.
- If realignment is unfeasible, relocation within the river channel is preferable to removal.
- Removal should be considered as a last resort.

- Removal/relocation of snags would be undertaken so as to cause the least disturbance to the bed or nearby sensitive aquatic habitat. An aquatic ecologist would be present on site when working with snags that require lopping, realignment, relocation and/or removal.
- A soil and water management plan (SWMP) will be prepared detailing erosion and sediment controls and other water quality controls that would be put in place to avoid or minimise impacts to waterways during construction activities. The SWMP would be prepared in accordance with the *NSW Soils and Construction – Managing Urban Stormwater Volume 1 and 2*. The SWMP would be reviewed by State Water's Senior Environmental Officer prior to commencement of works.
- Work method statements (WMS) would be prepared for high risk activities within waterways (e.g. bridge construction). The WMS would include, but not be limited to, the following and be reviewed by State Water's Senior Environmental Officer prior to commencement of works:
    - Description of works/activities including machinery.
    - Outline of the sequence of the works/activities
    - An environmental risk assessment to determine potential risks to discrete work elements or activities likely to affect the environment.
    - A map indicating the locations of likely potential environmental impacts.
    - Evaluation of methods to reduce environmental risks.
    - Mitigation measures to reduce environmental risks (including those listed in this assessment).

  - A process for assessing the performance of the implemented mitigation measures.
  - A process for resolving environmental issues and conflicts.
  - Emergency procedures for chemical spills and other potential emergency incidents.
- Compound and stockpile sites should be located at least 40 m from any waterways where possible and should be adequately protected to avoid or minimise any potential pollution of waterways through adequate erosion and sediment controls or impervious bunds.
- Stage works so that construction activities that need to be undertaken within waterways are undertaken during low dam levels (bridge construction).
- Water releases required to reduce the dam level during the construction period should be appropriately managed. A water release management plan will be prepared and the following considered:
- Where possible use water releases undertaken as part of the water sharing plan to reduced water levels where required for construction activities.
- Adequate monitoring of water quality (temperature, algal blooms) should be undertaken to ensure water quality impacts due to release of water are avoided or minimised. The multi-level intake should be used in an effective manner to minimise potential water quality impacts.
- The water release management plan should be developed in consultation with all relevant stakeholders including but not limited to State Water and DPI (Fisheries).

- The riparian zone of the Peel River should be replanted at the new full supply level along upstream waterways for a minimum of 10 m from the new FSL and along the shoreline of the dam where practicable, particularly in areas identified as having a high risk of erosion. Revegetation should be undertaken using natives species of local provenance.
- The raising and design of the multi-level off-take tower will be undertaken so as cold water pollution and algal bloom impacts can be adequately managed (i.e. allow for releases of water from various depths independently and/or concurrently to allow mixing of water if required to mitigate cold water pollution).
- The release of water during operation will be undertaken under the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010 (NOW 2010). An adequate operating protocol for the use of the ECA will be developed to provide the best ecological outcome. The operating protocol should consider the Environmental Water Delivery: Namoi River (Barma Water Resources *et al*. 2012) which provides information on the environmental assets and potential options for environmental water use in the Namoi catchment including at Chaffey Dam. It should also include monitoring requirements, as described in Barma Water Resources *et al*. (2012), to assess the success of the releases. The operating protocol should be developed in consultation with all relevant stakeholders including but not limited to State Water and DPI (Fisheries).
- An operating protocol for avoiding or minimising cold water releases will also be developed. The protocol should consider conflicting algal management. The operating protocol will be prepared in accordance with the guidelines for managing cold water releases from high priority dams (NOW 2011). The following will be considered:

- The water to be released should match as closely as possible the natural temperature regime, especially during the spring, summer and autumn periods. The natural seasonal temperature regime should be determined through effective monitoring of upstream and downstream reference sites.
- The impact of water releases on temperatures downstream will be monitored through the selection of appropriately located downstream sites and comparisons with reference locations.
- DPI-Fisheries is to be notified immediately if any fish kills occur in the vicinity of the works. In such a case all works are to cease until the issue is rectified and approval is given to proceed.
- An incident emergency spill plan would be developed and incorporated into the CEMP. The plan would include measures to avoid spillages of fuels, chemicals, and fluids into any adjacent/nearby waterways and an emergency response plan. Emergency spill kits would be kept onsite at all times. A boom would be at hand in the case of any spills or material entering waterways.
- Exclusion zones for riparian zones that do not need to be accessed would be established before works
  start to avoid any disturbances of the banks.
- Temporary works, flow diversion barriers and in-stream sediment control barriers would be removed as soon as practicable and in a manner that would not exacerbate future channel erosion.
- Detailed design and construction of the bridges would be in accordance with requirements for fish passage and in consultation with DPI (Fisheries) where necessary.
- Should detailed design determine that fish passage needs to be temporarily blocked for construction purposes, a permit under part 7 of the FM Act would be sought.

6.2 OFFSETS

An Offset Plan will be developed with input from SEWPaC, OEH and the Namoi CMA. The final Offset Plan will be submitted with the Preferred Infrastructure Report (PIR) or Response to Submissions (RtS) report and approved prior to determination of the Project. The objective of offsetting is to ensure that an overall 'maintain or improve' outcome is met for the project: where impacts cannot be avoided, or entirely minimised, the residual impact will be offset.

The Project will impact upon habitat for listed threatened species and vegetation communities. The exact offset requirements will be calculated according to the EPBC Act Offsets Policy and using the EPBC offset calculator for relevant EPBC listed species and communities. The Biobanking Assessment Methodology and Calculator will be applied for TSC listed species. . For endangered ecological communities the offset site should contain the equivalent communities and due to their conservation significance, a ratio of up to 1:10 (impacted:offset) may be required.

Offsets will need to comprise the same or better habitat values or else include management actions that will ensure that sufficient improvement is able to be achieved. There is a good opportunity to formally conserve connecting habitat (vegetated corridors) nearby in the selection of an offset area and thereby achieve broader landscape scale benefits. Offsite offset areas may be required to achieve this.

Availability of offsets

Surveys within a one kilometre radius of the study site and broad scale vegetation mapping of this area identified areas in close proximity to the development site that are suitable as offset areas (refer Section 6.2). In particular areas that are considered to meet the criteria of the EPBC listed White Box-Yellow Box-Blakely's Red Gum grassy woodland and derived grassland should be considered as potential offset areas. One such area includes the area surrounding the Bowling Alley Point cemetery. This area exhibited a high diversity within the ground cover (Figure 6-1), an intact overstorey and extensive regeneration of the overstorey species. The cemetery also contains a known record for Queensland Bluegrass and conservation and management of habitat surrounding the cemetery would have positive outcomes for the long term survival of this species should it be confirmed to occur there.

State Water has advised that it owns approximately 1000 ha of land in close proximity to the dam that provides a potential source of land for offsets. An Offset Strategy is provided in Appendix I including a map of Crown land within close proximity to the dam that may provide suitable offsets. A detailed Offset Plan will be submitted with the Preferred Infrastructure Report (PIR) or Response to Submissions (RtS) report and approved prior to determination of the Project.

Figure 6-1 Box-gum grassy woodland vegetation in good condition surrounding Bowling Alley Point cemetery

Security and management of the offset site

The offset site should be protected in perpetuity and appropriate management actions attached to the land title. Mechanisms considered suitable to achieve this outcome include:

- BioBanking agreement
- Conservation Property Vegetation Plan
- Conservation agreement
- Planning agreement

Management actions recommended to be included within the Offset Strategy include, but are not be limited to:

- Fencing and signage
- Minimum biomass retention (through controlled grazing if appropriate)
- Regular weed control
- Feral animal control

6.2.2 Current State and Commonwealth Offset Policies

Principles for the use of biodiversity offsets in NSW

Biodiversity offsets counterbalance specific impacts of development on biodiversity. Offsets are undertaken elsewhere and result in the legal protection of land and the implementation of management actions to remove threats (OEH 2012b).

The biodiversity offset principles developed by OEH should guide the development of an Offset Strategy, namely:

1. Impacts must be avoided first by using prevention and mitigation measures
2. All regulatory requirements must be met
3. Offsets must never reward ongoing poor performance
4. Offsets will complement other government programs
5. Offsets must be underpinned by sound ecological principles
6. Offsets should aim to result in a net improvement in biodiversity over time
7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs
8. Offsets should be agreed prior to the impact occurring
9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated
10. Offsets must be targeted
11. Offsets must be located appropriately
12. Offsets must be supplementary
13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

Further discussion of how these 13 principles would be met is provided in Appendix I.

Commonwealth offset policy

The EPBC Act Environmental Offsets Policy (EOP) (SEWPaC 2012) outlines the Australian Government's approach to the use of environmental offsets ('offsets') under the EPBC Act. It replaces the draft policy statement *Use of environmental offsets under the* EPBC Act (2007). This policy relates to all matters protected under the EPBC Act and includes the EPBC listed White Box-Yellow Box-Blakely's Red Gum Grassy Woodland community that occurs at the site.

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Where appropriate, offsets are considered during the assessment phase of an environmental impact assessment under the EPBC Act.

The offset principles outlined in the EPBC Act EOP would further guide the development of an Offset Strategy. These principles are presented below.

Suitable offsets must:

1. deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action
2. be built around direct offsets but may include other compensatory measures
3. be in proportion to the level of statutory protection that applies to the protected matter
4. be of a size and scale proportionate to the residual impacts on the protected matter
5. effectively account for and manage the risks of the offset not succeeding

6. be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or Territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)
7. be efficient, effective, timely, transparent, scientifically robust and reasonable
8. have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

In assessing the suitability of an offset, government decision-making will be:

1. informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty
2. conducted in a consistent and transparent manner

The Offset Strategy provided in Appendix I provides a preliminary calculation of offset requirements for the EPBC CEEC White box-Yellow Box Blakely's Red Gum Woodland to be impacted by the Project according to the EPBC Act Environmental Offsets calculator. Under this scenario, an offset of approximately 75 ha would be required to compensate for the loss of 10 ha of this community. This outcome is highly dependent on the assumptions made in the calculator, details of which are provided in Appendix I.

The EPBC Act Environmental Offsets Policy will be applied to the losses of Booroolong Frog and Bluegrass following further assessment of their occurrence on site during surveys to be conducted over summer 2012/2013.

7 CONCLUSIONS

The study area presents a range of habitats from poor to good quality. Areas currently used for agricultural and grazing contain both disturbed lands with little ecological value as well as areas of Box-gum woodland that contain moderate native species diversity and some habitat for native fauna. The areas surrounding the dam, outside of the new FSL contain high diversity and good quality vegetation communities and provide invaluable habitat for the local flora and fauna. These areas also contain rocky outcrops which provide important habitat opportunities for species such as the Border Thick-tailed Gecko.

At the new FSL, Chaffey Dam will extend approximately 1.7 km upstream to Bowling Alley Point. The reservoir would have a capacity of 100 GL and inundate the margins of the existing reservoir which consist of 87 ha of Derived grasslands, 45 ha of exotic non-native vegetation, 30 ha of Box-gum grassy woodland, 9 ha of planted non-indigenous native vegetation, 6 ha of River Oak Riparian Woodland, 3 ha of Silvertop Stringybark forest, and 0.25 ha of Wetlands and marshes.

Overall, the Project has the potential to impact one threatened flora species, two threatened fauna species and two threatened ecological communities. Of these, the Booroolong Frog is likely to be significantly impacted by the Project as it may result in the loss of approximately 600 individuals from a known population of the species once inundation to the new FSL occurs. Further detailed surveys during the summer 2012/2013 breeding seasons will aim to determine the occupancy (distribution and abundance) of Booroolong Frogs both within and outside the FSL, up to 12 km upstream of Chaffey Dam. These surveys will include areas upstream of the known population considered to support suitable potential habitat for the species, but not currently known to be occupied. A management plan will be prepared in consultation with SEWPaC, OEH and Namoi CMA that will include a strategy for the relocation of juvenile Booroolong Frogs, as well as habitat restoration and improvement to reduce threatening process within known and potential habitat for the species upstream on the Peel River. Whilst there may be a significant impact on the portion of the population immediately upstream of the dam on the Peel River, this impact will be localised and the impact to the species across its range is unlikely to be significant. Inundation to the new FSL will be gradual so it is possible that a proportion of the population would have the opportunity to relocate to suitable habitat further upstream on the Peel River. Further, with the implementation of extensive mitigation and offset measures, the magnitude of this impact would be substantially reduced and may result in the removal of threatening processes for the broader population, resulting in positive long term impacts.

The Border Thick-tailed Gecko will also be impacted by the Project, specifically by construction on the dam wall. There is abundant habitat available for this species on Goat Mountain, and the recommended management measures aim to reduce the impact to this species during the construction phase by relocating any individuals found on the wall. It is likely that the Border Thick-tailed Gecko will recolonise the wall post-construction and no significant impacts will result.

Queensland Bluegrass was recorded near the study area in 2003. As such, there is the potential for this species to occur within the study area and to be impacted by the Project. Surveys to date have not been sufficient to determine whether or not this species is present or absent from the study area and employing the precautionary principle, it is assumed that a population may occur and that there is the potential for a significant impact to this species. Further surveys have been recommended within this report which in order to determine whether a significant impact is likely for this species.

Up to 120 ha of White Box-Yellow Box-Blakely's Red Gum woodland and derived grassland in mostly poor to moderate condition will be effectively cleared (inundated) by the Project. Extensive areas of this community in similar or better condition occur immediately adjacent to the area to be impacted and within the locality. The effective clearing of the community within the study area is unlikely to result in the extinction of the community in the locality. Recommended offsets in areas containing the community around the dam aim to enable the long term management and security of the community in the locality. As such, a significant impact is considered unlikely and a net positive 'maintain or improve' outcome can be achieved.

Without implementation of the Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources 2010, Project impacts to the Darling River EEC located downstream of the dam would include a reduction of annual flows by an average of two per cent. Cold water pollution may also result. Impacts due to modified flow regime and cold water pollution currently occur as a result of the dam and the changes that would result with the augmentation of the dam are unlikely to significantly increase these impacts. Current operating protocols to minimise cold water pollution would be adapted to continue minimising this impact. Furthermore, 5,000 megalitres of environmental contingency allowance (ECA) would be created following the dam augmentation. With adequate management, significant impacts to the Darling River EEC are unlikely.

8 REFERENCES

Astles, K.L., Winstanley, R.K., Harris, J.H. and Gehrke, P.C. (2003). Regulated Rivers and Fisheries Restoration Project - Experimental study of the effects of cold water pollution on native fish. NSW Fisheries Final Report Series No. 44

Austeco (1990). Chaffey Dam Enlargement Proposal: Impact on Terrestrial Fauna. Report prepared for Department of Water Resources.

Bennett, A.F. (1998, 2003). Linkages in the Landscape: The Role of Corridors and Connectivity in Wildlife Conservation. IUCN, Gland, Switzerland and Cambridge, UK.

Bevitt, R., Erskine, W., Gillespie, G., Harris, J., Lake, P. S., Miners, B., Rutherford, R. and Varley, I. (1998). Expert Panel Environmental Flow Assessment of Various Rivers Affected by the Snowy Mountains Scheme. *Report to the NSW Department of Land and Water Conservation*, Sydney.

Cropper, S.C. (1993). *Management of Endangered Plants*. East Melbourne, Victoria: CSIRO.

Davies, P.E., Harris, J.H., Hillman, T.J., Walker, K.F. (2008). Sustainable Rivers Audit report 1. A report on the ecological health of rivers in the Murray-Darling Basin, 2004-2007. Prepared by the Independent Sustainable Rivers Audit Group for the Murray–Darling Basin Ministerial Council.

DEC (2004). Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities.

DECC (NSW) 2008. Hygiene protocol for the control of disease in frogs. Information Circular Number 6. DECC (NSW), Sydney South.

DECC (2009) BioBanking Assessment Methodology and Credit Calculator Operational Manual. Department of Environment and Climate Change NSW, Sydney.

DECCW (2010) Draft National Recovery Plan White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Grassland. NSW Department of Climate Change and Water, Sydney.

DEWHA (2010). Survey guidelines for Australia's threatened frogs.

DSE (2003). Action Statement No. 118: Booroolong Frog *Litoria booroolongensis*. Department of Sustainability and Environment, Victoria, Australia.

SEWPaC (2011). Survey guidelines for Australia's threatened reptiles.

SEWPaC (2012) Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy. Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Fairfull, S. and Witheridge, G. (2003). Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW DPI, Cronulla, 16 pp.

Fisher, A.M. and Goldney, D.C. (1997). Use by Birds of Riparian Vegetation in an Extensively Fragmented Landscape. *Pacific Conservation Biology*, Vol. 3(3): 275-288.

Foster, N. (2003). Peel River aerial survey, unpublished report. NSW Government, Sydney.

Foster, N. and Lewis, A. (2009). Ecological Features of the Regulated Peel River. NSW Department of Water and Energy, Sydney.

GHD (2007). Chaffey Dam upgrade, further assessment of long-term options. Contract No 3571. State Water Corporation.

GHD (2008a). Chaffey Dam Upgrade Ecological Assessment. Report prepared for State Water Corporation.

GHD (2008b). Chaffey Dam Upgrade Preliminary environmental assessment (stage 1) summary report, State Water Corporation.

GHD (2008c). Chaffey Dam Upgrade: Water Quality Assessment. Report prepared for State Water Corporation.

Gillespie, G. R. and Hero, J.-M. (1999). Potential impacts of introduced fish and fish translocations on Australian amphibians. In: A. Campbell (Ed.) *Declines and Disappearances of Australian Frogs*. Environment Australia.

Grant (2007) *in* GHD (2008a). Chaffey Dam Upgrade Ecological Assessment. Proposed Augmentation of Chaffey Dam: Environmental Assessment: The Platypus. Report prepared by Dr T.R. Grant of Education and Environment Services Pty. Ltd. for GHD Services Pty Ltd and State Water.

Hunter, D. (2001). Surveys and monitoring of threatened frog species in South-eastern New South Wales between October, 2000 and March, 2001. Unpublished report to the NSW National Parks and Wildlife Service.

Joint ANZECC-MCFFA National Forest Policy Statement Implementation Sub-committee (JANIS) (1997). Nationally agreed criteria for the establishment of a comprehensive, adequate and representative reserve system for forests in Australia. Prepared by the Technical Working Group on Reserve Criteria, Australian Government.

Koch, A. (2009). Tree hollows in Tasmania: a guide, Hobart: CRC for Forestry and the Forestry Practices Authority.

Koehn, J; Doeg, T; Harrington, D and Milledge, G. (1997). Dartmouth Dam: Effects on the downstream aquatic fauna, *Riverine Environment Research Forum* Murray Darling Basin Commission, Canberra.

Lyon, J.P., Ryan, T.J. and Scroggie, M.P. (2007). Effects of temperature on the fast-start swimming performance of an Australian freshwater fish. Letter: Ecology Of Freshwater Fish

MHL (2005). Chaffey Dam Upgrade Environmental Investigations, Manly Hydraulics Laboratory and NSW Department of Commerce.

Molino Stewart (2010). Chaffey Dam Auxiliary Spillway Review of Environmental Factors. Report prepared for State Water.

Molino Stewart (2011). Chaffey Dam Augmentation, Preliminary Environmental Assessment. Report prepared for State Water.

Murray-Darling Basing Commission (2008). Sustainable Rivers Audit-SRA Report 1: A report on the ecological health of rivers in the Murray-Darling Basin, 2004-2007.

Namoi CMA (2012). Regional Vegetation Communities in the Namoi Catchment. http://www.namoi.cma.nsw.gov.au/416845.html?2

New South Wales (2006). *State of the Environment Report 1996*, NSW Government, Sydney.

NSW Cold Water Pollution Interagency Group (2012). Cold Water Pollution Strategy in NSW - report on the implementation of stage one, NSW Department of Primary Industries, a division of NSW Department of Trade and Investment, Regional Infrastructure and Services

NSW DPI n.d. Key Fish Habitat: Tamworth Regional. NSW Department of Primary Industries. Accessed 1 November 2012.

NSW Office of Environment and Heritage (2012). *National Recovery Plan for Booroolong Frog* (*Litoria booroolongensis*) Office of Environment and Heritage (NSW), Hurstville.

NSW Office of Water (2011). NSW Cold Water Pollution Strategy: Guidelines for managing cold water releases from high priority dams.

NSW Scientific Committee (2002). White box yellow box Blakely's red gum woodland – endangered ecological community listing, accessed at http://www.environment.nsw.gov.au/determinations/BoxgumWoodlandEndComListing.htm

NWES (2009a). Flora and Fauna Impact Assessment for the proposed Chaffey Dam Safety Upgrade Options 1 & 2- Addendum report to the GHD Ecological Assessment Report.

NWES (2009b). Review of the conservation status of the Booroolong Frog (*Litoria booroolongensis*) within the Namoi River Catchment. Report prepared for the Namoi Catchment Management Authority.

OEH (2012a). Public registers maintained by the Environment Protection Authority and the Office of Environment and Heritage. http://www.environment.nsw.gov.au/publicregister/. Last updated 20 July 2012.

OEH (2012b) Principles for the use of biodiversity offsets in NSW. http://www.environment.nsw.gov.au/biocertification/offsets.htm. Accessed October 2012.

OEH (2012c) NSW Threatened Species Profiles. http://www.environment.nsw.gov.au/threatenedspecies/index.htm. Accessed October 2012.

Rutherford, J.C., Lintermans, M., Groves, J., Liston, P., Sellens, C. And Chester, H. (2009). Effects of cold water releases in an upland stream. eWater Cooperative Research Centre Technical Report.

Ryan, T. and Preece, R. (2003). Potential for Cold Water Shock in the Murray-Darling Basin A scoping study for the Murray-Darling Basin Commission.

Sherman, B., Todd, C.R., Koehn, J.D. and Ryan, T. (2007). Modelling the impact and potential mitigation of cold water pollution on murray cod populations downstream of Hume Dam, Australia. *River. Res. Applic*. 23:377-389.

State Water (2009). Chaffey Dam: Dam facts and figures.

Storrie, A. (2010). Coolatai Grass – Primefact. NSW Department of Primary Industries.

Strahler, A.N. (1952). Hypsometric (area-altitude) analysis of erosional topology. *Geological Society of America Bulletin* 63 (11): 1117–1142.

The Ecology Lab (2007). Aquatic Ecology Assessment for the Keepit Dam Upgrade. Report to Parsons Brinckerhoff Australia Pty Ltd.

Thoms, M., Norris, R., Harris, J., Williams, D., Cottingham, P. (1999). Environmental Scan of the Namoi River Valley. Prepared for the Department of Land and Water Conservation and the Namoi River Management Committee.

Water Sharing Plan for the Peel Valley Regulated, Unregulated, Alluvium and Fractured Rock Water Sources (2010). Plan under section 50 of the *Water Management Act 2000*.

Webster, R. (2012). Letter on behalf of the National Parks Association of NSW, Tamworth-Namoi Branch, to Sofie Zivanovic (WorleyParsons). 5 October 2012.

9 GLOSSARY

AoS	Assessment of Significance (7 Part test)
ASL	Above sea level
AWS	Automatic weather station
BOM	Australian Bureau of Meteorology
CAP	Catchment Action Plan
CEMP	Construction environmental management plan
Cwth	Commonwealth
DECCW	Refer to OEH
DP&I	(NSW) Department of Planning and Infrastructure
EEC	Endangered ecological community – as defined under relevant law applying to the proposal
EIA	Environmental impact assessment
EPBC Act	*Environmental Protection and Biodiversity Conservation Act 1999* (Cwth)
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
ESD	Ecologically Sustainable Development
FM Act	*Fisheries Management Act 1994* (NSW)
FSL	Full Supply Level
Ha	hectares
ISEPP	*State Environmental Planning Policy (Infrastructure) 2007* (NSW)
KFH	Key Fish Habitat
km	kilometres
LEP	Local Environment Plan
LGA	Local Government Area
m	Metres
NES	Matters of National Environmental Significance under the EPBC Act (*c.f.*)
Noxious Weeds Act	*Noxious Weeds Act 1993* (NSW)
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
NSW	New South Wales
NV Act	*Native Vegetation Act 2003* (NSW)
OEH	(NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy (NSW)
SSI	State Significant Infrastructure
SEWPAC	(Cwth) Department of Sustainability, Environment, Water, Population and Communities
SIS	Species Impact Statement

Sp./spp.	Species/multiple species
TEC	Threatened Ecological Community - as defined under relevant law applying to the proposal
TSC Act	*Threatened Species Conservation Act 1995* (NSW)

APPENDIX A DATABASE SEARCH RESULTS

Numbers in parentheses indicate number of species records within search area from relevant database.

Primary Industries Fisheries Records viewer: Lists records of threatened species on the schedules of the FM Act within the Hunter River Catchment

OEH Bionet Wildlife Atlas: Lists records of threatened species on the schedule of the TSC Act within 10 km of the study area

EPBC Protected Matters Search tool: Lists items/species on the Schedules of the EPBC Act with the potential to occur within 10km of the study area

ACRONYMS

EPBC: Environment Protection and Biodiversity Conservation Act

FM: Fisheries Management Act

TSC: Threatened Species Conservation Act

E: Endangered

V: Vulnerable

CE: Critically Endangered

EEC: Endangered Ecological Community

CEEC: Critically Endangered Ecological Community

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
FAUNA				
Birds				
Botaurus poiciloptilus **Australasian Bittern**		EPBC-E		
Callocephalon fimbriatum **Gang-gang Cockatoo**				TSC-V
Chthonicola sagittata **Speckled Warbler**	TSC-V (4)			TSC-V
Climacteris picumnus **Brown Treecreeper**	TSC-V (4)			
Daphoenositta chrysoptera **Varied Sittella**	TSC-V (1)			TSC-V

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
Geophaps scripta scripta **Squatter Pigeon (southern)**		EPBC-V		
Glossopsitta pusilla **Little Lorikeet**	TSC-V (1)			
Hieraaetus morphnoides **Little Eagle**	TSC-V (1)			
Lathamus discolor **Swift Parrot**		EPBC-E		
Leipoa ocellata **Malleefowl**		EPBC-V		
Melanodryas cucullata cucullata **Hooded Robin (south-eastern form)**	TSC-V (3)			TSC-V
Neophema pulchella **Turquoise Parrot**				TSC-V
Ninox connivens **Barking Owl**	TSC-V (1)			
Ninox strenua **Powerful Owl**	TSC-V (1)			TSC-V
Petroica boodang **Scarlet Robin**				TSC-V
Petroica phoenicea **Flame Robin**				TSC-V
Rostratula australis **Australian Painted Snipe**		EPBC-V		
Stagonopleura guttata **Diamond Firetail**	TSC-V (2)			TSC-V
Xanthomyza phrygia **Regent Honeyeater**	TSC-CE (1)	EPBC-E		
Frogs				
Litoria booroolongensis	TSC-E	EPBC-E		

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
Booroolong Frog				
Mammals				
Chalinolobus dwyeri **Large-eared Pied Bat**		EPBC-V		
Dasyurus maculatus **Spotted-tailed Quoll**	TSC-V (6)	EPBC-E		TSC-V
Miniopterus schreibersii oceanensis **Eastern Bentwing-bat**	TSC-V (1)			
Nyctophilus corbeni **(or *N. timoriensis*)** **South-eastern Long-eared Bat**		EPBC-V		
Petaurus norfolcensis **Squirrel Glider**	TSC-V (7)			TSC-V
Petrogale penicillata **Brush-tailed Rock-wallaby**		EPBC-V		
Phascolarctos cinereus **Koala**	TSC-V (4)			TSC-V
Pseudomys novaehollandiae **New Holland Mouse**		EPBC-V		
Pteropus poliocephalus **Grey-headed Flying-fox**		EPBC-V		
Aquatic				
Bidyanus bidyanus **Silver Perch**			FM-V	
Maccullochella peelii **Murray Cod**		EPBC-V		
Mogurnda adspersa **Purple-spotted Gudgeon**			FM-E	
Notopala sublineata **River snail**			FM-E	
The Murray Darling Basin population of			FM-endangered	

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
the eel-tailed catfish			population	
Western Population of Olive Perchlet			FM-endangered population	
Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River (Darling River EEC)	TSC-EEC		FM-EEC	
Reptiles				
Elseya belli **Bell's Turtle, Namoi River Turtle**		EPBC-V		
Underwoodisaurus sphyrurus **Border Thick-tailed Gecko**	TSC-V (11)	EPBC-V		
FLORA				
Asterolasia sp. "Dungowan Creek" **Dungowan Starbush**	TSC-E			
Bothriochloa biloba **Lobed Bluegrass**		EPBC-V		
Dichanthium setosum **Bluegrass**	TSC-V (1)	EPBC-V		TSC-V
Diuris pedunculata **Small Snake Orchid**	TSC-E	EPBC-E		
Eucalyptus nicholii **Narrow-leaved Peppermint**	TSC-V (1)	EPBC-V		
Eucalyptus oresbia **Small-fruited Mountain Gum**	TSC-V			TSC-V
Eucalyptus rubida subsp. barbigerorum **Blackbutt Candlebark**	TSC-V	EPBC-V		TSC-V
Euphrasia arguta		EPBC-CE		TSC-CE
Haloragis exalata subsp. velutina	TSC-V	EPBC-V		

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
Tall Velvet Sea-berry				
Tasmannia purpurascens **Broad-leaved Pepperbush**		EPBC-V		
Thesium australe **Austral Toadflax**		EPBC-V		
Tylophora linearis		EPBC-E		
EEC				
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland		EPBC-CEEC		
New England Peppermint (*Eucalyptus novaanglica*) Grassy Woodlands		EPBC-CEEC		
New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Basalts and Sediments in the New England Tableland Bioregion	TSC-EEC			
Weeping Myall Woodlands		EPBC-EEC		
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		EPBC-CEEC		
White Box Yellow Box Blakely's Red Gum Woodland	TSC-EEC			
OTHER LISTED SPECIES				
Migratory Birds				
Apus pacificus **Fork-tailed Swift**		Species or species habitat may occur within		

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
		area		
Ardea modesta **Great Egret**		Species or species habitat may occur within area		
Ardea ibis **Cattle Egret**		Species or species habitat may occur within area		
Gallinago hardwickii **Latham's Snipe**		Species or species habitat may occur within area		
Haliaeetus leucogaster **White-bellied Sea-Eagle**		Species or species habitat likely to occur within area		
Hirundapus caudacutus **White-throated Needletail**		Species or species habitat may occur within area		
Lathamus discolor **Swift Parrot**		EPBC-E Species or species habitat likely to occur within area		
Leipoa ocellata **Malleefowl**		EPBC-V Species or species habitat may occur within area		
Merops ornatus **Rainbow Bee-eater**		Species or species habitat may occur within area		
Monarcha melanopsis **Black-faced Monarch**		Species or species habitat likely to occur within area		
Myiagra cyanoleuca		Breeding likely to		

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
Satin Flycatcher		occur within area		
Rhipidura rufifrons **Rufous Fantail**		Breeding may occur within area		
Rostratula benghalensis s. lat. **Painted Snipe**		EPBC-V Species or species habitat may occur within area		
Xanthomyza phrygia **Regent Honeyeater**		EPBC-E Species or species habitat may occur within area		
INVASIVE SPECIES				
Mammals				
Felis catus **Cat, House Cat, Domestic Cat**		Species or species habitat likely to occur within area		
Oryctolagus cuniculus **European Rabbit**		Species or species habitat likely to occur within area		
Sus scrofa **Pig**		Species or species habitat likely to occur within area		
Vulpes vulpes **Red Fox**		Species or species habitat likely to occur within area		
Plants				
Asparagus asparagoides **Bridal Creeper**		Species or species habitat likely to occur within area		
Genista sp. X Genista monspessulana		Species or species habitat may occur		

Species	OEH Wildlife Atlas 10km search (20/08/12)	EPBC Protected Matters 10km search (01/05/12)	FM Act	OEH requested (07/06/2012)
Broom		within area		
Lycium ferocissimum **African Boxthorn**		Species or species habitat may occur within area		
Nassella neesiana **Chilean Needle grass**		Species or species habitat likely to occur within area		
Nassella trichotoma **Serrated Tussock**		Species or species habitat likely to occur within area		
Pinus radiata **Radiata Pine, Monterey Pine**		Species or species habitat may occur within area		
Rubus fruticosus aggregate **Blackberry**		Species or species habitat likely to occur within area		
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtiji **Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow**		Species or species habitat likely to occur within area		

APPENDIX B THREATENED SPECIES EVALUATIONS

The tables in this appendix present the habitat evaluation for threatened species, ecological communities and endangered populations listed as occurring within 10 km of the study area in the *Atlas of NSW Wildlife*[1] and those identified as potentially occurring within 10 km of the study area according to the Commonwealth EPBC *Protected Matters Search Tool*[2].

The likelihood of occurrence is based on presence of habitat, proximity of nearest records and mobility of the species (where relevant). The assessment of potential impact is based on the nature of the proposal, the ecology of the species and its likelihood of occurrence. The following classifications are used:

Presence of habitat:

Present: Potential or known habitat is present within the study area

Marginal: Habitat present is not typical but may be suitable

Absent: No potential or known habitat is present within the study area

Likelihood of occurrence

None: Species known or predicted within the locality but no suitable habitat present within the study area

Unlikely: Species known or predicted within the locality. Suitable habitat may be present in the study area but the proximity of nearest records suggest it is unlikely to occur

Possible: Suitable habitat present and the species could occur in the study area based on the proximity of nearest records

Present: Species was recorded during the field investigations or recent records within the study area exist

Likelihood of Impact

No: The proposal would not result in an impact to this species. No Assessment of Significance (AoS) is necessary for this species

Low: The proposal is unlikely to result in an impact to this species. No Assessment of Significance (AoS) is necessary for this species

Moderate: The proposal could impact this species or its habitats. This species is considered further in this assessment. The risk to this species is considered manageable and an AoS is not considered necessary.

High: The proposal is likely to impact this species or its habitats. An AoS has been applied to these entities

Information on habitat is sourced from species profiles on the NSW OEH threatened species database or the Australian Government's Species Profiles and Threats database (SPRAT) unless otherwise stated.

[1] The *Atlas of NSW Wildlife* (Bionet) is administered by the NSW Office of Environment and Heritage and is an online database of fauna and flora records that contains over four million recorded sightings.

[2] This online tool is designed for the public to search for matters protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is managed by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities.

B.1 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FAUNA

Species	Description of habitat[3]	Presence of habitat	Likelihood of occurrence	Possible impact?
FAUNA				
Birds				
Botaurus poiciloptilus **Australasian Bittern** **TSC-E, EPBC-E**	In NSW, this species occurs along the coast and is frequently recorded in the Murray-Darling Basin, notably in floodplain wetlands of the Murrumbidgee, Lachlan, Macquarie and Gwydir Rivers. Occurs in permanent freshwater wetlands with tall, dense vegetation. Favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, , Bolboschoenus*) or cutting grass (*Gahnia*) growing over muddy or peaty substrate. Hides during the day amongst dense reeds or rushes and feed mainly at night on frogs, fish, yabbies, spiders, insects and snails. Feeding platforms may be constructed over deeper water from reeds trampled by the bird; platforms are often littered with prey remains. Breeding occurs in summer from October to January; nests are built in secluded places in densely-vegetated wetlands on a platform of reeds; there are usually six olive-brown eggs to a clutch. In Australia, the Bittern occurs with the Australian Painted Snipe *Rostratula benghalensis australis.*	Present	Possible – the Nankeen Night Heron, an ecologically similar species, was recorded upstream of Chaffey Dam on the Peel River	Low
Callocephalon fimbriatum **Gang-gang Cockatoo** **TSC-V**	The Gang-gang Cockatoo is distributed from southern Victoria through south- and central-eastern New South Wales. In New South Wales, the Gang-gang Cockatoo is distributed from the south-east coast to the Hunter region, and inland to the Central Tablelands and south-west slopes. It occurs regularly in the Australian Capital Territory. It is rare at the extremities of its range, with isolated records known from as far north as Coffs Harbour and as far west as Mudgee. In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at	Present	Possible – may occur in winter, although no records within 10 km of site	Low – surveys over the history of the project have not detected this species. There is abundant better quality habitat adjacent to the site.

[3] Information sourced from species profiles on NSW DECCW's threatened species database (http://www.environment.nsw.gov.au/threatenedspecies/) or the Australian Government's Species Profiles and Threats database (SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl)

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. May also occur in sub-alpine Snow Gum *Eucalyptus pauciflora* woodland and occasionally in temperate rainforests. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting. Feed mainly on seeds of native and introduced trees and shrubs, with a preference for eucalypts, wattles and introduced hawthorns. They will also eat berries, fruits, nuts and insects and their larvae. They are mainly arboreal (found in trees), coming to the ground only to drink and to forage among fallen fruits or pine cones.			
Chthonicola sagittata **Speckled Warbler** **TSC-V**	The Speckled Warbler has a patchy distribution throughout south-eastern Queensland, the eastern half of NSW and into Victoria, as far west as the Grampians. The species is most frequently reported from the hills and tablelands of the Great Dividing Range, and rarely from the coast. There has been a decline in population density throughout its range, with the decline exceeding 40% where no vegetation remnants larger than 100ha survive. The Speckled Warbler lives in a wide range of Eucalyptus dominated communities that have a grassy understorey, often on rocky ridges or in gullies. Typical habitat would include scattered native tussock grasses, a sparse shrub layer, some eucalypt regrowth and an open canopy. Large, relatively undisturbed remnants are required for the species to persist in an area. The diet consists of seeds and insects, with most foraging taking place on the ground around tussocks and under bushes and trees. Pairs are sedentary and occupy a breeding territory of about ten hectares, with a slightly larger home-range when not breeding. The rounded, domed, roughly built nest of dry grass and strips of bark is located in a slight hollow in the ground or the base of a low dense plant, often among fallen branches and other litter. A side entrance allows the bird to walk directly inside. Some cooperative breeding occurs. The species may act as host to the Black-eared Cuckoo. Speckled Warblers often join mixed species feeding flocks in winter, with other species such as Yellow-rumped, Buff-	Present	Present – detected north of the dam wall in 2008	Low – area where this species has been observed (Goat Mountain) will not be impacted by the Project. May occur at other locations around the dam, however better quality habitat is abundant outside the new FSL.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	rumped, Brown and Striated Thornbills.			
Climacteris picumnus **Brown Treecreeper** **TSC-V**	The Brown Treecreeper is endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. The western boundary of the range of *Climacteris picumnus victoriae* runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper *Climacteris picumnus picumnus* which then occupies the remaining parts of the state. The eastern subspecies lives in eastern NSW in eucalypt woodlands through central NSW and in coastal areas with drier open woodlands such as the Snowy River Valley, Cumberland Plains, Hunter Valley and parts of the Richmond and Clarence Valleys.The population density of this subspecies has been greatly reduced over much of its range, with major declines recorded in central NSW and the northern and southern tablelands. Declines have occurred in remnant vegetation fragments smaller than 300 hectares that have been isolated or fragmented for more than 50 years. Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (*Eucalyptus camaldulensis*) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands with a dense shrub layer; fallen timber is an important habitat component for foraging. Also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains.	Present	Present – recorded in 2008	Low – there is abundant better quality habitat available adjacent to the site.
Daphoenositta chrysoptera **Varied Sittella** **TSC-V**	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands, with a nearly continuous distribution in NSW from the coast to the far west. It inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and *Acacia* woodland. The Varied Sittella feeds on arthropods gleaned	Present – broad habitat preferences.	Possible	Low - there is abundant better quality habitat available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	from crevices in rough or decorticating bark, dead branches, standing dead trees, and from small branches and twigs in the tree canopy. It builds a cup-shaped nest of plant fibres and cobweb in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.			
Geophaps scripta scripta **Squatter Pigeon (southern)** **TSC-E, EPBC-V**	Found from north Queensland to the North West Slopes of NSW and extending down to the Liverpool Plains and Dubbo. Today they are very rare in the southern parts of their range. The extent of occurrence is estimated to be 440 000 km². The Squatter Pigeon (southern) occurs mainly in grassy woodlands and open forests that are dominated by eucalypts. It has also been recorded in sown grasslands with scattered remnant trees (Leach 1988), disturbed habitats (i.e. around stockyards, along roads and railways, and around settlements), in scrub and acacia growth, and remains common in heavily-grazed country north of the Tropic of Capricorn. Commonly observed in habitats that are located close to bodies of water. The Squatter Pigeon (southern) has been observed foraging along roads and railway lines and around settlements with domestic fowl. In New South Wales, the Squatter Pigeon (southern) is thought to have formerly occurred in sites that, today, consist of eucalypt woodlands that are intersected with patches of acacia and stands of cypress pine *Callitris columellaris* and that have a ground cover of grasses and herbs. The subspecies has also been recorded in scrub and acacia growth. The northern subspecies of the Squatter Pigeon occurs in dry sclerophyll woodlands (dominated by eucalypts or *Melaleuca*) and, less frequently, open savannas in north-eastern Queensland. The northern subspecies is said to particularly common in habitats that occur on sandy soils, are punctuated with low gravelly ridges, and are located close to water. Feed on the ground, on seeds of grasses, herbs and shrubs, as well as insects. Nest on the ground.	Present – 33 ha of woodland habitat will be impacted as a result of the Project.	Unlikely - Two known localities in the far north of the Nandewar region	No – no nearby records and abundant better quality habitat is available adjacent to the site.
Glossopsitta pusilla **Little Lorikeet** **TSC-V**	The Little Lorikeet is distributed widely across the coastal and Great Divide regions of eastern Australia from Cape York to South Australia. NSW provides a large portion of the species' core habitat, with lorikeets found westward as far as Dubbo and Albury. Nomadic movements are	Present	Present – recorded in 2008	Moderate – some hollow-bearing trees will be impacted by the Project, although abundant

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	common, influenced by season and food availability. Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophoras, Melaleucas and other tree species. Riparian habitats are particularly used, due to higher soil fertility and hence greater productivity. Isolated flowering trees in open country, e.g. paddocks, roadside remnants and urban trees also help sustain viable populations of the species. Feeds mostly on nectar and pollen, occasionally on native fruits such as mistletoe, and only rarely in orchards. Roosts in treetops, often distant from feeding areas. Nests in proximity to feeding areas if possible, most typically selecting hollows in the limb or trunk of smooth-barked Eucalypts. Entrance is small (3 cm) and usually high above the ground (2–15 m). These nest sites are often used repeatedly for decades, suggesting that preferred sites are limited. Riparian trees often chosen, including species like Allocasuarina. Nesting season extends from May to September.			better quality habitat is available adjacent to the site.
Hieraaetus morphnoides **Little Eagle** **TSC-V**	The Little Eagle is a medium-sized bird of prey that is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch, where pairs build a large stick nest in winter. Lays two or three eggs during spring, and young fledge in early summer. Preys on birds, reptiles and mammals, occasionally adding large insects and carrion.	Present	Possible	No – breeding habitat will not be impacted by the Project.
Lathamus discolor **Swift Parrot** **TSC-E, EPBC-E**	Breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland. In NSW mostly occurs on the coast and south west slopes. On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations. Favoured feed trees include winter flowering species such as Swamp Mahogany *Eucalyptus robusta*, Spotted Gum *Corymbia maculata*, Red Bloodwood *C. gummifera*, Mugga Ironbark *E. sideroxylon*, and White Box *E. albens*. Commonly used lerp infested trees include Grey Box *E. microcarpa*,	Present	Possible	Low – small amount of foraging habitat will be impacted, although abundant better quality habitat available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	Grey Box *E. moluccana* and Blackbutt *E. pilularis*. Return to home foraging sites on a cyclic basis depending on food availability.			
Leipoa ocellata **Malleefowl** **TSC-E, EPBC-V**	The stronghold for this species in NSW is the mallee in the south west centred on Mallee Cliffs NP and extending east to near Balranald and scattered records as far north as Mungo NP. West of the Darling River a population also occurs in the Scotia mallee including Tarawi NR and Scotia Sanctuary, and is part of a larger population north of the Murray River in South Australia. The population in central NSW has been significantly reduced through land clearance and fox predation and now occurs chiefly in Yathong, Nombinnie and Round Hill NRs and surrounding areas, though birds continue to survive in Loughnan NR. To the south of this area the species is probably locally extinct in such reserves as Pulletop NR (last recorded 1989), Ingalba NR (1982) and Buddigower NR (1990) and the intensely studied population at Yalgogrin was, in 2003, predicted to be locally extinct by 2008 (although this has not been confirmed). Further east, a population continues to persist in the Goonoo forest near Dubbo. Outside these areas, occasional records have been made in the Pilliga forests (most recently 1999), around Cobar (1991) and Goulburn River NP (1989) though the extent and status of populations in these areas are unknown. Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species. Prefers areas of light sandy to sandy loam soils and habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers. A pair may occupy a range of between 50 and 500 ha, overlapping with those of their neighbours. Mainly forage in open areas on seeds of acacias and other native shrubs (*Cassia, Beyeria, Bossiaea*), buds, flowers and fruits of herbs and various shrubs, insects (cockroaches, ants, soil invertebrates), and cereals if available. Incubate eggs in large	Absent	Unlikely	No

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	mounds that contain considerable volumes of sandy soil.			
Melanodryas cucullata cucullata **Hooded Robin** **TSC-V**	The Hooded Robin is common in few places, and rarely found on the coast. It is considered a sedentary species, but local seasonal movements are possible. The south-eastern form is found from Brisbane to Adelaide throughout much of inland NSW, with the exception of the north-west. The species is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and Tasmania. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. Often perches on low dead stumps and fallen timber or on low-hanging branches, using a perch-and-pounce method of hunting insect prey. Territories range from around 10 ha during the breeding season, to 30 ha in the non-breeding season. May breed any time between July and November, often rearing several broods. The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than 1 m to 5 m above the ground. The nest is defended by both sexes with displays of injury-feigning, tumbling across the ground. A clutch of two to three is laid and incubated for fourteen days by the female. Two females often cooperate in brooding.	Present	Possible – although not recorded during surveys in October 2012	Low – abundant habitat is available adjacent to the site.
Neophema pulchella **Turquoise Parrot** **TSC-V**	The Turquoise Parrot's range extends from southern Queensland through to northern Victoria, from the coastal plains to the western slopes of the Great Dividing Range. Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland. Usually seen in pairs or small, possibly family, groups and have also been reported in flocks of up to thirty individuals. Prefers to feed in the shade of a tree and spends most of the day on the ground searching for the seeds or grasses and herbaceous plants, or browsing on vegetable matter. Forages quietly and may be quite tolerant of disturbance. However, if flushed it will fly to a nearby tree and then return to the ground to browse as soon as the danger has passed. Nests in tree hollows, logs or posts, from August to December. It lays four or five	Present	Possible – although not recorded during surveys in October 2012	Low - abundant habitat is available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	white, rounded eggs on a nest of decayed wood dust.			
Ninox connivens **Barking Owl** **TSC-V**	Inhabits eucalypt woodland, open forest, swamp woodlands and, especially in inland areas, timber along watercourses. Denser vegetation is used occasionally for roosting. During the day they roost along creek lines, usually in tall understorey trees with dense foliage such as *Acacia* and *Casuarina* species, or the dense clumps of canopy leaves in large *Eucalypts*. Feeds on a variety of prey, with invertebrates predominant for most of the year, and birds and mammals such as smaller gliders, possums, rodents and rabbits becoming important during breeding. Live alone or in pairs. Territories range from 30 to 200 hectares and birds are present all year. Three eggs are laid in nests in hollows of large, old eucalypts including River Red Gum (*Eucalyptus camaldulensis*), White Box (*Eucalyptus albens*), (Red Box) *Eucalyptus polyanthemos* and Blakely's Red Gum (*Eucalyptus blakelyi*). Breeding occurs during late winter and early spring.	Present	Possible – although prefers dense habitat	Low - Approximately 7 trees with large hollows will be impacted by the Project. There is abundant better quality habitat available adjacent to the site.
Ninox strenua **Powerful Owl** **TSC-V**	Endemic to eastern and south-eastern Australia, mainly on the coastal side of the Great Dividing Range from Mackay to south-western Victoria. In NSW the Powerful Owl lives in forests and woodlands occurring in the coastal, escarpment, tablelands and western slopes environments. Specific habitat requirements include eucalypt forests and woodlands on productive sites on gentle terrain; a mosaic of moist and dry types, with mesic gullies and permanent streams; presence of leafy sub-canopy trees or tall shrubs for roosting; presence of large old trees to provide nest hollows. Optimal habitat includes a tall shrub layer and abundant hollows supporting high densities of arboreal marsupials. Roosts in groves of dense mid-canopy trees or tall shrubs in sheltered gullies, typically on wide creek flats and at the heads of minor drainage lines, but also adjacent to cliff faces and below dry waterfalls. Species commonly used for roosting include the She-oaks *Allocasuarina* spp., rainforest species such as Coachwood *Ceratopetalum apetalum*, Lilly Pilly *Acmena smithii* and Sassafras *Doryphora sassafras*, Black Wattle *Acacia melanoxylon*, Turpentine *Syncarpia glomulifera* and eucalypts. Roosting sites are commonly among small groves of up to 2 ha of similar-sized trees with dense foliage in the height range 3-15 m. Nests	Present – foraging habitat only	Possible	Low – may use site occasionally to forage, but abundant better quality habitat is available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	in old hollow eucalypts in unlogged, unburnt gullies and lower slopes within 100 m of streams or minor drainage lines, with hollows greater than 45 cm diameter and greater than 100 cm deep; surrounded by canopy trees and subcanopy or understorey trees or tall shrubs. Hollow entrances are greater than 6 m above ground, commonly more than 20 m where the forest permits, in trees of at least 80 cm diameter at breast height. During the breeding season, the male Powerful Owl roosts in a "grove" of up to 20-30 trees, situated within 100-200 metres of the nest tree where the female shelters. Nesting occurs from late autumn to mid-winter, but is slightly earlier in north-eastern NSW (late summer - mid autumn). The Powerful Owl is highly sensitive to nest disturbance during the egg and chick stages and will readily abandon the nest if disturbed. Home range has been estimated as 300-1500 ha according to habitat productivity. Moist forest in unlogged corridors in gully systems is used for nesting and roosting, and also preferentially for foraging although much foraging is also conducted in dry and regrowth forest. The main prey items are medium-sized arboreal marsupials, particularly the Greater Glider, Common Ringtail Possum and Sugar Glider.			
Petroica boodang **Scarlet Robin** **TSC-V**	Found from SE Queensland to SE South Australia and also in Tasmania and SW Western Australia. In NSW, it occurs from the coast to the inland slopes. After breeding, some Scarlet Robins disperse to the lower valleys and plains of the tablelands and slopes. Some birds may appear as far west as the eastern edges of the inland plains in autumn and winter. Lives in dry eucalypt forests and woodlands. The understorey is usually open and grassy with few scattered shrubs. This species lives in both mature and regrowth vegetation. It occasionally occurs in mallee or wet forest communities, or in wetlands and tea-tree swamps. Scarlet Robin habitat usually contains abundant logs and fallen timber: these are important components of its habitat. Breeds on ridges, hills and foothills of the western slopes, the Great Dividing Range and eastern coastal regions; this species is occasionally found up to 1000 metres in altitude. Primarily a resident in forests and woodlands, but some adults and young birds disperse to more open habitats after breeding. In	Present	Possible – non-breeding season only	Low – may impact a small amount of foraging habitat however abundant habitat is available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	autumn and winter many Scarlet Robins live in open grassy woodlands, and grasslands or grazed paddocks with scattered trees. The Scarlet Robin is a quiet and unobtrusive species which is often quite tame and easily approached. Birds forage from low perches, fence-posts or on the ground, from where they pounce on small insects and other invertebrates which are taken from the ground, or off tree trunks and logs; they sometimes forage in the shrub or canopy layer. Scarlet Robin pairs defend a breeding territory and mainly breed between the months of July and January; they may raise two or three broods in each season. This species' nest is an open cup made of plant fibres and cobwebs and is built in the fork of tree usually more than 2 metres above the ground; nests are often found in a dead branch in a live tree, or in a dead tree or shrub. Birds usually occur singly or in pairs, occasionally in small family parties; pairs stay together year-round. In autumn and winter, the Scarlet Robin joins mixed flocks of other small insectivorous birds which forage through dry forests and woodlands.			
Petroica phoenicea **Flame Robin** **TSC-V**	Endemic to SE Australia, and ranges from near the Queensland border to SE South Australia and also in Tasmania. In NSW, it breeds in upland areas and in winter, many birds move to the inland slopes and plains. It is likely that there are two separate populations in NSW, one in the Northern Tablelands, and another ranging from the Central to Southern Tablelands. Breeds in upland tall moist eucalypt forests and woodlands, often on ridges and slopes. Prefers clearings or areas with open understoreys. The groundlayer of the breeding habitat is dominated by native grasses and the shrub layer may be either sparse or dense. Occasionally occurs in temperate rainforest, and also in herbfields, heathlands, shrublands and sedgelands at high altitudes. In winter, birds migrate to drier more open habitats in the lowlands (i.e. valleys below the ranges, and to the western slopes and plains). Often occurs in recently burnt areas; however, habitat becomes unsuitable as vegetation closes up following regeneration. In winter lives in dry forests, open woodlands and in pastures and native grasslands, with or without scattered trees. In winter, occasionally seen in heathland or other shrublands in coastal areas. Birds forage from low perches, from	Present	Possible – non-breeding season only.	Low - may impact a small amount of foraging habitat however abundant habitat is available adjacent to the site

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	which they sally or pounce onto small invertebrates which they take from the ground or off tree trunks, logs and other coarse woody debris. Flying insects are often taken in the air and sometimes gleans for invertebrates from foliage and bark. In their autumn and winter habitats, birds often sally from fence-posts or thistles and other prominent perches in open habitats. Occur singly, in pairs, or in flocks of up to 40 birds or more; in the non-breeding season they will join up with other insectivorous birds in mixed feeding flocks. Breeds in spring to late summer. Nests are often near the ground and are built in sheltered sites, such as shallow cavities in trees, stumps or banks. Builds an open cup nest made of plant materials and spider webs.			
Rostratula australis **Australian Painted Snipe** **TSC-E, EPBC-V, Marine, Migratory**	Little is known of the ecology, habitat requirements and reproductive biology of Australian Painted Snipe. They feed in shallow water or at the waters' edge and on mudflats, taking seeds and invertebrates such as insects, worms, molluscs and crustaceans. Females, which are larger and more brightly coloured than males, are thought to sometimes be polyandrous, mating with several males and leaving each one to incubate and raise chicks. They lay 3-4 eggs per clutch and incubation lasts about 15-16 days. Most records of Australian Painted Snipe are from temporary or infrequently filled freshwater wetlands and although they have occurred at many sites, no site can be identified in which they are resident or regular in occurrence. This may suggest the species is nomadic but the extent to which its cryptic behaviour may contribute to this belief is uncertain. The birds are able to remain hidden in rank vegetation, but many reports are of birds not being secretive, but rather still and unobtrusive. Primarily occurs along the east coast from north Queensland (excluding Cape York) to the Eyre Peninsula in South Australia, including the majority of Victoria and NSW. In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Inhabits inland and coastal shallow freshwater wetlands. The species occurs in both ephemeral and permanent wetlands, particularly where there is a cover of vegetation, including grasses, Lignum and Samphire. Individuals have also been known to use artificial	Present	Possible – although would probably only use an artificial habitat occasionally.	No – the Project will not negatively impact this species.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	habitats, such as sewage ponds, dams and waterlogged grassland. Nests on the ground amongst tall vegetation, such as grass tussocks or reeds. Forages nocturnally on mud flats and in shallow water. Breeding is often in response to local conditions; generally occurs from September to December.			
Stagonopleura guttata **Diamond Firetail** **TSC-V**	The Diamond Firetail is widely distributed in NSW, with a concentration of records from the Northern, Central and Southern Tablelands, the Northern, Central and South Western Slopes and the North West Plains and Riverina. Not commonly found in coastal districts, though there are records from near Sydney, the Hunter Valley and the Bega Valley. This species has a scattered distribution over the rest of NSW. Also found in the Australian Capital Territory, Queensland, Victoria and South Australia. Groups separate into small colonies to breed, between August and January. Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Feeds exclusively on the ground, on ripe and partly-ripe grass and herb seeds and green leaves, and on insects (especially in the breeding season). Usually encountered in flocks of between five to 40 birds, occasionally more. Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests. Birds roost in dense shrubs or in smaller nests built especially for roosting. Appears to be sedentary, though some populations move locally, especially those in the south. Has been recorded in some towns and near farm houses.	Present	Possible	Low – abundant habitat available adjacent to the site.
Xanthomyza phrygia **Regent Honeyeater** **TSC-CE, EPBC-E, Migratory**	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented	Present – key eucalypt and mistletoe species for foraging are present at the site	Possible – may use site for foraging however site does not occur within the known key breeding regions.	Low – abundant habitat is available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E. mckieana, E. macrorhyncha, E. laevopinea,* and *Angophora floribunda*. Nectar and fruit from the mistletoes *A. miquelii, A. pendula* and *A. cambagei* are also eaten during the breeding season. When nectar is scarce lerp and honeydew comprise a large proportion of the diet. A shrubby understorey is an important source of insects and nesting material. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.			
Frogs				
Litoria booroolongensis **Booroolong Frog** **TSC-E, EPBC-E**	The Booroolong Frog is restricted to NSW and north-eastern Victoria, predominantly along the western-flowing streams of the Great Dividing Range. It has disappeared from much of the Northern Tablelands, however several populations have recently been recorded in the Namoi catchment. The species is rare throughout most of the remainder of its range. Live along permanent streams with some fringing vegetation cover such as ferns, sedges or grasses. Adults occur on or near cobble banks and other rock structures within stream margins. Shelter under	Present	Present	High. Seven part test has been prepared.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	rocks or amongst vegetation near the ground on the stream edge. Sometimes bask in the sun on exposed rocks near flowing water during summer. Known to be associated with the following vegetation formation: dry sclerophyll forests (shrub/grass sub-formation), dry sclerophyll forests (shrubby sub-formation), forested wetlands, freshwater wetlands, grassy woodlands, heathlands, wet sclerophyll forests (grassy sub-formation). Breeding occurs in spring and early summer and tadpoles metamorphose in late summer to early autumn. Eggs are laid in submerged rock crevices and tadpoles grow in slow-flowing connected or isolated pools. Forage on stream banks or vegetation and timber within 100m of stream. May shelter on stream banks or vegetation and fallen timber within 100m of stream. Best detected from December to February.			
Mammals				
Chalinolobus dwyeri **Large-eared Pied Bat** **TSC-V, EPBC-V**	Found mainly in areas with extensive cliffs and caves, from Rockhampton in Queensland south to Bungonia in the NSW Southern Highlands. It is generally rare with a very patchy distribution in NSW. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Hirundo arie*l), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. Found in well-timbered areas containing gullies. This species probably forages for small, flying insects below the forest canopy. Likely to hibernate through the coolest months. It is uncertain whether mating occurs early in winter or in spring.	Marginal – foraging habitat only	Possible – foraging only	No
Dasyurus maculatus **Spotted-tailed Quoll** **TSC-V, EPBC-E**	Found on the east coast of NSW, Tasmania, eastern Victoria and north-eastern Queensland. Recorded across a range of habitat types, including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Individual animals use hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces as den sites. Mostly nocturnal, although will	Marginal – foraging habitat only	Possible – on occasion, although surveys have failed to detect this species.	Low – abundant better quality habitat is available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	hunt during the day; spends most of the time on the ground. The home-range of this species is unknown, but estimates are between 800ha and 20km^2. Usually traverse their ranges along densely vegetated creeklines. They need suitable den sites and abundant food, requiring large areas of intact vegetation for foraging. Use 'latrine sites', often on flat rocks among boulder fields and rocky cliff-faces; latrine sites can be recognised by the accumulation of the sometimes characteristic 'twisty-shaped' faeces deposited by animals. Consumes a variety of prey, including gliders, possums, small wallabies, rats, birds, bandicoots, rabbits and insects; also eats carrion and takes domestic fowl.			
Miniopterus schreibersii oceanensis **Eastern Bentwing-bat** **TSC-V**	Eastern Bent-wing Bats occur along the east and north-west coasts of Australia. Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures. Form discrete populations centred on a maternity cave that is used annually in spring and summer for the birth and rearing of young. Maternity caves have very specific temperature and humidity regimes. At other times of the year, populations disperse within about 300 km range of maternity caves. Cold caves are used for hibernation in southern Australia. Breeding or roosting colonies can number from 100 to 150,000 individuals. Hunt in forested areas, catching moths and other flying insects above the tree tops.	Marginal – foraging habitat only.	Present – foraging habitat only.	Low - Bridges to be impacted by the Project do not provide ideal habitat for this species.
Nyctophilus corbeni ***(or Nyctophilus timoriensis)*** **South-eastern Long-eared Bat** **TSC-V, EPBC-V**	Overall, the distribution of the south eastern form coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being the distinct stronghold for this species. It is distributed throughout inland NSW except in the north-west area which is dominated by treeless plains. It can be found in the Hunter Valley, extending from central NSW to the eastern Hunter Valley coast. Records also indicate populations in River Red Gum, *Eucayptus camaldulensis,* forests along the Murray River. In the Hunter Valley, NSW, the species is found in areas such as the Monobalai Nature Reserve and Goulburn River and Wollemi National Parks. It has primarily been recorded in moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. There are a small number of records from closed forest adjacent to dry sclerophyll woodlands; in	Present	Possible	Low – abundant better quality habitat available adjacent to the site.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	Araucarian notophyll vine forest in the Bunya Mountains and in semi evergreen vine thickets on the banks of the Dawson River and in the Brigalow Belt Bioregion. Inhabits a variety of vegetation types, including mallee, bulloke *Allocasuarina leuhmanni* and box eucalypt dominated communities, but it is distinctly more common in box/ironbark/cypress-pine vegetation that occurs in a north-south belt along the western slopes and plains of NSW and southern Queensland. Roosts in tree hollows, crevices, and under loose bark. Found that roost sites were on average 1.89 ± 1.61 km (range 0.34–7.06 km) from the capture point. Slow flying agile bat, utilising the understorey to hunt non-flying prey - especially caterpillars and beetles - and will even hunt on the ground. Mating takes place in autumn with one or two young born in late spring to early summer.			
Petaurus norfolcensis **Squirrel Glider** **TSC-V**	The Squirrel Glider is sparsely distributed along the east coast and immediate inland districts from western Victoria to north Queensland. The species is found inland as far as the Grampians in Victoria and the Pilliga and the Coonabarabran areas of NSW. Inhabits dry sclerophyll forest and woodland and is generally absent from rainforest and closed forest. In NSW, potential habitat includes Box-Ironbark forests and woodlands in the west, the River Red Gum forests of the Murray Valley and the eucalypt forests of the northeast. Requires abundant hollow-bearing trees and a mix of eucalypts, acacias and banksias. Nightly movements are estimated at between 300 and 500m. Home-ranges have been estimated at between 0.65 and 8.55ha. Smooth-barked eucalypts are preferred as these eucalypts form hollows more readily than rough-barked and support a greater diversity of invertebrates. Squirrel Glider's forage in the upper and lower forest canopies and in the shrub understorey.	Present - Widespread remnants of white box woodlands on medium to high fertility soils often found to support squirrel gliders in the Nandewar region.	Possible - Substantial numbers occur in the Nandewar region, however this species was not detected during surveys.	Low – not recorded during surveys, and if this species is present on occasion, there is abundant good quality habitat available outside the impact area.
Petrogale penicillata **Brush-tailed Rock-wallaby** **TSC-E, EPBC-V**	The range of the Brush-tailed Rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range. The species' range is now fragmented, particularly in the south where they are now mostly found as small isolated populations dotted across their former range. In NSW they occur from the Queensland border in the north to the Shoalhaven in the	Absent	Unlikely - Less than 5 known populations remaining in Nandewar region including Mt Kaputar NP, north of	No

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	south, with the population in the Warrumbungle Ranges being the western limit. Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Throughout their range, Brush-tailed Rock-wallabies feed on a wide variety of grasses and shrubs, and have flexible dietary requirements. Shelter or bask during the day in rock crevices, caves and overhangs and are most active at night. Highly territorial and have strong site fidelity with an average home range size of about 15 ha. Live in family groups of 2 – 5 adults and usually one or two juvenile and sub-adult individuals. Dominant males associate and breed with up to four females. Breeding is likely to be continuous, at least in the southern populations, with no apparent seasonal trends in births.		Kelvin State Forest.	
Phascolarctos cinereus **Koala** **TSC-V**	Occurs in eastern Australia, from north-eastern Queensland to south-eastern South Australia and to the west of the Great Dividing Range. In NSW it mainly occurs on the central and north coasts with some populations in the western region. It was historically abundant on the south coast of NSW, but now occurs in sparse and possibly disjunct populations. The koala inhabits a range of eucalypt forest and woodland communities, including coastal forests, the woodlands of the tablelands and western slopes, and the riparian communities of the western plains. Examples of important shelter trees are cypress pine and brush box. The quality of forest and woodland communities as habitat for koalas is influenced by a range of factors, such as; species and size of trees present; structural diversity of the vegetation; soil nutrients; climate and rainfall; size and disturbance history of the habitat patch.Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species. Home range size varies with quality of habitat, ranging from less than two ha to several hundred hectares in size. Breeding season for the koala peaks between September and February.	Marginal – site does not qualify as potential Koala habitat as defined under SEPP 44	Unlikely – no surveys have detected this species during the life of the Project.	Low
Pseudomys novaehollandiae **New Holland Mouse**	The New Holland Mouse has a fragmented distribution across Tasmania, Victoria, New South Wales and Queensland. Known to inhabit open heathlands, open woodlands with a heathland understorey and vegetated sand dunes. Lives predominantly in burrows shared with	Absent	Unlikely	No

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
EPBC-V	other individuals. The home range of the New Holland Mouse ranges from 0.44 ha to 1.4 ha. Breeding typically occurs between August and January, but can extend into autumn. The species peaks in abundance during early to mid stages of vegetation succession typically induced by fire. Nocturnal and omnivorous, feeding on seeds, insects, leaves, flowers and fungi, and is therefore likely to play an important role in seed dispersal and fungal spore dispersal.			
Pteropus poliocephalus **Grey-headed Flying-fox** **TSC-V, EPBC-V**	Grey-headed Flying-foxes are found within 200 km of the eastern coast of Australia, from Bundaberg in Queensland to Melbourne in Victoria. Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops. Roosting camps are generally located within 20 km of a regular food source, often in stands of riparian rainforest, Paperbark or Casuarina forest, and are commonly found in gullies, close to water, or in vegetation with a dense canopy. Forage on the nectar and pollen of native trees, in particular *Eucalyptus*, *Melaleuca* and *Banksia,* and fruits of rainforest trees and vines. Travel up to 50 km to forage. Annual mating commences in January and a single young is born each October or November. Site fidelity to camps is high with some camps being used for over a century.	Marginal – may occur on occasion	Possible – foraging only	No
Reptiles				
Elseya belli **Bell's Turtle, Namoi River Turtle** **TSC-V, EPBC-V**	In NSW, currently found only in the upper reaches of the Namoi and Gwydir River systems, on the escarpment of the North West Slopes. A separate population exists in Queensland. Shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Occupied pools are most commonly less than 3 m deep with rocky or sandy bottoms and patches of vegetation. Most typically uses narrow stretches of rivers or streams 30 - 40 m wide, running through habitat that has now been converted to grazing land. Preferred habitat has fallen logs in stream for basking. Nests are dug out in riverbanks of sand or loam during October to January. Eggs take over two months to hatch and so are vulnerable to nest predation for an extended period. Primarily a vegetarian, eating both aquatic plants and terrestrial leaves	Present	Unlikely – is considered to be locally extinct in the Peel River	No

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	that fall into the watercourse. Also takes invertebrates ranging from insects to crayfish.			
Underwoodisaurus sphyrurus **Border Thick-tailed Gecko** **TSC-V, EPBC-V**	Found only on the tablelands and slopes of northern NSW and southern Queensland, reaching south to Tamworth and west to Moree. Most common in the granite country of the New England Tablelands. Often occurs on steep rocky or scree slopes. Favours forest and woodland areas with boulders, rock slabs, fallen timber and deep leaf litter.	Present – dam wall	Present - on dam wall	Yes. Seven part test has been prepared.
Aquatic				
Bidyanus bidyanus **Silver Perch** **FM-V**	Silver perch grows to a maximum size of 500mm. Were once widespread and abundant throughout most of the Murray-Darling river system. The most abundant remaining natural population occurs in the central Murray River downstream of Yarrawonga Weir as well as several of its anabranches and tributaries (including the Edward River, an anabranch of the Murray which flows through Deniliquin, and the Murrumbidgee River). The central Murray population is considered secure and self-sustaining. There have also been reports of self-sustaining populations in other rivers, including the MacIntyre and Macquarie Rivers in northern NSW and the Warrego River in Queensland, mostly from recreational anglers. Little is currently known about the status of these populations. Silver perch seem to prefer fast-flowing, open waters, especially where there are rapids and races, however they will also inhabit warm, sluggish water with cover provided by large woody debris and reeds. They are omnivorous, feeding on small aquatic insects, molluscs, earthworms and green algae. Adults migrate upstream in spring and summer to spawn. Juveniles also sometimes move upstream in response to rising water temperatures and levels.	Riffles and small rapids present downstream of Chaffey Dam. Warm sluggish waters with woody debris occur in Chaffey Dam and in upstream reaches.	Present. Chaffey Dam does not contain a self sustaining natural population. However, Silver Perch is stocked in Chaffey Dam and is found in downstream and upstream reaches (Stocking for recreational fisheries enhancement).	Low - Impacts would be minimal. Silver Perch is stocked in Chaffey Dam. The species occurs in various habitats though prefers fast flowing, open waters. The proposed works would retain availability of existing habitats though the occurrence of riverine habitat would slightly decrease and the extent of still waters would increase. Downstream flows would on average decrease by around 2% from current conditions which is unlikely to impact the species. Cold water pollution currently impacts downstream areas. The proposed works are unlikely to increase this impact

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
				under appropriate management measures.
Maccullochella peelii **Murray Cod** **EPBC-V**	Grow up to a maximum size of 1200mm. Found extensively throughout the Murray Darling Basin in the south-eastern region of Australia. Murray cod are able to live in a wide range of habitats from clear, rocky streams in the upper western slopes regions of New South Wales to the slow flowing, turbid rivers and billabongs of the western plains. Generally, they are found in waters up to 5m deep and in sheltered areas with cover from rocks, timber or overhanging banks. The most common components of adult cod's diet include crustaceans such as yabbies, shrimp and crayfish, and fish such as the introduced common carp, goldfish and redfin perch, and the native fishes bony herring, catfish, golden perch, western carp gudgeon and even other cod. It appears that Murray cod prefer protected spawning sites, and typically spawn large (3.0-3.5mm diameter) adhesive eggs onto firm substrates such as hollow logs, rocks, pipes and clay banks, from spring to early summer.	Habitat present within Chaffey Dam and upstream and downstream.	Present. Murray Cod is stocked in Chaffey Dam and is found in downstream and upstream reaches (Stocking for recreational fisheries enhancement).	Low - Impacts would be minimal. Murray Cod is stocked in Chaffey Dam. The species occurs in a wide range of habitats. The proposed works would retain availability of existing habitats though the occurrence of riverine habitat would slightly decrease and the extent of still waters would increase. Downstream flows would on average decrease by around 2% from current conditions which is unlikely to impact the species. Cold water pollution currently impacts downstream areas. The proposed works are unlikely to increase this impact under appropriate management measures.
Mogurnda adspersa **Purple-spotted Gudgeon** **FM-E**	Purple spotted Dudgeons occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. The western population of the purple spotted gudgeon was previously widespread in the Murray, Murrumbidgee and Lachlan River systems and tributaries of the Darling, but has experienced a significant decline in recent times. Purple spotted gudgeons are now	Habitat present upstream and downstream of the dam.	No previous records in study area. Nearest record near Bingara over 170 kilometres downstream. More than 100 purple spotted	No. Species unlikely to be present in impact zone.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	extremely rare in inland NSW, having been recorded from this area only once since 1983. Purple spotted Gudgeons are found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large woody debris (snags).They feed mainly on insect larvae, but also consume worms, tadpoles, small fish and some plant matter. Females can spawn several times. The adhesive eggs are deposited in a cluster on a hard surface and hatch after 3-8 days.		gudgeons were released into Gulligal Lagoon in the Namoi Demonstration Reach in 2009. Species unlikely to be present due to fish barriers.	
Notopala sublineata **River snail** **FM-E**	Occurs in the Murray-Darling system. *N. sublineata* consists of three sub-species, which until recently were considered separate species. *N. sublineata hanleyi* is restricted to the Murray and Murrumbidgee drainages, and *N. sublineata sublineata* to the Darling River and its tributaries. A third subspecies *N. sublineata alisoni* has a wide distribution in more northern inland and coastal drainages, outside of NSW. Live specimens were discovered in late 2004 from irrigation pipelines near Mildura. River snails were also recorded in the Pilliga region in the Namoi Catchment. Once occurred in flowing rivers throughout the Murray-Darling system, where it was found along the banks attached to logs and rocks or crawling in the mud. Like other species in the family Viviparidae, the females brood their young to a crawl-away stage, rather than having drifting or swimming larvae. As a result they have limited dispersal abilities. As a filter feeder the river snail feeds on bacteria suspended in the water and also grazes on the bacterial 'biofilms' that occur on hard surfaces in free flowing waters.	Habitat present downstream and upstream of the dam.	Unlikely. Habitat present in the study area, however there are no previous records for the species, and targeted searches in October 2012 failed to locate this species.	Low. Targeted searches did not record *N. sublineata*. Species unlikely to be present in impact zone.
The Murray Darling Basin population of the eel-tailed catfish **FM-EP**	Eel-tailed catfish are naturally distributed throughout the Murray-Darling Basin and in the Eastern drainages NSW north of Newcastle. Eel-tailed catfish numbers in the Murray-Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold water pollution and fishing pressures and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments. Non migratory and lives in a wide range of habitats including rivers, creeks, lakes, billabongs and lagoons, and although it inhabits flowing streams, prefers sluggish or still waters. It can be found in clear to turbid waters, and over substrates ranging from mud to gravel and rock. It is rare in natural riverine habitats but can be found in farm dams through-out	Habitat present within Chaffey Dam and upstream and downstream.	Present. The cat fish is known to occur in Chaffey Dam.	Low. The species occurs in various habitat types from flowing streams to still waters, from clear to turbid waters. The proposed works would retain availability of existing habitats though the occurrence of riverine habitat would slightly decrease and the

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	inland NSW and southern Queensland. Moderate remnant populations occur in the Macquarie catchment upstream of Warren, the Castlereagh catchment upstream of Mendooran, the Namoi catchment upstream of Wee Waa, the Gwydir catchment upstream of Moree and the Border Rivers catchment upstream of Goondiwindi.			extent of still waters would increase. Downstream flows would on average decrease by around 2% from current conditions which is unlikely to impact the species. Cold water pollution currently impacts downstream areas. The proposed works are unlikely to increase this impact under appropriate management measures.
Western Population of Olive Perchlet **FM-EP**	Inhabits rivers, creeks, ponds and swamps. They are usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (e.g. large woody debris (snags) and vegetation) during the day but disperse during the night to feed on micro-crustaceans and insects, including larvae. Males and females reach sexual maturity in one year. Spawning occurs in November and December, when water temperatures reach about 23°C.	Habitat present upstream and downstream of the dam.	No. No previous records in the study area. This population has suffered a serious decline and is now found only at a few sites in the Darling River drainage. Species unlikely to be present.	No. Species unlikely to be present in impact zone.
Aquatic Ecological Community in the natural drainage system of the lowland catchment of the Darling River (Darling River EEC) **FM-EEC, TSC-EEC**	Includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches (a secondary channel that diverts from and rejoins the river), flow diversions to anabranches and the floodplains of the Darling River within NSW, and including Menindee Lakes and the Barwon River. Specifically, these areas include the main Barwon-Darling channel from Mungindi (Qld-NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers), and regulated tributaries (Gwydir, Namoi, Macquarie, Castlereagh, and Bogan Rivers). Excluded from the definition are man-made/artificial	Yes. Downstream of Chaffey Dam.	Yes. Downstream of Chaffey Dam.	High. There is the potential for certain components of the EEC to be impacted due to downstream impacts (i.e. flow, cold water pollution). 7 part test undertaken.

Species	Description of habitat3	Presence of habitat	Likelihood of occurrence	Possible impact?
	canals, water distribution and drainage works, farm dams and off-stream reservoirs. Occurs in a lowland riverine environment characterised by meandering channels and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplains. The complex river morphology provides a multitude of aquatic habitats that play a critical role in the life cycles of the species comprising the community. In its natural state, many of the water-bodies in this area are characterised by variable and unpredictable patterns of high and low flows. This variability in environmental conditions has led to adaptations in native aquatic flora and fauna. For example, many fish species rely on the seasonal flow pattern for successful reproduction.			

B.2 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON THREATENED FLORA

Using searches undertaken for the Central West CMA catchment, Canbelego Downs and Bogan-Macquarie sub-catchments using the DECCW threatened species database (as the subject site occurs close to the boundaries of these sub-catchments) and over a 10 kilometre radius using the Commonwealth EPBC Act Protected Matters search tool.

Species	Description of habitat[4]	Presence of habitat	Likelihood of occurrence	Possible impact?
FLORA				
***Asterolasia* sp. "Dungowan Creek"** **Dungowan Starbush** **TSC-E**	A newly discovered shrub 1.5 - 3.5 m high with branches and leaves covered by fawn-coloured star-shaped hairs. Dungowan Starbush is only known from a single population at Dungowan Dam near Tamworth. This location is not currently within a conservation reserve but is within a restricted-access area. Fruiting bodies were observed for the first time in February, during recent surveys. When first collected in 1995, the total population was comprised of seven individuals of which only two plants now remain. Recent surveys in the Back River Nature Reserve have located an additional two small populations of three and five adult plants. Dungowan Starbush grows in rocky alluvial soil along a creekbank dominated by River Oak *Casuarina cunninghamiana*. Recent populations have been found growing near major drainage lines. Flowers in spring.	Present although degraded	Unlikely. Targeted searches in suitable habitat did not detect this species.	No.
Bothriochloa biloba **Lobed Bluegrass** **EPBC-V**	An erect to decumbent grass up to 1m high. Lobed Blue-grass grows in cleared eucalypt forests and relict grassland, often dominated by Purple Wiregrass (Aristida ramosa), Red-leg Grass (Bothriochloa macra), Red Grass (B. decipiens), Queensland Bluegrass (Dicanthium sericeum) or Austrostipa aristiglumis. Dense stands of Lobed Blue-grass have been recorded in Windmill Grass (Chloris truncata) Grassland in the north-western slopes of NSW. Lobed Blue-grass prefers heavier-textured soils such as brown or black clay soils.	Present	Unlikely	Low

[4] Information sourced from species profiles on NSW DECCW's threatened species database (http://www.environment.nsw.gov.au/threatenedspecies/) or the Australian Government's Species Profiles and Threats database (SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl)

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Dichanthium setosum **Bluegrass** **TSC-V, EPBC-V**	Bluegrass is an upright grass less than 1 m tall. Occurs on the New England Tablelands, North West Slopes and Plains and the Central Western Slopes of NSW, as well as in Queensland and Western Australia. It occurs widely on private property, including in the Inverell, Guyra, Armidale and Glen Innes areas. Flowering time is mostly in summer. Associated with heavy basaltic black soils. Often found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture. (Often collected from disturbed open grassy woodlands on the northern tablelands, where the habitat has been variously grazed, nutrient-enriched and water-enriched). It is open to question whether the species tolerates or is promoted by a certain amount of disturbance, or whether this is indicative of the threatening processes behind its depleted habitat. Associated species include *Eucalyptus albens, Eucalyptus melanophloia, Eucalyptus melliodora, Eucalyptus viminalis, Myoporum debile, Aristida ramosa, Themeda triandra, Poa sieberiana, Bothriochloa ambigua, Medicago minima, Leptorhynchos squamatus, Lomandra* aff. *longifolia, Ajuga australis, Calotis hispidula* and *Austrodanthonia, Dichopogon, Brachyscome, Vittadinia, Wahlenbergia* and *Psoralea* species. Locally common or found as scattered clumps in populations.	Typical habitat absent. Unable to confirm if species occurring on atypical habitat at time of survey	Possible. Recorded at Bowling Alley Point (500m east of the study area) in similar habitat to that in areas around the dam.	Yes, if species occurs within the study area.
Diuris pedunculata **Small Snake Orchid** **TSC-E, E-EPBC**	A member of the 'Donkey' orchid group, with bright yellow striped flowers and two drooping side petals. Confined to NSW. It was originally found scattered from Tenterfield south to the Hawkesbury River, but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor. The Small Snake Orchid grows on grassy slopes or flats. It prefers moist areas, and has been found growing in open areas of dry sclerophyll forests with grassy understoreys, in riparian forests (including gallery rainforests), swamp forests, in sub-alpine grasslands and herbfields. The species is not often found in dense forests or heavily shrubby areas. Soils are well-structured red-brown clay loams and stony loams, though occasionally the Small Snake-orchid has been found in peaty soils in seasonally moist areas, from shale, and fine granite. The altitude range known for the species is 50–900 m. The flowering period of the species is between August and October.	Present	Unlikely. Targeted searches in suitable habitat did not detect this species.	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Eucalyptus nicholii **Narrow-leaved Peppermint** **TSC-V, EPBC-V**	A medium-sized tree 15 - 20 m tall with rough, thick, grey-brown bark which extends to the larger branches. This species is widely planted as an urban street tree and in gardens but is quite rare in the wild. It is confined to the New England Tablelands of NSW, where it occurs from Nundle to north of Tenterfield, largely on private property. It occurs in grassy or sclerophyll woodland in association with many other eucalypts that grow in the area, including *E. andrewsii* and many of the stringybarks, such as *E. caliginosa.* Grows on shallow relatively infertile soils on shales and slates; Niangala to Glen Innes. The species is reserved in Single National Park and also in Oxley Wild Rivers National Park. The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland, and Upland Wetlands of the New England Tablelands and the Monaro Plateau.	Absent	Unlikely	No
Eucalyptus oresbia **Small-fruited Mountain Gum** **TSC-V**	A tall tree to 30 m with smooth white, yellow or cream bark, which sheds in long ribbons. Restricted to a small area between Nundle and Hanging Rock in the southern section of the New England Tablelands and also north of Murrurundi in the upper Hunter Valley. Occurs on steep slopes in wet forest at higher altitudes.	Absent	Unlikely	No
Eucalyptus rubida subsp. barbigerorum **Blackbutt Candlebark** **TSC-V, EPBC-V**	A large tree to 40 m tall. Known from scattered populations on the New England Tablelands from Guyra to the Tenterfield area. Most populations occur on private property. Grows in woodland on medium or high fertility soils, often on cold flats. Associated species include Yellow Box (*Eucalyptus melliodora*), Ribbon Gum (*E. viminalis*), Mountain Gum (*E. dalrympleana* subsp. *heptantha*) and Rough-barked Apple (*Angophora floribunda*). The distribution of this species overlaps with the "White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland" EPBC Act-listed threatened ecological community.	Present	Unlikely, Conspicuous species not detected during surveys.	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Euphrasia arguta **EPBC-CE**	An erect, semi-parasitic annual herb growing up to 45 cm high. *Euphrasia arguta* had not been found since 1904 until its rediscovery in 2008. It is listed as presumed extinct under the New South Wales Threatened Species Conservation Act 1995 and its status is under review. Now known from six sites spanning 25 km. Four of the sites are in Nundle State Forest, south east of Tamworth, NSW, while another occurs both within Nundle State Forest and on adjacent forested private land. The sixth site is on private land nearby. Its known area of occupancy in 2009 was approximately 0.03 km2. All sites are in the Nandewar IBRA Bioregion of northern NSW, in the south-east section of Namoi NRM region. The species' previous habitat consisted of grassy areas near rivers at elevations up to 700 m above sea level, with an annual rainfall of 600 mm. The recently discovered populations are in grassy forests or regrowth vegetation following clearing of a firebreak. Flowers mainly from October to January, although one flowering collection was made in June. As *Euphrasia arguta* is an annual plant, population numbers may fluctuate substantially from year to year and site to site.	Present	Unlikely. Targeted searches in suitable habitat did not detect this species.	No
Haloragis exalata **subsp. *velutina*** **Tall Velvet Sea-berry** **TSC-V, V-EPBC**	A shrub to 1.5 m high. This subspecies of Tall Sea-berry occurs on the north coast of NSW and southeastern Queensland. It occurs from near Kempsey, north to Carnarvon National Park inland of Bundaberg. It is plentiful in inaccessible areas of the upper Macleay River. Grows in damp places near watercourses. This subspecies also occurs in woodland on the steep rocky slopes of gorges. Associated species include Broad-leaved Apple (*Angophora subvelutina*), Forest Red-gum (*Eucalyptus tereticornis*), Green Wattle (*Acacia irrorata*), and *Scutellaria humilis.*	Absent	Unlikely	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Tasmannia purpurascens **Broad-leaved Pepperbush** **TSC-V, EPBC-V**	A medium to tall shrub growing 1–3 m high. Known from the eastern side of the NSW northern tablelands in and around Barrington Tops National Park (NP), Gloucester Tops NP and Ben Halls Gap NP. Occurs in chocolate brown soils with basalt substrate. Associated vegetation includes wet, tall eucalypt forest, sub-alpine woodland and the transition zone between tall forest and cool temperate rainforest (*Nothofagus moorei)*. It is found in cool temperature high rainfall areas between 1200 and 1615 m altitude. Flowers in November.	Absent	Unlikely	No
Thesium australe **Austral Toadflax** **TSC-V, EPBC-V**	An erect perennial herb to 40 cm high. Found in very small populations scattered across eastern NSW, along the coast, and from the Northern to Southern Tablelands. It is also found in Tasmania and Queensland and in eastern Asia. Occurs in grassland or grassy woodland, often found in damp sites in association with Kangaroo Grass (*Themeda australis*). A root parasite that takes water and some nutrients from other plants, especially Kangaroo Grass. Flowering is predominantly in spring and summer.	Present	Unlikely. No nearby records.	No
Tylophora linearis **TSC-V, EPBC-E**	An herbaceous climber with clear latex that grows to about 2 m long. Known from eight localities in the Dubbo area and Mt Crow near Barraba in NSW, and "Myall Park" near Glenmorgan in Queensland. This species is conserved within Goobang National Park, Eura State Forest, Goonoo SF, Pilliga West SF and Coolbaggie Nature Reserve. Grows in dry scrub, open forest and woodlands associated with *Melaleuca uncinata*, *Eucalyptus fibrosa*, *E. sideroxylon*, *E. albens*, *Callitris endlicheri*, *C. glaucophylla*, *Allocasuarina luehmannii*, *Acacia hakeoides*, *A. lineata*, *Myoporum* spp., and *Casuarina* spp. The distribution of this species overlaps with the following EPBC Act-listed threatened ecological communities: Brigalow (*Acacia harpophylla* dominant and co-dominant), and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland. Flowers in spring, with flowers recorded in November or May with fruiting probably 2 to 3 months later.	Absent	Unlikely	No
EEC				

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland **EPBC-CEEC**	Distributed in a band extending from Chinchilla, Queensland to Dubbo, NSW. Within this broad geographic extent, the distribution of the ecological community is concentrated in three major but disjunct occurrences where climate, soils and landform are conducive to the development of tussock grasslands: the Darling Downs west of Toowoomba, Queensland, the Liverpool Plains around Gunnedah, NSW, and the Moree Plains north-west of Moree, NSW. This community may be recognised by the following diagnostic features: Distribution mainly in the Darling Downs of southern Queensland and the Liverpool Plains and Moree Plains of northern NSW; Occurrence is mainly associated with fine textured, often cracking clay soils derived from either basalt or alluvium; Occurrence on landforms that are typically flat to very low slopes (less than 5 percent/1 degree); Tree canopy usually absent to sparse, comprising less than 10% projective crown cover; The ground layer is typically dominated by perennial native grasses and contains 3 or more of the indicator native species	Absent	Unlikely	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
New England Peppermint (*Eucalyptus novaanglica*) Grassy Woodlands **EPBC-CEEC**	A type of temperate grassy eucalypt woodland to open forest in which the tree canopy is dominated or co-dominated by *Eucalyptus nova-anglica* (New England Peppermint) and the ground layer is mostly grassy. Distribution limited to the tablelands and slopes of northeastern NSW, extending into southeastern Queensland. Generally occurs on valley flats and lower slopes subject to cold air drainage at elevations of 900 to 1400 m above sea level (asl). Two forms of the ecological community are currently recognised, each associated with a particular substrate. One form is on poorly drained loam-clay soils, derived from basalt, fine-grained sedimentary and acid volcanic substrates, and the other form is on coarse sandy soils overlying granitic substrates. Woodland stands grade into open grassland, where either waterlogging or frost hollows determine whether the tree canopy is sparse to absent. It typically lacks a substantial shrub layer, but has a dense ground layer of grasses and other herbs. Has a tree canopy that is typically 8 to 20 m high with a variable crown cover ranging from less than 30% in woodlands to 30-50% in open forests. The tree canopy is dominated or co-dominated by *Eucalyptus nova-anglica* (New England Peppermint), which often occurs in fairly pure stands. Other tree species may be present, depending on the characteristics of the site, and may include: *Eucalyptus pauciflora* (Snow Gum), *E. stellulata* (Black Sallee), *E. dalrympleana* subsp. *heptantha* (Mountain Gum), *E. blakelyi* (Blakely's Red Gum), *E. radiata* subsp. *sejuncta* (Narrow-leaved Peppermint) and *E. rubida* (Candlebark). Part of the national ecological community is listed as endangered in New South Wales, as 'New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Basalts and Sediments in the New England Tableland Bioregion'.	Absent	Unlikely	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
New England Peppermint (*Eucalyptus nova-anglica*) Woodland on Basalts and Sediments in the New England Tableland Bioregion **TSC-EEC**	Dominated by trees of New England Peppermint *Eucalyptus nova-anglica* and occasionally Mountain Gum *E. dalrympleana subsp. heptantha*, and is usually 8-20 metres tall. The woodland has a predominantly grassy understorey with few shrubs. The species present at a site will vary according to recent rainfall or drought condition and the degree of disturbance (including fire). In NSW all sites are within the New England Tablelands. This community is or has been known to occur in the Armidale Dumaresq, Guyra, Inverell, Severn and Tenterfield Local Government Areas, but may occur elsewhere on the New England Tablelands. It has recently been identified in eastern portions of Namoi CMA on the tablelands. Reserves containing the community include Bolivia Hill, Boorolong, Mount Duval, Yina and Imbota Nature Reserves and Warra National Park. The community occurs primarily in valley flats subject to cold air drainage. The valley flats are composed of basaltic soils, fine-grained sedimentary and acid volcanic substrates with poorly drained loam-clay soils.	Absent	Unlikely	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
Weeping Myall Woodlands **EPBC-EEC**	The Weeping Myall Woodlands occurs on the inland alluvial plains west of the Great Dividing Range in NSW and Queensland, with one small outlying patch in northern Victoria. It occurs in the Riverina, NSW South Western Slopes, Darling Riverine Plains, Brigalow Belt South, Brigalow Belt North, Murray-Darling Depression, Nandewar and Cobar Peneplain IBRA Bioregions. Occurs in a range from open woodlands to woodlands, generally 4-12 m high, in which Weeping Myall (*Acacia pendula*) trees are the sole or dominant overstorey species. Other common names for Weeping Myall include Myall, Boree, Balaar, Nilyah, Bastard Gidgee, and Silver Leaf Boree. Weeping Myall trees often occur in monotypic stands, however other vegetation may also occur in the ecological community, though not as dominant species. These include: Western Rosewood (*Alectryon oleifolius* subsp. *elongatus*); Poplar Box (*Eucalyptus populnea*); or Black Box (*Eucalyptus largiflorens*). Grey Mistletoe (*Amyema quandang*) commonly occurs on the branches of Weeping Myall trees throughout the ecological community's range. The understorey of Weeping Myall Woodlands often includes an open layer of shrubs above an open ground layer of grasses and herbs, though the ecological community can exist naturally either as a shrubby or a grassy woodland. Generally occur on flat areas, shallow depressions or gilgais on raised (relict) alluvial plains. These areas are not associated with active drainage channels and are rarely if ever flooded. The ecological community occurs on black, brown, red-brown or grey clay or clay loam soils. The Weeping Myall Woodlands provide important habitat for a range of animals such as the Superb Parrot (*Polytelis swainsonii*), Painted Honeyeater (*Grantiella picta*) and the Bush Stone-curlew (*Burhinus grallarius*).	Absent	Unlikely	No

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland **EPBC-CEEC**	Occurs in an arc along the western slopes and tablelands of the Great Dividing Range from Southern Queensland through NSW to central Victoria (Beadle 1981). It occurs in the Brigalow Belt South, Nandewar, New England Tableland, South Eastern Queensland, Sydney Basin, NSW North Coast, South Eastern Highlands, South East Corner, NSW South Western Slopes, Victorian Midlands and Riverina BioregionsBox – Gum Grassy Woodlands and Derived Grasslands are characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs, and the dominance, or prior dominance, of White Box, Yellow Box or Blakely's Red Gum trees. In the Nandewar Bioregion, Grey Box (*Eucalyptus microcarpa* or *E. moluccana*) may also be dominant or codominant. The tree-cover is generally discontinuous and consists of widely-spaced trees of medium height in which the canopies are clearly separated. Associated, and occasionally co-dominant, trees include, but are not restricted to: Grey Box (*Eucalyptus microcarpa*), Fuzzy Box (*E. conica*), Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Red Stringybark (*E. macrorhyncha*), White Cypress Pine (*Callitris glaucophylla*), Black Cypress Pine (*C. enderlicheri*), Long-leaved Box (*E. gonicalyx*), New England Stringybark (*E. calignosa*), Brittle Gum (*E. mannifera*), Candlebark (*E. rubida*), Argyle Apple (*E. cinerea*), Kurrajong (*Brachychiton populneus*) and Drooping She-oak (*Allocasuarina verticillata*). occurs in areas where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres.	Present	Present	High. Seven part test undertaken.

Species	Description of habitat4	Presence of habitat	Likelihood of occurrence	Possible impact?
White Box Yellow Box Blakely's Red Gum Woodland **TSC-EEC**	Box-Gum Woodland is found from the Queensland border in the north, to the Victorian border in the south. It occurs in the tablelands and western slopes of NSW. An open woodland community (sometimes occurring as a forest formation) , in which the most obvious species are one or more of the following: White Box *Eucalyptus albens*, Yellow Box *E. melliodora* and Blakely's Red Gum *E. blakelyi*. The trees may occur as pure stands, mixtures of the three species or in mixtures with other trees, including wattles. Commonly co-occurring eucalypts include Apple Box (*E. bridgesiana*), Red Box (*E. polyanthemos*), Candlebark (*E. rubida*), Snow Gum (*E. pauciflora*), Argyle Apple (*E. cinerea*), Brittle Gum (*E. mannifera*), Red Stringybark (*E. macrorhyncha*), Grey Box (*E. microcarpa*), Cabbage Gum (*E. amplifolia*) and others. The understorey in intact sites is characterised by native grasses and a high diversity of herbs; the most commonly encountered include Kangaroo Grass (*Themeda australis*), Poa Tussock (*Poa sieberiana*), wallaby grasses (*Austrodanthonia* spp.), spear-grasses (*Austrostipa* spp.), Common Everlasting (*Chrysocephalum apiculatum*), Scrambled Eggs (*Goodenia pinnatifida*), Small St John's Wort (*Hypericum gramineum*), Narrow-leafed New Holland Daisy (*Vittadinia muelleri*) and blue-bells (*Wahlenbergia* spp.). Shrubs are generally sparse or absent, though they may be locally common. Remnants generally occur on fertile lower parts of the landscape where resources such as water and nutrients are abundant.	Present	Present	High. Seven part test undertaken.

B.3 EVALUATION OF THE LIKELIHOOD AND EXTENT OF IMPACT ON MIGRATORY SPECIES

Species	Description of habitat[5]	Presence of habitat	Likelihood of occurrence	Possible impact?
Migratory Birds				
Apus pacificus **Fork-tailed Swift** **EPBC-Marine, Migratory**	This species breeds in the north-east and mid-east Asia and winters in Australia and southern New Guinea. It is a visitor to most parts of Western Australia, beginning to arrive in the Kimberley in late September, in the Pilbara and Eucla in November and in the south-west land division in mid-December, and leaving by late April. It is common in the Kimberley, uncommon to moderately common near north-west, west and southeast coasts and rare to scarce elsewhere. They never settle voluntarily on the ground and spend most of their lives in the air, living on the insects they catch in their beaks.	Marginal	Possible	No
Ardea modesta **Great Egret** **EPBC-Marine, Migratory**	The Eastern Great Egret has been reported in a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). These include swamps and marshes; margins of rivers and lakes; damp or flooded grasslands, pastures or agricultural lands; reservoirs; sewage treatment ponds; drainage channels; salt pans and salt lakes; salt marshes; estuarine mudflats, tidal streams; mangrove swamps; coastal lagoons; and offshore reefs. The species usually frequents shallow waters. Eastern Great Egrets usually nest in colonies and rarely as solitary pairs. In Australia, breeding sites are located in wooded and shrubby swamps including mangrove forests (the main habitat of the species in the Top End), *Melaleuca* swamps (on the eastern coast of Australia and south-western Western Australia) and mixed eucalypt/acacia/lignum swamps (in the Channel Country and Murray-Darling Basin). The Eastern Great Egret has a diverse diet that includes fish, insects, crustaceans, molluscs, frogs, lizards, snakes and small birds and mammal.	Present	Possible	No

[5] Information sourced from species profiles on NSW DECCW's threatened species database (http://www.environment.nsw.gov.au/threatenedspecies/) or the Australian Government's Species Profiles and Threats database (SPRAT: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl)

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Ardea ibis **Cattle Egret** **EPBC-Marine, Migratory**	The Cattle Egret is found in grasslands, woodlands and wetlands, and is not common in arid areas. It also uses pastures and croplands, especially where drainage is poor. Will also forage at garbage dumps, and is often seen with cattle and other stock. The Cattle Egret is partially migratory, moving during winter. The Cattle Egret prefers grasshoppers, especially during breeding season, but eats many other invertebrates. It also eats frogs, cane toads, lizards and some small mammals. Its sharp bill is used in a lunging and stabbing manner. It often feeds by following large animals such as cattle, grabbing insects and worms that they disturb with their feet. They also will sit on cattle to look out for insects. Cattle Egret pairs are monogamous for the breeding season, and they breed in colonies, usually with other waterbirds. Their shallow platform nests are made in wetland areas in trees and bushes, usually as high up as possible. Both parents build the nest and incubate the eggs, with one brood per season being raised.	Present	Possible	No
Gallinago hardwickii **Latham's Snipe** **EPBC-Migratory**	In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2000 m above sea-level. They usually inhabit open, freshwater wetlands with low, dense vegetation (e.g. swamps, flooded grasslands or heathlands, around bogs and other water bodies). However, they can also occur in habitats with saline or brackish water, in modified or artificial habitats, and in habitats located close to humans or human activity. Latham's Snipe does not breed within Australian jurisdiction. Latham's Snipe is an omnivorous species that feeds on seeds and other plant material (mainly from species in families such as Cyperaceae, Poaceae, Juncaceae, Polygonaceae, Ranunculaceae and Fabaceae), and on invertebrates including insects (mainly flies and beetles), earthworms and spiders and occasionally molluscs, isopods and centipedes.	Present	Possible	No

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Haliaeetus leucogaster **White-bellied Sea-Eagle** EPBC-Migratory	White-bellied Sea-Eagles are a common sight in coastal and near coastal areas of Australia. Birds form permanent pairs that inhabit territories throughout the year. Their loud "goose-like" honking call is a familiar sound, particularly during the breeding season. Birds are normally seen, perched high in a tree, or soaring over waterways and adjacent land. In addition to Australia, the species is found in New Guinea, Indonesia, China, south-east Asia and India. The White-bellied Sea-Eagle feeds mainly off aquatic animals, such as fish, turtles and sea snakes, but it takes birds and mammals as well. It is a skilled hunter, and will attack prey up to the size of a swan. Sea-Eagles also feed on carrion (dead prey) such as sheep and fish along the waterline. They harass smaller birds, forcing them to drop any food that they are carrying. Sea-Eagles feed alone, in pairs or in family groups. White-bellied Sea-Eagles build a large stick nest, which is used for many seasons in succession. The nest can be located in a tree up to 30m above the ground, but may be also be placed on the ground or on rocks, where there are no suitable trees. At the start of the breeding season (May to October), the nest is lined with fresh green leaves and twigs. The female carries out most of the incubation of the two white eggs, but the male performs this duty from time to time.	Present	Present	No
Hirundapus caudacutus **White-throated Needletail** **EPBC-Migratory**	White-throated Needletails often occur in large numbers over eastern and northern Australia. They arrive in Australia from their breeding grounds in the northern hemisphere in about October each year and leave somewhere between May and August. They are aerial birds and for a time it was commonly believed that they did not land while in Australia. It has now been observed that birds will roost in trees, and radio-tracking has since confirmed that this is a regular activity. The White-throated Needletail feeds on flying insects, such as termites, ants, beetles and flies. They catch the insects in flight in their wide gaping beaks. Birds usually feed in rising thermal currents associated with storm fronts and bushfires and they are commonly seen moving with wind fronts. White-throated Needletails are non-breeding migrants in Australia.	Present – broad habitat preference	Possible	No

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Leipoa ocellata **Malleefowl** **EPBC-V, Migratory**	The stronghold for this species in NSW is the mallee in the south west centred on Mallee Cliffs NP and extending east to near Balranald and scattered records as far north as Mungo NP. West of the Darling River a population also occurs in the Scotia mallee including Tarawi NR and Scotia Sanctuary, and is part of a larger population north of the Murray River in South Australia. The population in central NSW has been significantly reduced through land clearance and fox predation and now occurs chiefly in Yathong, Nombinnie and Round Hill NRs and surrounding areas, though birds continue to survive in Loughnan NR. To the south of this area the species is probably locally extinct in such reserves as Pulletop NR (last recorded 1989), Ingalba NR (1982) and Buddigower NR (1990) and the intensely studied population at Yalgogrin was, in 2003, predicted to be locally extinct by 2008 (although this has not been confirmed). Further east, a population continues to persist in the Goonoo forest near Dubbo. Outside these areas, occasional records have been made in the Pilliga forests (most recently 1999), around Cobar (1991) and Goulburn River NP (1989) though the extent and status of populations in these areas are unknown. Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall (300 - 450 mm mean annual rainfall) areas. Utilises mallee with a spinifex understorey, but usually at lower densities than in areas with a shrub understorey. Less frequently found in other eucalypt woodlands, such as Inland Grey Box, Ironbark or Bimble Box Woodlands with thick understorey, or in other woodlands such dominated by Mulga or native Cypress Pine species. Prefers areas of light sandy to sandy loam soils and habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers. A pair may occupy a range of between 50 and 500 ha, overlapping with those of their neighbours. Mainly forage in open areas on seeds of acacias and other native shrubs (*Cassia, Beyeria, Bossiaea*), buds, flowers and fruits of herbs and various shrubs, insects (cockroaches, ants, soil invertebrates), and cereals if available. Incubate eggs in large mounds that contain considerable volumes of sandy soil.	Absent	Unlikely	No

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Merops ornatus **Rainbow Bee-eater** **EPBC-Migratory**	The Rainbow Bee-eater is found throughout mainland Australia, as well as eastern Indonesia, New Guinea and, rarely, the Solomon Islands. In Australia it is widespread, except in desert areas, and breeds throughout most of its range, although southern birds move north to breed. The Rainbow Bee-eater is most often found in open forests, woodlands and shrublands, and cleared areas, usually near water. It will be found on farmland with remnant vegetation and in orchards and vineyards. It will use disturbed sites such as quarries, cuttings and mines to build its nesting tunnels. Southern populations move north, often in huge flocks, during winter; northern populations are present year round. Rainbow Bee-eaters eat insects, mainly catching bees and wasps, as well as dragonflies, beetles, butterflies and moths. They catch flying insects on the wing and carry them back to a perch to beat them against it before swallowing them. Bees and wasps are rubbed against the perch to remove the stings and venom glands.	Present	Possible – has been recorded during past surveys	Low – the increased FSL may inundate some nest sites upstream of the existing FSL, however abundant potential nesting areas upstream of the increased FSL will remain.
Monarcha melanopsis **Black-faced Monarch** **EPBC-Migratory**	The Black-faced Monarch is found along the coast of eastern Australia, becoming less common further south. The Black-faced Monarch is found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range, but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. The Black-faced Monarch forages for insects among foliage, or catches flying insects on the wing. The Black-faced Monarch builds a deep cup nest of casuarina needles, bark, roots, moss and spider web in the fork of a tree, about 3 m to 6 m above the ground. Only the female builds the nest, but both sexes incubate the eggs and feed the young.	Present – broad habitat preferences	Possible	No – will not impact breeding or foraging resources

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Myiagra cyanoleuca **Satin Flycatcher** **EPBC-Migratory**	The Satin Flycatcher is found along the east coast of Australia from far northern Queensland to Tasmania, including south-eastern South Australia. It is also found in New Guinea. The Satin Flycatcher is not a commonly seen species, especially in the far south of its range, where it is a summer breeding migrant. The Satin Flycatcher is found in tall forests, preferring wetter habitats such as heavily forested gullies, but not rainforests. The Satin Flycatcher is a migratory species, moving northwards in winter to northern Queensland and Papua New Guinea, returning south to breed in spring. The Satin Flycatcher takes insects on the wing, foraging actively from perches in the mid to upper canopy.	Absent	Unlikely	No
Rhipidura rufifrons **Rufous Fantail** **EPBC-Migratory**	The Rufous Fantail is found in northern and eastern coastal Australia, being more common in the north. It is also found in New Guinea, the Solomon Islands, Sulawesi and Guam. The Rufous Fantail is found in rainforest, dense wet forests, swamp woodlands and mangroves, preferring deep shade, and is often seen close to the ground. During migration, it may be found in more open habitats or urban areas. Strongly migratory in the south of its range, it moves northwards in winter, and virtually disappears from Victoria and New South Wales at this time. The Rufous Fantail feeds on insects, which it gleans from the middle and lower levels of the canopy. It is a very active feeder and constantly fans tail and flicks wings and body while foraging. The Rufous Fantail builds a small compact cup nest, of fine grasses bound with spider webs, that is suspended from a tree fork about 5 m from the ground. The bottom of the nest is drawn out into a long stem.	Absent	Unlikely	No

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Rostratula benghalensis s. lat. **Painted Snipe** **TSC-E, EPBC-V, Migratory, Marine**	Little is known of the ecology, habitat requirements and reproductive biology of Australian Painted Snipe. They feed in shallow water or at the waters' edge and on mudflats, taking seeds and invertebrates such as insects, worms, molluscs and crustaceans. Females, which are larger and more brightly coloured than males, are thought to sometimes be polyandrous, mating with several males and leaving each one to incubate and raise chicks. They lay 3-4 eggs per clutch and incubation lasts about 15-16 days. Most records of Australian Painted Snipe are from temporary or infrequently filled freshwater wetlands and although they have occurred at many sites, no site can be identified in which they are resident or regular in occurrence. This may suggest the species is nomadic but the extent to which its cryptic behaviour may contribute to this belief is uncertain. The birds are able to remain hidden in rank vegetation, but many reports are of birds not being secretive, but rather still and unobtrusive. Primarily occurs along the east coast from north Queensland (excluding Cape York) to the Eyre Peninsula in South Australia, including the majority of Victoria and NSW. In NSW, this species has been recorded at the Paroo wetlands, Lake Cowell, Macquarie Marshes and Hexham Swamp. Most common in the Murray-Darling Basin. Inhabits inland and coastal shallow freshwater wetlands. The species occurs in both ephemeral and permanent wetlands, particularly where there is a cover of vegetation, including grasses, Lignum and Samphire. Individuals have also been known to use artificial habitats, such as sewage ponds, dams and waterlogged grassland. Nests on the ground amongst tall vegetation, such as grass tussocks or reeds. Forages nocturnally on mud flats and in shallow water. Breeding is often in response to local conditions; generally occurs from September to December.	Present – small area of wetland	Possible – may use site on occasion	Low – a small area of wetland will be impacted by the increased FSL, however it is unlikely that this species would rely on the study site for breeding.

Species	Description of habitat5	Presence of habitat	Likelihood of occurrence	Possible impact?
Xanthomyza phrygia **Regent Honeyeater** **TSC-CE, EPBC-E, Migratory**	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. There are only three known key breeding regions remaining: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley and the Bundarra-Barraba region. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years non-breeding flocks converge on flowering coastal woodlands and forests. The species inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak. Regent Honeyeaters inhabit woodlands that support a significantly high abundance and species richness of bird species. These woodlands have significantly large numbers of mature trees, high canopy cover and abundance of mistletoes. Every few years non-breeding flocks are seen foraging in flowering coastal Swamp Mahogany and Spotted Gum forests, particularly on the central coast and occasionally on the upper north coast. Birds are occasionally seen on the south coast. The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of eucalypts and mistletoes. Key eucalypt species include Mugga Ironbark, Yellow Box, Blakely's Red Gum, White Box and Swamp Mahogany. Also utilises *E. microcarpa, E. punctata, E. polyanthemos, E. mollucana, Corymbia robusta, E. crebra, E. caleyi, Corymbia maculata, E. mckieana, E. macrorhyncha, E. laevopinea,* and *Angophora floribunda*. Nectar and fruit from the mistletoes *A. miquelii, A. pendula* and *A. cambagei* are also eaten during the breeding season. When nectar is scarce lerp and honeydew comprise a large proportion of the diet. A shrubby understorey is an important source of insects and nesting material. The species breeds between July and January in Box-Ironbark and other temperate woodlands and riparian gallery forest dominated by River Sheoak. Regent Honeyeaters usually nest in horizontal branches or forks in tall mature eucalypts and Sheoaks. Also nest in mistletoe haustoria.	Present	Possible	Low – some of the key eucalypt and mistletoe species will be impacted by the increased FSL, however abundant better quality habitat exists adjacent to the study site.

APPENDIX C WEATHER CONDITIONS DURING THE SURVEY PERIODS

Date	Minimum temp (°C)	Maximum temp. (°C)	Rainfall	Wind speed (km/h) 3pm
Survey 1				
28/05/2012	2	19.5	0	9
29/05/2012	2.8	20.8	0	28
30/05/2012	5.1	20.4	0	20
31/05/2012	4.0	21.1	0	19
Survey 2				
08/10/2012	6.3	23.8	0	17
09/10/2012	2.7	24.4	0	22
10/10/2012	5.6	28.8	0	22
11/10/2012	11.4	15.3	5.6	15
12/10/2012	2.8	14.8	4.6	37
13/10/2012	-0.3	21.4	0	20

Observations from Tamworth Airport, but some from Tamworth (Oxley Lane). Accessed from Bureau of Meteorology on 15th October 2012.

APPENDIX D FLORA SPECIES LIST

Abundance is given by a cover abundance scale (modified Braun-Blanquet) according to the vegetation type they were found in:

1	1 to a few individuals present, less than 5% cover
2	many individuals present, but still less than 5% cover
3	5 - < 25% cover
4	25 - < 50% cover
5	50 - < 75% cover
6	75 - 100% cover

Vegetation community abbreviations are as follows:

BGW	Box – gum grassy woodlands, Brigalow Belt South and Nandewar
DGL	Derived grasslands, Brigalow Belt South and Nandewar
SBW	Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (dominated by Silvertop Stringybark)
RGF	Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (dominated by Ribbon Gum)
ROF	River Oak Riparian Woodland, eastern NSW
PLTD	Planted non-indigenous vegetation

Cover/abundance scores relate to general abundance over the entire site, not to representative quadrats.

Species of conservation significance are highlighted. Introduced species are denoted by an asterisk (*). Weeds declared as noxious within the Tamworth local control area are denoted by a triangle (△). Where uncertainty exists due to the unavailability of mature reproductive material, the taxon is preceded by a question mark, or plants are identified to genus level only. Botanical nomenclature follows G.J. Harden (ed) (1990-2002) Flora of New South Wales, UNSW Press, except where recent changes have occurred.

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
TREES								
Acacia implexa	Hickory Wattle	Fabaceae	1		2			
Acacia neriifolia	Silver Wattle	Fabaceae			1			
Acacia podolyrifolia	Queensland Silver Wattle	Fabaceae	0-1					
Angophora floribunda	Rough Barked Apple	Myrtaceae	1-3		2			
Brachychiton populneus subsp. populneus	Kurrajong	Sterculiaceae	0-1			1		
Casuarina cunninghamiana	River Oak	Casuarinaceae					2-5	
Eucalyptus albens	White Box	Myrtaceae	0-1					
Eucalyptus blakelyi	Blakely's Red Gum	Myrtaceae	1-2		1			
Eucalyptus camaldulensis	River Red Gum	Myrtaceae						0-2
Eucalyptus dealbata	Tumbledown Red Gum	Myrtaceae			1			
Eucalyptus globulus	Tasmanian Blue Gum	Myrtaceae						0-4
Eucalyptus laevopinea	Silvertop Stringybark	Myrtaceae			2-3	1		
Eucalyptus meliodora	Yellow-Box	Myrtaceae	2-3		1			
Eucalyptus nortonii	Bundy	Myrtaceae				1		
Eucalyptus viminalis	Ribbon Gum	Myrtaceae				2		
Notelaea microcarpa var. *microcarpa*	Velvet Mock Olive	Oleaceae	2		2			
**Pinus* sp.	Pine	Pinaceae						0-2
**Populus* sp.	Poplar	Salicaceae		0-2				
△**Salix* sp.	Willow	Salicaceae		0-1			0-1	
**Schinus areira*	Pepper Tree	Anacardaceae		0-1			0-1	
SHRUBS, SUB-SHRUBS								
Acacia brownii	Brown's Wattle	Fabaceae			0-1			

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
Acacia ulicifolia	Prickly Moses	Fabaceae	2					
Amyema micquelii		Loranthaceae	0-1					
**Bidens pilosa*	Cobblers Pegs	Asteraceae	1				0-1	
Bursaria spinosa subsp. *spinosa*	Blackthorn	Pittosporaceae	1		2	2		
Cassinia laevis	Cough Bush	Asteraceae	2		1-2	2		
Cassinia quinquefaria		Asteraceae	2		0-1			
Dodonaea viscosa subsp. *angustifolia*	Sticky Hop-bush	Sapindaceae				1		
Hibbertia obtusifolia	Grey Guinea Flower	Dilleniaceae	2		2			
Indigofera australis	Australian Indigo	Fabaceae			0-2	1		
Olearia elliptica subsp. *elliptica*	Sticky Daisy Bush	Asteraceae			2	2		
△**Opuntia stricta*	Prickly Pear	Cactaceae	0-1	0-2	0-1			
**Marrubium vulgare*	White Horehound	Lamiaceae	0-1					
Melichrus urceolatus	Urn-heath	Ericaceae	1		2			
Pimelea glauca	Smooth Rice-flower	Thymelaeaceae	2					
**Pyracantha angustifolia*	Orange Firethorn	Malaceae		0-2				
△**Rosa rubiginosa*	Sweet Briar	Rosaceae				2	1	
△**Rubus fruticosus* (aggregate)	Blackberry	Rosaceae	0-1	0-5		2-3	1	
Pultenaea villosa	Hairy Bush-pea	Fabaceae	1					
Xanthorrhoea sp.	Grass Tree	Xanthorrhoeaceae						
VINES AND TWINERS								
Glycine cladestina	Twining Glycine	Fabaceae	1			1		
Hardenbergia violacea	Purple Coral Pea	Fabaceae			1	2		
Pandorea pandorana	Wonga Wonga Vine	Bignoniaceae				1		
FERNS								

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
Asplenium flabellifolium	Necklace Fern	Aspleniaceae				0-1		
Cheilanthes sieberi subsp. *sieberi*	Rock fern	Adiantaceae	1	0-1	2			
Pellaea falcata	Sickle Fern	Adiantaceae			0-3			
FORBS								
Acaena echinata		Rosaceae	2					
Acaena ovina		Rosaceae			2	2		
**Amaranthus caudatus*	Love-lies bleeding	Amaranthaceae	0-2					
**Anagallis arvensis*	Scarlet Pimpernel	Myrsinaceae				2		
**Artotheca calendula*	Capeweed	Asteraceae		0-2				
Asperula conferta	Common Woodruff	Rubiaceae	1	1	1			
**Carthamus lanatus*	Saffron Thistle	Asteraceae		0-2		1		
Calotis lappulacea	Yellow Burr-daisy	Asteraceae	2	2				
**Centaurea melitensis*	Maltese Cockspur	Asteraceae		0-2				
Chrysocephalum apiculatum	Common Everlasting	Asteraceae		0-2				
**Cirsium vulgare*	Black Thistle	Asteraceae		2	1	2		
**Conyza bonariensis*	Fleabane	Asteraceae	2			2	2	
Cymbonotus lawsonianus	Bears Ear	Asteraceae		0-1				
Daucus glochidiatus	Native carrot			0-1			2	
Dianella caerulea	Blue Flax-lily	Phormiaceae			1			
Dichondra repens	Kidney Weed	Convolvulaceae	2		2	2	2	
Drosera ?hookeri						1		
**Echium plantagineum*	Patterson's Curse	Boraginaceae	2				2	
Einadia hastata	Berry Saltbush	Chenopodiaceae	0-1					
Einadia nutans	Climbing Saltbush	Chenopodiaceae	0-1					
Euchiton involucratus	Star Cudweed	Asteraceae			0-1			

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
**Galium aparine*	Goosegrass	Rubiaceae	1			2		
Geranium solanderi	Native Geranium	Geraniaceae	2	2	2	2	2	
**Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	Apocynaceae	2		1			
Gonocarpus tetragynous	Raspwort	Haloragaceae				1		
Goodenia glabra		Goodeniaceae			0-1			
Goodenia hederacea	Ivy Goodenia	Goodeniaceae	1					
Haloragis heterophylla	Rough Raspwort	Haloragaceae	0-1	0-1				
**Hirschfeldia incana*	Buchan Weed	Brassicaceae	1	1				
Hydrocotyle laxiflora	Stinking Pennywort	Apiaceae	2	0-2		2		
**Hypochaeris glabra*	Smooth Catsear	Asteraceae	2					
**Hypochaeris radicata*	Catsear	Asteraceae	2	1	2	2		
**Lepidium africanum*	Common Peppercress	Brassicaceae		0-1				
**Malva parviflora*	Small-flowered Mallow	Malvaceae		1				
**Medicago arabica*	Spotted Medic	Fabaceae	2	2				
**Medicago* sp.	Medic	Fabaceae		2-3			2-3	
Oxalis exilis		Oxalidaceae					1	
Oxalis ?perrenans	Native Oxalis	Oxalidaceae	1	2	1	2		
**Pavonia hastata*		Malvaceae	1					
**Petrorhagia nanteuilii*	Proliferous Pink	Caryophyllaceae				2		
**Plantago lanceolata*	Lambs Tongue	Fabaceae	1	2	1		2	
**Polygonum arviculare*	Wireweed	Polygonaceae				2		
Poranthera microphylla	Small-leaved Poranthera	Phyllanthaceae	1					
Rumex brownii	Swamp Dock	Polygonaceae		0-2		1		
**Rumex crispus*	Curled Dock	Polygonaceae					0-1	
**Salvia verbenaca*	Wild Sage	Lamiaceae		1	0-1			
**Sanguisorba minor*	Sheeps Burnett	Rosaceae		0-1				

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
Senecio quadridentatus	Cotton Fireweed	Asteraceae			2			
**Silybum marinum*	Varigated Thistle	Asteraceae	1			1	1	
**Sisymbrium officinale*	Headge Mustard	Brassicaceae	0-1					
**Solanum pseudocapsicum*	Madeira Winter	Solanaceae		0-2				
**Sonchus asper*	Prickly Sow-thistle	Asteraceae	2					
**Stellaria media*	Common Chickweed	Caryophyllaceae				2		
Stellaria pungens	Prickly Starwort	Caryophyllaceae	0-1					
Swainsona galegifolia	Smooth Darling Pea	Fabaceae				1		
**Taraxicum officinale*	Dandelion	Asteraceae		0-1				
**Trifolium arvense*	Hares-foot Clover	Fabaceae	1	2				
**Trifolium repens*	White Clover	Fabaceae		0-3			2-4	
Urtica incisa	Stinging Nettle	Urticaceae	1					
**Urtica urens*	Small Nettle	Urticaceae	2	2	1		2	
**Verbascum thapsus*	Great Muellein	Scrophulariaceae	1	2	1	2		
**Verbena bonariensis*	Purpletop	Verbenaceae	2	2-3	2		2	
**Vicia sativa* subsp. *nigra*	Narrow-leaved Vetch	Fabaceae	1				1	
**Vinca major*	Greater Periwinkle	Apocynaceae					0-5	
Vittadinia cuneata	Fuzzweed	Asteraceae	0-1					
Vittidinia muelleri		Asteraceae	1	1				
Wahlenbergia communis	Tufted Bluebell	Campanulaceae	2	1				
Wahlenbergia multicaulis	Small Bluebell	Campanulaceae	1					
△**Xanthium occidentale*	Noogoora Burr	Asteraceae					0-2	
△**Xanthium spinosum*	Bathurst Burr	Asteraceae		0-2				
GRASSES								
Aristida personata	Purple Wiregrass	Poaceae	2-4	2	2			

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
Aristida ramosa	Purple Wiregrass	Poaceae			2-4		2	
Aristida vagans	Three-awned Wiregrass	Poaceae	0-3		0-4	2-4		
Austrodanthonia laevis	Wallaby Grass	Poaceae	0-3	0-4				
Austrodanthonia racemosa	Wallaby Grass	Poaceae		0-4	0-3			
Austrodanthonia sp.	Wallaby Grass	Poaceae				2		
Austrostipa ramosissima	Stout Bamboo Grass	Poaceae	2-4	0-5				
Austrostipa scabra subsp. scabra	Speargrass	Poaceae	3	0-5				
Bothriochloa macra	Red Leg Grass	Poaceae	2	2-5	0-4	2-4		
**Bromus* sp.	Brome	Poaceae	0-2				2	
Chloris truncata	Windmill Grass	Poaceae	0-2					
Cymbopogon refractus	Barbed Wire Grass	Poaceae			0-3			
Cynodon dactylon	Couch	Poaceae	0-4	0-6				
**Dactylis glomerata*	Cocksfoot	poaceae				0-2		
Dichanthium sericeum	Queensland Bluegrass	Poaceae		2-5	2	2		
Dichelachne micrantha	Plumegrass	Poaceae	0-1					
Echinopogon ovatus	Hedgehog Grass	Poaceae	2	0-2	2	2		
Enneapogon gracilis	Slender Bottle-washers	Poaceae	2					
**Eragrostis cillianensis*	Stink Grass	Poaceae		0-3			2	
**Hordeum* sp.	Barely Grass	Poaceae					0-3	
**Hyparhenia hirta*	Coolatai Grass	Poaceae		0-6				
Imperata cylindrica	Blady Grass	Poaceae				0-2		
Microlaena stipoides	Weeping Grass	Poaceae	2-4	2-4		2-4		
Notodanthonia longifolia	Long-leaved Wallaby grass	Poaceae			2-3	1		
Panicum effusum	Hairy Panic	Poaceae		2		2		
**Paspalum dialatum*	Paspalum	Poaceae		0-4				
**Pennisetum cladestinum*	Kikuyu	Poaceae		0-5		2	0-4	

Scientific name	Common name	Family	Abundance					
			BGW	DGL	SBW	RGF	ROF	PLTD
**Phalaris aquatica*	Phalaris	Poaceae					0-6	
Phragmites australis	Phragmites	Poaceae					0-5	
**Phyllostachys* sp.	Bamboo	Poaceae		0-4				
Poa labillardierei	River Tussock	Poaceae					0-4	
Poa sieberiana var. *sieberiana*	Snow Grass	Poaceae	0-2					
**Setaria* sp.	Pigeon Grass	Poaceae		0-1				
Sporobolus creber	Slender Ratstail Grass	Poaceae		2-5	2	0-4		
Themeda australis	Kangaroo Grass	Poaceae	0-3		2-3	2	2	
GRAMINOIDS								
Carex Inversa	Knob Sedge	Cyperaceae		0-2		1		
Cyperus fulvus	Sticky Sedge	Cyperaceae		0-2			2	
Juncus filicaulis		Juncaceae		0-2			2	
Juncus sp.		Juncaceae		0-2			2	
Lepidosperma laterale	Variable Sword-sedge	Cyperaceae			2	2		
Lomandra filiformis subsp. *coriacea*		Lomandraceae	1		2	1		
Lomandra longifolia	Spiny-headed Mat-rush	Lomandraceae			2	0-1		
Lomandra multiflora subsp. *multiflora*	Many-flowered Mat-rush	Lomandraceae		1	1			
Luzula flaccida		Juncaceae		0-1				
Schoenus apogon	Common Bog-rush	Cyperaceae		1-2				
Typha orientalis	Broad-leaf Cumbungi	Typhaceae					0-5	

APPENDIX E FAUNA SPECIES LIST

Table E-1. Fauna species (excluding birds) recorded during May 2012 (Survey 1) and October 2012 (Survey 2)

Threatened or migratory species are shaded in grey.

Introduced species are identified with an asterisk *

Common Name	Scientific Name	Observation Type	Survey 1 May 2012	Survey 2 October 2012
Amphibians				
Booroolong Frog	*Litoria booroolongensis*	Observed		Spotlight
Peron's Tree Frog	*Litoria peronii*	Observed		Spotlight
Birds				
SEE TABLE E-2				
Mammals				
Chocolate Wattled Bat	*Chalinolobus morio*	Anabat	Possible^	Definite^
Common Brushtail Possum	*Trichosurus vulpecula*	Observed		Spotlight
Eastern Bentwing-bat	*Miniopterus schreibersii oceanensis*	Anabat		Definite^
Eastern Freetail Bat	*Mormopterus* sp. 2	Anabat		Probable^
Eastern Grey Kangaroo	*Macropus giganteus*	Observed, Scats		Opportunistic
European Rabbit*	*Oryctolagus cuniculus*	Observed, Scats	Opportunistic	Opportunistic
Gould's Wattled Bat	*Chalinolobus gouldii*	Anabat		Definite^
Inland Broad-nosed Bat	*Scotorepens balstoni*	Anabat		Possible^
Inland Freetail Bat	*Mormopterus* sp. 3	Anabat		Possible^
Large Forest Bat	*Vespadelus darlingtoni*	Anabat		Possible^
Little Forest Bat	*Vespadelus vulturnus*	Anabat	Probable^	Definite^
Long-eared Bat	*Nyctophilus* species *(N.gouldi, Ny geoffroyi* or *N. corbeni)*	Anabat	Probable^	Definite^
Red Fox*	*Vulpes vulpes*	Observed		Spotlight; Opportunistic
Short-beaked Echidna	*Tachyglossus aculeatus*	Observed		Opportunistic
South-eastern Freetail Bat	*Mormopterus* sp. 4	Anabat		Definite^
Southern Forest Bat	*Vespadelus regulus*	Anabat	Probable^	Possible^

Common Name	Scientific Name	Observation Type	Survey 1 May 2012	Survey 2 October 2012
Swamp Wallaby	*Wallabia bicolor*	Observed		Opportunistic
Vesper Bat	*Vespadelus spp*	Anabat	Definite^	Definite^
White-striped Freetail Bat	*Tadarida australis*	Anabat		Definite^
Reptiles				
Border Thick-tailed Gecko	*Underwoodisaurus sphyrurus*	Observed		Spotlight
Dubious Dtella	*Gehyra dubia.*	Observed		Spotlight
Eastern Bearded Dragon	*Pogona barbata*	Observed		Opportunistic
Red-bellied Black Snake	*Pseudechis porphyriacus*	Observed		Opportunistic
Aquatic				
Yabby	*Cherax destructor*	Observed		Spotlight
Common Carp	*Cyprinus carpio*	Observed		Opportunistic
Eastern Long-necked Turtle	*Chelodina longicollis*	Observed		Spotlight

Key for Anabat analysis

Microbat species can overlap in frequency range and a call shape so hence the reason for possible and probable rankings. Poor call quality can also make identification difficult.

Definite – For microbat species detected with the Anabat, no possibility of confusion of calls with other species.

Probable – For microbat species detected with the Anabat, limited possibility of confusion of calls with those of other bat species.

Possible - For microbat species detected with the Anabat, likelihood of confusion with other species, but possible identification based on calls.

Table E-2. Bird species and their habitats observed during May 2012 (Survey 1) and October 2012 (Survey 2)

Common Name	Scientific Name	Woodland	River Oak Riparian Woodland	Disturbed Lands and Grassland	Riparian Zone and Reservoir	Opportunistic
Birds						
Australasian Darter	*Anhinga novaehollandiae*		✓			✓
Australasian Grebe	*Tachybaptus novaehollandiae*				✓	
Australian Hobby	*Falco longipennis*					✓
Australian	*Cracticus tibicen*	✓	✓	✓		

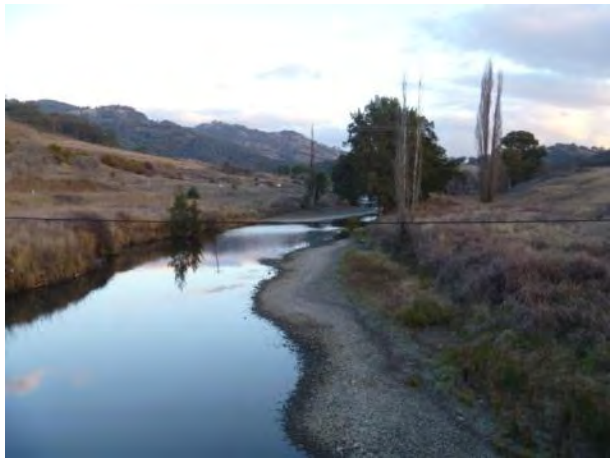
Common Name	Scientific Name	Woodland	River Oak Riparian Woodland	Disturbed Lands and Grassland	Riparian Zone and Reservoir	Opportunistic
Magpie						
Australian Pelican	*Pelecanus conspicillatus*				✓	✓
Australian Raven	*Corvus coronoides*	✓	✓	✓		
Australian Wood Duck	*Chenonetta jubata*	✓			✓	✓
Azure Kingfisher	*Alcedo azurea*				✓	
Black-fronted Dotterel	*Elseyornis melanops*				✓	✓
Black-shouldered Kite	*Elanus axillaris*					✓
Black-winged Stilt	*Himantopus himantopus*					✓
Black Swan	*Cygnus atratus*				✓	
Brown Falcon	*Falco berigora*					✓
Brown Thornbill	*Acanthiza pusilla*	✓				
Channel-billed Cuckoo	*Scythrops novaehollandiae*	✓				
Common Starling*	*Sturnus vulgaris*	✓				
Crested Pigeon	*Ocyphaps lophotes*					✓
Crimson Rosella	*Platycercus elegans*	✓				✓
Dollarbird	*Eurystomus orientalis*					✓
Dusky Moorhen	*Gallinula tenebrosa*				✓	✓
Eastern Rosella	*Platycercus eximius*	✓	✓	✓		✓
Eastern Spinebill	*Acanthorhynchus tenuirostris*		✓			
Eurasian Coot	*Fulica atra*					✓
Fairy Martin	*Hirundo ariel*		✓		✓	✓
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	✓				

Common Name	Scientific Name	Woodland	River Oak Riparian Woodland	Disturbed Lands and Grassland	Riparian Zone and Reservoir	Opportunistic
Flycatcher (Leaden or Satin)	*Myiagra* spp.	✓				
Galah	*Eolophus roseicapilla*	✓		✓		✓
Great Cormorant	*Phalacrocorax carbo*				✓	✓
Great Crested Grebe	*Podiceps cristatus*					
Grey Butcherbird	*Cracticus torquatus*	✓				✓
Grey Fantail	*Rhipidura fuliginosa*	✓	✓			✓
Intermediate Egret	*Ardea intermedia*					✓
Jacky Winter	*Microeca fascinans*					
Laughing Kookaburra	*Dacelo novaeguineae*		✓			✓
Little Black Cormorant	*Phalacrocorax sulcirostris*				✓	✓
Little Corella	*Cacatua sanguinea*	✓		✓		✓
Little Pied Cormorant	*Microcarbo melanoleucos*				✓	✓
Masked Lapwing	*Vanellus miles*			✓		✓
Magpie-lark	*Grallina cyanoleuca*	✓	✓	✓		✓
Mistletoebird	*Dicaeum hirundinaceum*		✓			
Musk Lorikeet	*Glossopsitta concinna*	✓	✓			✓
Nankeen Night Heron	*Nycticorax caledonicus*					
Noisy Friarbird	*Philemon corniculatus*	✓	✓			
Noisy Miner	*Manorina melanocephala*	✓	✓	✓		✓
Pacific Black Duck	*Anas superciliosa*	✓	✓		✓	✓
Pied Butcherbird	*Cracticus nigrogularis*	✓		✓		✓

Common Name	Scientific Name	Woodland	River Oak Riparian Woodland	Disturbed Lands and Grassland	Riparian Zone and Reservoir	Opportunistic
Pied Cormorant	*Phalacrocorax varius*				✓	
Pied Currawong	*Strepera graculina*	✓	✓			
Purple Swamphen	*Porphyrio porphyrio*					✓
Red-browed Finch	*Neochmia temporalis*		✓			✓
Red-rumped Parrot	*Psephotus haematonotus*					✓
Red Wattlebird	*Anthochaera carunculata*		✓			
Rufous Whistler	*Pachycephala rufiventris*		✓			✓
Sacred Kingfisher	*Todiramphus sanctus*				✓	
Scarlet Honeyeater	*Myzomela sanguinolenta*					✓
Silver Gull	*Larus novaehollandiae*				✓	✓
Silvereye	*Zosterops lateralis*	✓	✓			✓
Southern Boobook	*Ninox novaeseelandiae*	✓				
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*					✓
Straw-necked Ibis	*Threskiornis spinicollis*					✓
Striated Pardalote	*Pardalotus striatus*	✓	✓			
Striated Thornbill	*Acanthiza lineata*	✓				
Sulphur-crested Cockatoo	*Cacatua galerita*	✓	✓			✓
Superb Fairy-wren	*Malurus cyaneus*	✓	✓	✓		✓
Wedge-tailed Eagle	*Aquila audax*	✓				
Welcome Swallow	*Hirundo neoxena*		✓		✓	✓
Whistling Kite	*Haliastur*					✓

Common Name	Scientific Name	Woodland	River Oak Riparian Woodland	Disturbed Lands and Grassland	Riparian Zone and Reservoir	Opportunistic
	sphenurus					
White-bellied Sea-eagle	*Haliaeetus leucogaster*					✓
White-breasted Woodswallow	*Artamus leucorynchus*	✓				
White-browed Scrubwren	*Sericornis frontalis*	✓			✓	✓
White-faced Heron	*Egretta novaehollandiae*				✓	✓
White-necked Heron	*Ardea pacifica*					✓
White-plumed Honeyeater	*Lichenostomus penicillatus*		✓			
White-throated Treecreeper	*Cormobates leucophaeus*		✓			
Willie Wagtail	*Rhipidura leucophrys*		✓			✓
Yellow Thornbill	*Acanthiza nana*		✓			

APPENDIX F AQUATIC SITE DESCRIPTIONS

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
US1	Peel River, around 5 kilometres upstream of the dam wall	 View of the Peel River at site US1, image taken from a road bridge over the River facing downstream.	This site was located at a road crossing (where Tamworth-Nundle Road meets Rivers Road). The river was 15 metre wide (at water level) and 40 metres wide from top of banks. There were some sand bars within the stream and small grasses and shrubs, typical of disturbed areas dominated the riparian zone. The substrate was predominantly pebbles and gravel lying on a bed of silt. There was some woody debris, overhanging vegetation and filamentous algae within the waterway which contributed to instream habitat. This site was relatively disturbed as a result of runoff from areas containing stock. The banks were of a low slope and there was no evidence of stock access to the waterway.	Class 1	3rd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
US2	Peel River, around 7 kilometres upstream of the dam wall	 View of the Peel River at site US2, image taken from the right bank facing downstream.	This site was along the Peel River within close proximity to Rivers Road to its east. There was a culvert running beneath Rivers Road which drained an unformalised gully into the Peel River. At the confluence of this drainage line and the Peel River there was a high incidence of exotic grasses along the banks. Within the river, the bed was dominated by large boulders and bedrock with a layer of silt settled on top. At this site there were numerous riffles shaped by the boulders and exposed bedrock. The banks were lined by *Casuarina cunninghamiana* which provided some shading over the stream. Instream habitat was provided by trailing vegetation and exposed roots along the banks of the waterway as well as woody debris instream. The water column was very clear at the time of the survey and there appeared to be numerous deep pools scattered along the length of the site.	Class 1	3rd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
US3	Cannes Creek, around 4 kilometres upstream of the confluence with the Peel River (around 4 kilometres upstream of the dam wall)	 View of Cannes Creek at site US3, image taken from the right bank facing downstream.	Cannes Creek at this site was relatively disturbed. There was evidence of stock access along the banks in the form of erosion and a heavy silt load. There was also a road crossing in the form of a large box culvert at this site. The vegetation along the banks was dominated by exotic grasses, blackberry and some willows. There were also some willows growing instream where there was evidence of sediment build-up around the trees. Downstream of the road crossing, there was a bed of Broad-leaved cumbungi *(Typha orientalis)* which was slowing flow and contributing to a sediment build-up forming a bar within the waterway. There was some woody debris within the waterway which contributed to instream habitat. The bed was dominated by silt.	Class 2	2nd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
US4	Cannes Creek, around 2.5 kilometres upstream of the confluence with the Peel River (around 4 kilometres upstream of the dam wall)	 View of Cannes Creek at site US4, image taken from the right bank facing upstream.	This site was similar to the site at US3. There was a low lying area which looked to be used by vehicles to cross the creek. The upstream reaches of the site had moderate sloping banks and the downstream reaches were low sloping. The banks were vegetated by grasses and shrubs; there were some poplars along the banks. There were some bars and vegetation growing instream. There was minimal woody debris or other habitat features. This site meandered through the landscape and was relatively well connected along its length, at the time of survey.	Class 2	2nd order
US5	Hydes Creek, around 500 metres upstream of the confluence with the Peel River (around 3 kilometres upstream of the dam wall)	 View of Hydes Creek at site US5, image taken from a	Hydes Creek at this site was a meandering stream which was shaped by two large willows along the banks. Boulders and bars within the stream formed riffle habitats dotted along the length of the site. The width (at water level) at the time of the survey was around 2 metres and the substrate consisted of silt. Instream habitat features included woody debris, trailing vegetation, overhanging vegetation and some undercut banks.	Class 2	2nd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
		road bridge which crosses the creek, facing upstream.			
US6	Silver Gully, at the location of the box culverts, where the gully drains into the dam, around 2 kilometres upstream of the dam wall	 View of the shallow pool immediately upstream of the culverts at site US6, image taken from the right bank facing downstream.	This site was comprised of a running stream running through the Silver Gully and a shallow pool which had formed to the south at the waterway crossing. The channel was relatively straight and flowed through a gully where the right bank was heavily impacted by stock access. The left bank was relatively steep and well vegetated. The channel was relatively wide; the width at water level was around 12 metres. The stream was flowing with no riffles. There was little instream vegetation. Duckweed was growing along the shallow areas of the pooled water, where there was evidence of impact by stock access. Grasses and sedges grew along the banks of the channel. There was a well established riparian zone along the left bank, where the riparian zone of the right bank had few trees and was dominated by grasses.	Class 1	3rd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
		 View of the channel running through Silver Gully at site US6. Image taken from the right bank facing upstream.			
US7	Eddison's Creek drains into the Peel River/Chaffey Dam around 3 kilometres upstream of the dam wall	 View of Eddison's Creek at US7, image taken from	Eddison's Creek is a tributary of the Peel River which runs under a road crossing (3 cell box culvert) before it drains into the Peel River. There was also a fence crossing the creek around 20 metres upstream of the crossing. Eddison's Creek was dry at the time of survey indicating that it is an intermittent stream. It had a relatively wide channel, with low sloping banks. The bed of the channel was lined with cobble, pebble and gravel. Some large boulders along the banks would provide adequate stabilisation. There were cattle within the vicinity of the site and evidence of cattle walking within the channel, although there was no	Class 2	2nd order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
		within the creek facing downstream.	evidence of significant erosion as a result.		
DS1	Around 500 metres downstream of the dam wall	 View of the Peel River at site DS1, image taken from the right bank facing upstream.	This Peel River at this site was at medium fill level at the time of the survey and was flowing (5-12 metres wide at water level). The water was clear. The site consisted of a series of deep pools separated by a series of large riffles. There was a large amount of large woody debris at the site. The substrate was dominated by pebbles and gravel. The left bank was steep and the right bank of a low slope. The riparian zones were well vegetated and *C. cunninghamiana* dominated these zones. There was no evidence of erosion as a result of stock access, however, there was some urban rubbish and evidence of a campsite within the channel.	Class 1	3rd order (although flow is artificially controlled)

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
DS2	Tributary which meets the Peel River around 5.5 kilometres downstream of the dam wall	 Unknown tributary, at site DS2, which flows into the Peel River. Image taken from the road crossing facing upstream.	There was a road crossing in the form of a bridge at this site. The channel was relatively narrow (1 to 5 metres wide at water level at the time of the survey). The banks of the channel were moderately sloping and were dominated by grasses and shrubs within the vicinity of the crossing. The riparian zones were populated by trees further upstream and downstream of the site. The silty substrate included small boulders and some cobble scattered along the length of the channel. No instream or emergent vegetation was observed on site, and there was minimal woody debris. There were no riffles at this site.	Class 1	1st order

Site	Description	View	Site Observations	Class of Waterway (according to Fairful and Witheridge 2003)	Stream Order (according to Strahler system)
DS3	Peel River, around 6 kilometres downstream of the dam Wall	 View of the Peel River from a road bridge, facing upstream.	This site was around 12 metres wetted width and varied in depth. The total channel was much wider at up to 40 metres wide. The riparian zones were well vegetated with trees and shrubs, including some exotic species. The water was generally clear with some suspended matter. Upstream of the bridge there was some sediment build-up which has led to stands of reeds establishing. There were no bars within the water at the time of the survey. There was some woody debris, overhanging vegetation and trailing vegetation which provided good instream habitat. The stream was influenced by surrounding urban uses including the road crossing and a public park nearby. There was evidence of cattle access beyond the left bank.	Class 1	3rd order (although flow is artificially controlled)

APPENDIX G BOOROOLONG FROG HABITAT DESCRIPTIONS

Riffle/Rapid Number	Photo	Description	Exposure	FSL
			Shade/Sun	**Inside / Outside**
1		Some flat rocks, slow flowing. Approximately 4 riffles, each 1m x 1m.	Sun	Inside

2		Shaded by casuarinas. Riffle full width of river ~5m. One riffle 5m x 5m; Second riffle 3m long x 1m wide.	Shade	Inside
3		More rapids. Large, partially submerged rocks, fast flowing. Partially shaded by trees. Width of river ~ 5m. Deeper sections.	Partial shade	Inside

				
4		Lots of riffles 2-3m wide within offshoot of Peel River.	Partial shade	Inside

				
5		Main tributary of Peel River. Full width ~5m. Lots of partially submerged boulders. Narrows down to 3m.	Sun	Inside

				
6		Some deep patches. River ~4m wide. Very patchy. Approximately 4 riffles. Slow flowing.	Partial shade	Inside

				
7		4 rapids (2x3m; 1x2m; 0.5x6m; 2x3m). Very deep in between. Very fast flowing and mostly over solid rock, not many submerged rocks. Potentially unsuitable.	Sun	Outside

8	 	Partially submerged rocks and gravel. Slow flowing. 1 rapid (3x1m). Rapid part way downstream. Highly suitable – known habitat. Sheep present. Rapid ~5m wide, 20-25m long.	Partial shade	Inside

				
9		Shallow riffle with very small rocks. Approximately 12m wide x 8m long.	Sun	Inside

10	 	Riffle shallow/light rapid. 5m wide x 10m long. Small partially submerged rocks, no large ones.	Sun	Inside

11		Large boulders in water. Lots of algae. Slow flowing but shallow in places.	Partial shade	Inside
12		Submerged boulders, slow flowing then forms a rapid 6m wide x 5m long.	Partial shade	Inside

				
13		Line of stones (1m long x 12m wide). A small weak rapid ~9m wide x 2m long. No large rocks.	Partial shade	Inside

				
14		Slow-flowing rapid 3m wide x 3m long. Tributary off main river. Mostly larger boulders/rocks.	Partial shade	Outside

15		Small rapid. Not many partially submerged rocks. No gravel. 11m long x 4m wide. Low quality.	Sun	Outside
16		Good riffle, shallow rapid habitat. Full width of river (~8m). Gravel, partially submerged boulders. Partially shaded by Casuarinas. Narrows down to eastern bank (~3m wide). Rapid at WP038. Gravel, but no large partially submerged rocks, just solid rock layer. Gravel riffle at WP039 (from WP038). Slow flowing. Not many larger rocks. Partial shading at very end point (WP039). Full sun back to WP036. 10cm deep full width (WP039), ~9m wide.	Partial shade	Outside

				
17		Two rapids. First rapid ~5m wide. Deep and mostly big boulders. Partially submerged boulders on western banks (~2m wide and 4m long). Probably shaded in afternoon. Casuarina shading second rapid (WP041). 3m wide and continues to WP042 but many large boulders or solid rock. No gravel. Partially shaded at WP042. Poor-mod quality.	Partial shade	Outside

				
18		Very small riffle. Large rocks, boulders . Deep on eastern bank. 2-3m wide.	Partial shade	Outside

19		Small fast flowing rapid. Gravel present in parts. Partially shaded by casuarinas. Probably only 1m width of useful habitat. Deep in sections.	Partial shade	Outside
20		Slow flowing, shallow riffle habitat. Gravel in middle of river ~10m wide. River width ~20m wide. Not many larger rocks. At WP048 narrows down to 4m wide – rocks and gravel. At WP049 narrows down at western bank to ~1m wide. Mostly small rocks.	Sun	Outside

				
21		Some submerged rocks, but with deeper sections. Not much gravel. Shading in afternoon from slope on western bank. River ~ 7m wide. At WP051 very small rapid/riffle. ~4m wide and 7m long. Some gravel. Full sun, but maybe not in afternoon from slope.	Partial shade	Outside

22	 	Intermittent riffles and 1 rapid from solid rocks at WP052. Only 2m wide, then deep pool and a rapid. Lack of loose rocks. Potentially unsuitable.	Sun	Outside

23		Small rapid leading into deep pool. Mostly solid rock and some larger rocks. Full width of river ~6m wide and 3m long. At WP056 deep rapid. Partially submerged rocks on eastern bank. River very narrow ~4m wide. Shaded by casuarinas.	Shade	Outside

24		Small rapid. Solid rock partially submerged. Gravel and rocks but fairly deep. ~5m wide, same as river.	Partial shade	Outside
25		Good riffle habitat. Shallow. Mix of boulders, rocks and gravel. One rapid 2m x 2m. Another rapid 5m wide x 3m long. Partial shading by casuarinas on eastern bank. Full width of river provides habitat ~12-15m. At WP060 narrows down at middle of river, bit deep.	Partial shade	Outside

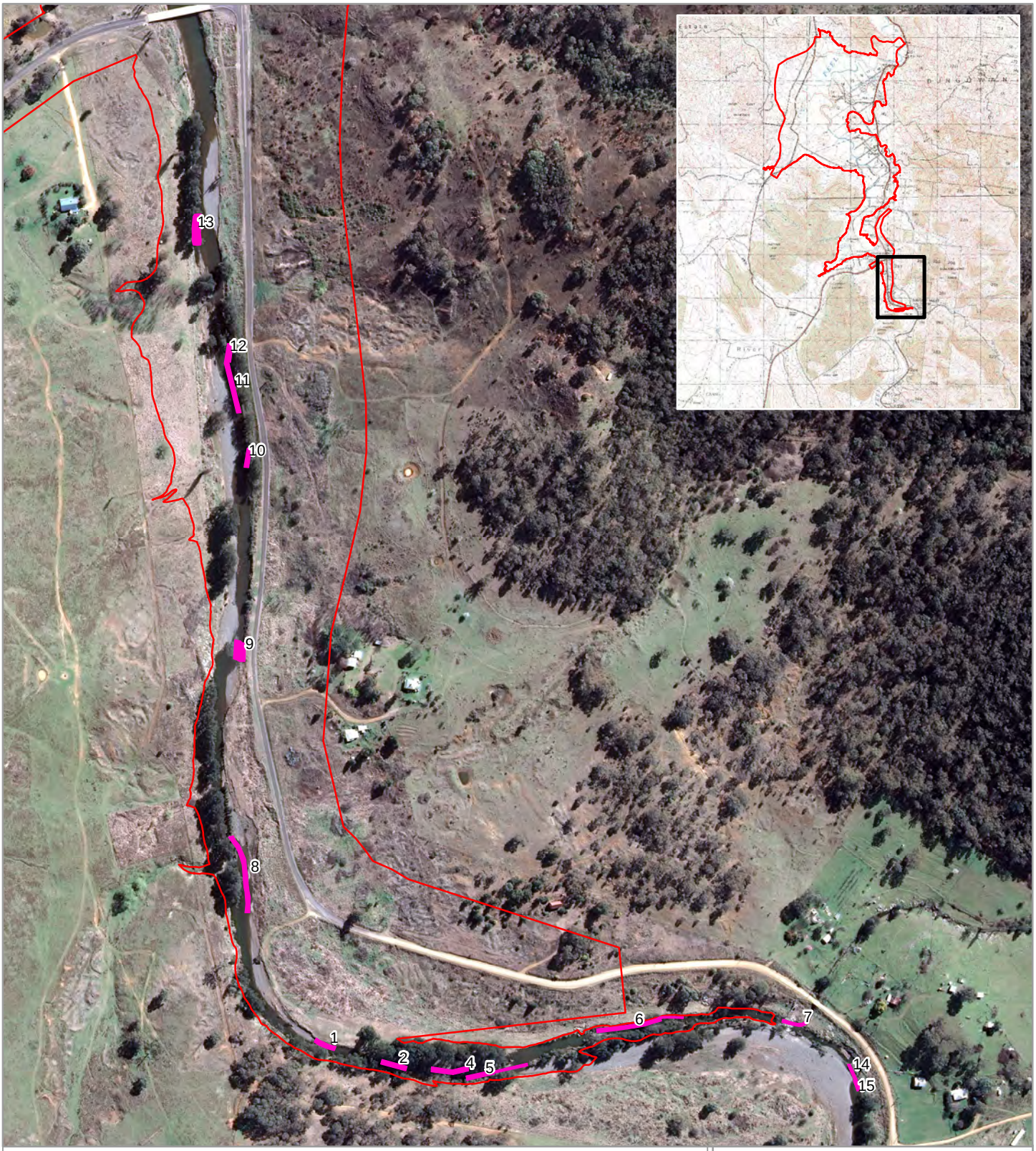
				
26		Very occasional boulders, mostly deeper and slow flowing. Partial shading by 1 large casuarina.	Partial shade	Outside

27	 	Slow flowing riffle habitat. 2x riffles ~ 6m wide. River width ~8m wide. Mostly rocks and some gravel. Partial shading from casuarinas on eastern bank. 2nd riffle ~8m wide (full river width) and 10m long. Partial shading. Goats present. At WP063 and upstream – full sun, slow moving but lots of partially submerged rocks. WP064 3-4 small weak rapids, narrowed down to 5m (full width of river). Good long stretch of potential habitat. Continues ~ 100m upstream.	Partial shade	Outside

APPENDIX H BOOROOLONG FROG HABITAT MAP - DETAILED

Chaffey Dam Augmentation Booroolong Frog habitat (1 of 2)



Legend

- Study area
- Booroolong Frog habitat

Notes:

- Field data collected by nghenvironmental field staff (May and October 2012)
- Base map sourced from ESRI Online © 2010 Microsoft Corporation and its data suppliers
- Aerial photo provided by Worley Parsons May 2012
- Study area digitised by nghenvironmental based on CAD layers supplied by Worley Parsons October 2012

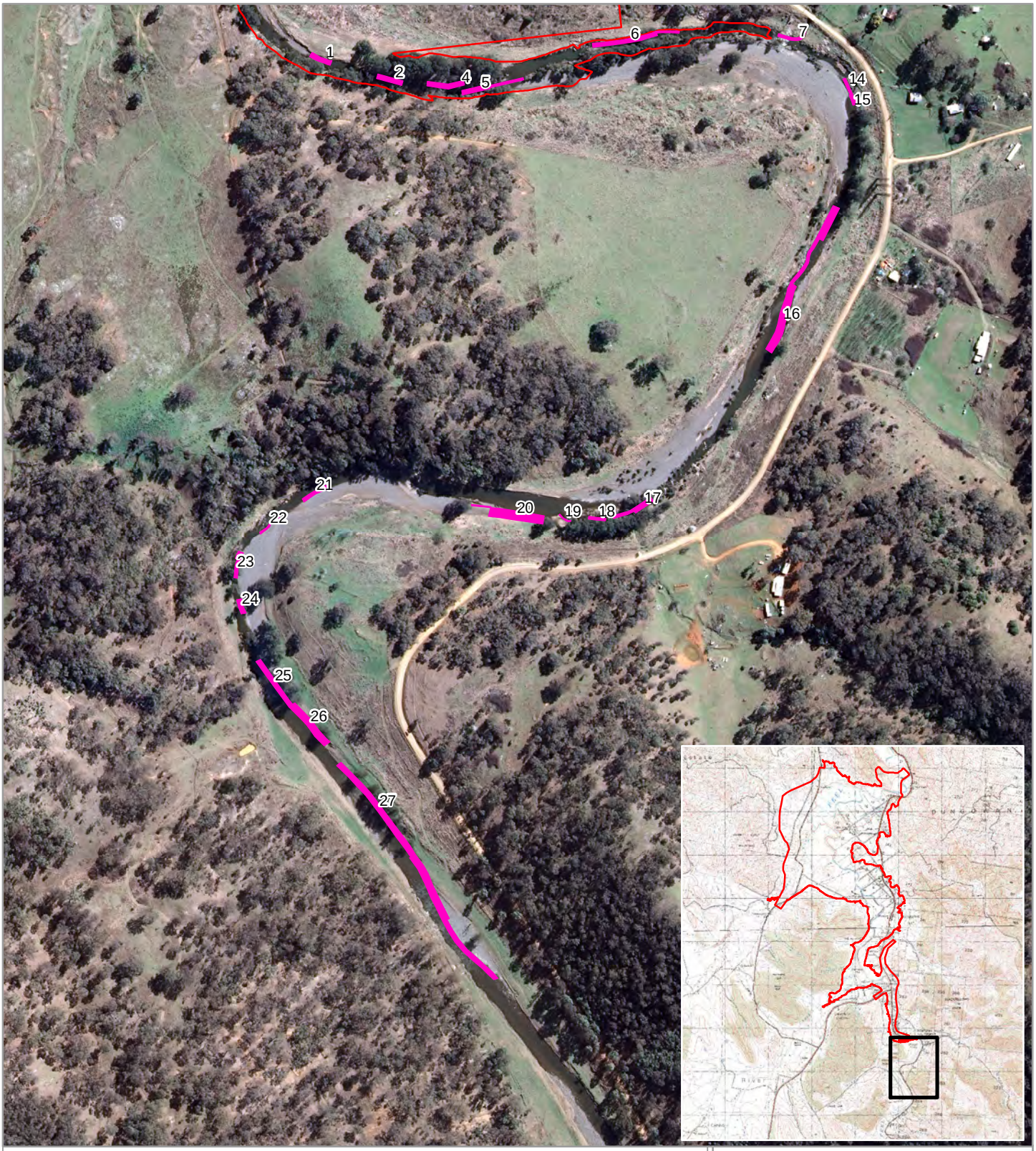
0 50 100 200 Meters

A4 @ 1:6000
Ref: 2400 - 7-1
Author: DM

ngh environmental

www.nghenvironmental.com.au

Chaffey Dam Augmentation Booroolong Frog habitat (2 of 2)



Legend

- Study area
- Booroolong Frog habitat

Notes:

- Field data collected by nghenvironmental field staff (May and October 2012)
- Topographic layer © Topoview 2006
- Aerial photo provided by Worley Parsons May 2012
- Study area digitised by nghenvironmental based on CAD layers supplied by Worley Parsons October 2012

0 50 100 200 Meters

A4 @ 1:6000
Ref: 2400 - 7-2
Author: DM

ngh environmental

www.nghenvironmental.com.au

APPENDIX I OFFSET STRATEGY OUTLINE

I.1 REQUIREMENT TO OFFSET

The DGR's issued for the Project stated that the EIS must address the following specific matters:

"the details of available offset measures to compensate the biodiversity impacts of the proposal where offset measures are proposed, consistent with the Principles for the use of biodiversity offsets in NSW"

The supplementary DGRs issued for the Project state that:

"In the event that impacts cannot be avoided or mitigated, a description of any offsets to compensate for any predicted or potential residual impacts on threatened species and ecological communities. This should be in accordance with the EPBC Act Environmental Offsets Policy and include

i. an assessment of how any proposed offset compensates for the residual impacts on threatened species and ecological communities which remain following avoidance and mitigation measures to be implemented;
ii. the location of any proposed offset;
iii. the timing of the delivery of any offset; and
iv. how the offset will be secured and managed in perpetuity"

The purpose of this appendix is to outline the offset strategy, providing more certainty around:

- How offsets will be identified
- How offsets will be managed
- How offsets will be secured
- How OEH's *Principles for the use of Biodiversity Offsets in NSW* and DSEWPaC's *EPBC Act 1999 Environmental Offsets Policy* are addressed

I.2 IDENTIFYING OFFSETS

The key components in identifying offsets are:

a) Calculating the areas to be impacted
b) Determining a suitable offset ratio
c) Selecting the offset site

I.2.1 Calculating the areas to be impacted (area required to be offset)

The Project will impact upon five native vegetation types, Box-gum grassy woodland, derived grassland, Silvertop Stringybark grassy open forest, River Oak Riparian Woodland and Wetlands and Marshes. The impacts to vegetation communities at the site is quantified and discussed in Section 5.3.1 and 5.4.1 of the Terrestrial and Aquatic Flora and Fauna Impact Assessment and summarised in Table I-1 below. It should be noted that the specific impacts resulting from the construction of the road realignments are unknown and that the area in Table I-1 is that in which development may occur. This is likely to be a gross overestimate of the actual impacts of the Project however, is included here as a worst case scenario.

Table I-1 Summary of impacts to native vegetation communities at the site that would require offsetting

Regional Vegetation Community (RVC)	Area (ha) within construction development envelope	Area to be inundated (ha)	TSC LISTED AREA (ha)	EPBC LISTED AREA (ha)
Box–gum grassy woodlands, Brigalow Belt South and Nandewar (RVC 17)	16(4)*	30 (6)*	46	10 (4+6)
Derived grasslands, Brigalow Belt South and Nandewar (RVC 28)	47	87	134	n/a
Silvertop Stringybark grassy open forests, eastern Nandewar and New England Tablelands (RVC 39)	5	3	n/a	n/a
River Oak Riparian Woodland, eastern NSW (RVC 71)	0	6	n/a	n/a
Wetlands and marshes, inland NSW (RVC 70)	0	0.25	n/a	n/a
TOTAL**	**68**	**126.25**	**180**	**10**

**numbers in parentheses show the EPBC listed component of the community.*

***Total areas do not include existing cleared, disturbed planted or exotic areas*

Impacts to threatened flora species

One threatened flora species Queensland Bluegrass (*Dichanthium setosum*), has the potential to be impacted by the Project. Further surveys for this species need to be conducted to determine if this species occurs at the site and if impacts to this species are likely. Queensland Bluegrass is listed as vulnerable under the EPBC Act. If impacts to this species were to occur then habitat for this species would also need to be offset according to the *EPBC Act 1999 Environmental Offsets Policy.* As it is unknown as to whether impacts to this species may occur, offsetting habitat for this species has not been included within this strategy at this stage.

Impacts to threatened fauna

It is known that the Project will impact upon the habitats of two threatened species listed under the TSC Act, the Booroolong Frog and Border Thick-tailed Gecko. The Booroolong Frog and Border Thick-tailed Gecko are also listed as Endangered and Vulnerable under the EPBC Act respectively. Habitat for these species would need to be offset according to the *EPBC Act 1999 Environmental Offsets Policy.*

I.2.2 Determining a suitable offset ratio

The OEH endorsed BioBanking methodology would be employed in determining the suitability of any proposed offset sites as BioBanking plot data already exists for the study area. The OEH 'Credit Convertor' tool may be used for estimating the offset areas required for the Project however, this tool relies on the outputs of the 'credit calculator' which is yet to be run for this Project. As such, an estimate of a suitable offset ratio cannot be provided. Employing the BioBanking methodology would ensure that

an adequate offset to achieve a 'maintain or improve' outcome for TSC Act listed entities and more common habitat types is realised.

Offset requirements would also need to be assessed against the *EPBC Act Environmental Offsets Policy* to ensure that MNES are adequately represented in any proposed offsets. MNES that will require offsetting by the Project are:

- Box-gum grassy woodland CEEC
- Booroolong Frog
- Border Thick-tailed Gecko

An offsets assessment guide has been produced by SEWPaC which provides an assessment of the suitability of proposed offset areas to offset matters listed under the EPBC Act. The guide requires that data be entered for both the MNES to be impacted and the proposed offset site. A preliminary scenario for offsetting the Box-gum grassy woodland CEEC vegetation to be impacted within the study area was run using the assessment guide based on a potential offset site scenario. This was facilitated by using the average qualities of vegetation surrounding the area to be impacted which may be used as an offset site. In constructing this scenario, the following assumptions were made:

- The vegetation at the offset site would contain the EPBC listed community.
- The quality of the Box-gum woodland vegetation within the study area is 7/10.
- An offset site in similar condition (7/10) could be improved to a level of 8/10 over a period of 5 years.
- That there was no risk of the loss of the offset and that there is 100% confidence in the result.

Incorporating these assumptions, the removal of the 10 ha of this community within the study area would require an offset of approximately 75 ha to completely offset the impacts to the community. It should be noted however, that this calculation is highly dependent on the assumptions above and that in reality there is likely to be at least some risk in losing the offset and some discrepancy in the confidence of the result. The condition of the offset site, the practicalities in its improvement and the timeframe this can occur in are also highly site specific. The information above should be interpreted as a rough guide only. For example if an offset site of poorer quality (5/10) could be improved to a quality of 7/10 with the same assumptions above, then the size of the required offset site would only be 40 ha however, it would require much more intensive management.

Offsets specific to the Booroolong Frog and Border Thick-tailed Gecko will also be required under the *EPBC Act Environmental Offsets Policy*. Potential offset site data specific to the habitat requirements of these species is unknown and as such, it is not possible to run a potential scenario until a suitable offset site is proposed (refer Section I.2.3 below). These offsets would be additional to those determined for the Box-gum grassy woodland CEEC above.

I.2.3 Selecting the offset site

When selecting the offset site (or sites) able to meet the requirements determined by the BioBanking Methodology and the EPBC Environmental Offsets Policy, the proponent will ensure the selected offset site is:

- Not already a type of biodiversity conservation reserve or an existing offset
- Of sufficient size to achieve the requirements
- Of appropriate type to achieve a 'like for like' or 'like for better' offset

- Complying with *Principles for the use of biodiversity offsets in NSW* guidance document

Any areas of ambiguity will be clearly stated so that a decision can be made about the overall suitability of the site. For example, it may be that exact ratios and types are not achieved but the overall package is still considered to achieve an overall neutral or beneficial outcome. If so, this will be identified and justified.

In selecting the offset site, a principle aim will be to offset vegetation containing trees of similar or greater maturity to ensure that habitat for hollow dependant fauna is also adequately offset. Connectivity to surrounding areas of similar vegetation will also be a priority.

If threatened flora species are to be impacted by the Project, it will be ensured that the offset site contains habitat that is suitable for these species.

A specific site has yet to be identified however, there are opportunities for offsetting in a number of areas surrounding Chaffey Dam (refer to Table 5-1 of the Terrestrial and Aquatic Flora and Fauna Impact Assessment). Advice from the proponent indicates that 1000 ha of land outside of the study site is owned by State Water and would be available for negotiation as offsets (Figure I-1). These areas contain vegetation and habitats of a similar type and condition to that which will be impacted by the Project.

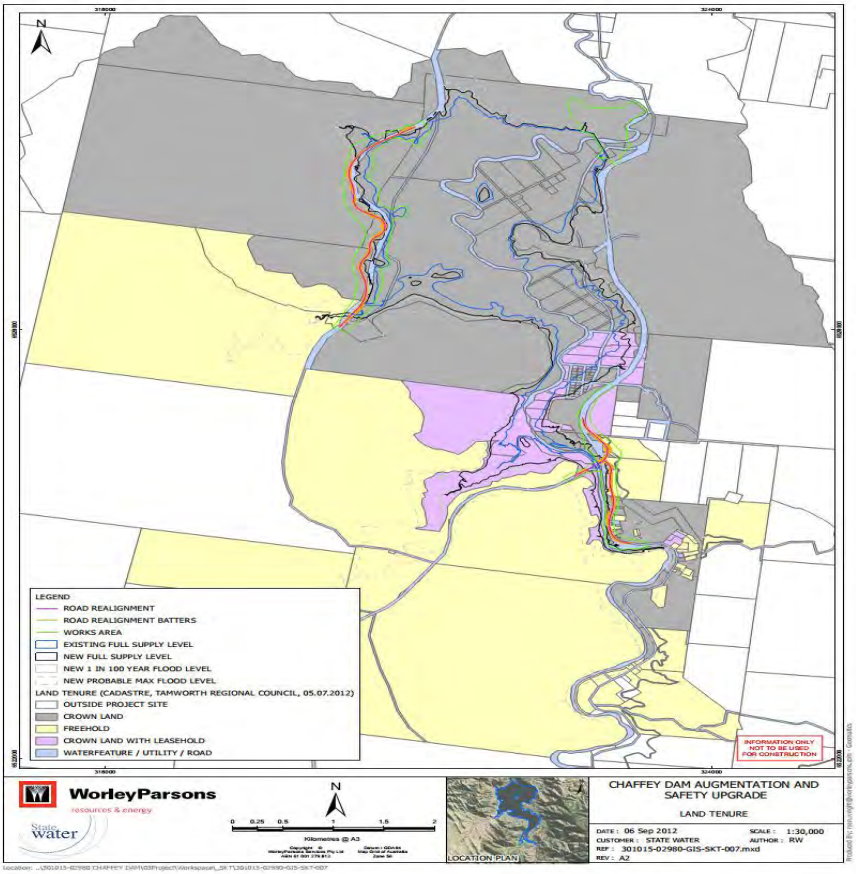


Figure I-1. Land Tenure at Chaffey Dam and surrounds

I.3 MANAGEMENT OF THE OFFSET SITE

It is proposed that the proponent would be responsible for the management of the offset site during the operational life of the dam. The proponent is likely to:

1. Retain or obtain ownership of the offset site or,
2. Finance the landowner of the site to undertake management actions but would retain responsibility for the management of the site.

This provides surety that the actions will be undertaken, as the requirement to offset would be a condition of the proponents consent.

Specific management requirements for the offset site will be developed as part of the offset plan once a site is determined however, the following actions are likely to be required:

- Fencing and signage to ensure the site is protected from inadvertent impacts of nearby agricultural and/or recreational activities.
- A highly controlled light grazing regime (using biomass indicators to ensure adequate ground cover is maintained in all seasons) may be appropriate, if it can enhance native species diversity.
- Controlled burning may be appropriate as a strategy to enhance native seed germination.
- Weed control and monitoring.
- Feral animal control and monitoring.
- Replanting native trees (species to be determined by an ecologist) to enhance landscape connectivity in specific areas.

At the end of the operational life of the dam, the ongoing management would be the responsibility of the landowner. It is expected that by this time the majority of the required management actions would have been undertaken and ongoing management tasks will largely coincide with routine agricultural activities. Land use restrictions will remain in place on the offset site so that any activities undertaken on the offset site must be compatible with the site's overall function: to improve biodiversity values.

For the duration of the project, the success of the management actions would be audited and reported as part of an annual environmental report for the Project.

I.4 IN-PERPETUITY SECURITY OF THE OFFSET SITE

An appropriate management vehicle is required that:

- Secures the site in perpetuity
- Allows for the ongoing management of the site (including how the designated management actions will be funded)

Four options may be considered for securing a long-term management arrangement at the offset site:

- BioBanking agreement (TSC Act , part 7 A)
- Conservation Property Vegetation Plan (CPVP) (Native Vegetation Act)
- Local Environmental Plan: Environmental Zone E2 or E3 (Environmental Planning and Assessment Act)
- Plan of management with S.88b covenant (Environmental Planning and Assessment Act)

It is likely that a Conservation Property Vegetation Plan (CPVP) would be established over the offset area that will be attached to the land title. To ensure that the CPVP is binding on successors in title, an abstract of the CPVP will be registered with the Land and Property Management Authority under the *Real Property Act 1900.* The CPVP would be a legally binding agreement under both the Native Vegetation Act 2003 and the Threatened Species Conservation Act 1995. The CPVP would include management actions associated with the offset area that will apply in perpetuity.

I.5 PRINCIPLES FOR THE USE OF BIODIVERSITY OFFSETS IN NSW

The NSW OEH has provided 13 principles that can be used as a frame work for considering environmental impacts and developing offset proposals. How the Project addresses each of these principles is outlined individually for each one below.

1. Impacts must be avoided first by using prevention and mitigation measures.

Offsets are then used to address remaining impacts. This may include modifying the proposal to avoid an area of biodiversity value or putting in place measures to prevent offsite impacts.

Inundation impacts from the raising of the dam wall are unavoidable. Chaffey Dam provides a critical water resource to the human population of the area and is not considered adequate to meet future demands. The level of the proposed new FSL has been determined based on the calculated future requirements and is only being increased to the level required to meet these requirements.

Measures have been recommended within the Terrestrial and Aquatic Flora and Fauna Impact Assessment to prevent offsite impacts.

2. All regulatory requirements must be met.

Offsets cannot be used to satisfy approvals or assessments under other legislation, e.g. assessment requirements for Aboriginal heritage sites, pollution or other environmental impacts (unless specifically provided for by legislation or additional approvals).

This Offset Strategy aims to satisfy the DGR's for the environmental assessment of the Project. Approvals or assessments under other legislation are not relevant to the Project.

3. Offsets must never reward ongoing poor performance.

Offset schemes should not encourage landholders to deliberately degrade or mismanage offset areas in order to increase the value from the offset.

This can be addressed in two ways:

a. The offset site can be set up in perpetuity – this removes the incentive to degrade the offset site to facilitate development at a later date
b. The management measures can have clear targets and be set out to push most management to the beginning of the agreement, where successful accomplishment of targets would be rewarded by less intensive management in ongoing years. This suits measures such as weed control which are more easily achieved with intensive efforts than with small ongoing efforts.

This strategy proposes to address both aspects, as discussed in Sections I.3 (management) and I.4 (in-perpetuity security) of this strategy.

4. Offsets will complement other government programs.

A range of tools is required to achieve the NSW Government's conservation objectives, including the establishment and management of new national parks, nature reserves, state conservation areas and regional parks and incentives for private landholders.

The offset site has not yet been selected. As discussed in Section I.2.3, it has been established that it cannot be a site already used as a type of biodiversity conservation reserve. The establishment of an offset site on private land contributes to NSW Government's conservation objectives and would complement existing conservation areas.

5. Offsets must be underpinned by sound ecological principles.

They must:

- include the consideration of structure, function and compositional elements of biodiversity, including threatened species
- enhance biodiversity at a range of scales
- consider the conservation status of ecological communities
- ensure the long-term viability and functionality of biodiversity.

Biodiversity management actions, such as enhancement of existing habitat and securing and managing land of conservation value for biodiversity, can be suitable offsets. Reconstruction of ecological communities involves high risks and uncertainties for biodiversity outcomes and is generally less preferable than other management strategies, such as enhancing existing habitat.

These are features that need to be considered in the selection of the offset site as well as the management actions for the site. As set out in Section I.2 of this strategy, the selection of the offset site will consider the ability to enhance landscape connectivity. As set out in Section I.3, it will be managed, subject to a management plan prepared for the offset site specifically. The success of management actions will be monitored and adapted as required to achieve their set objectives.

6. Offsets should aim to result in a net improvement in biodiversity over time.

Enhancement of biodiversity in offset areas should be equal to or greater than the loss in biodiversity from the impact site.

Setting aside areas for biodiversity conservation without additional management or increased security is generally not sufficient to offset against the loss of biodiversity. Factors to consider include protection of existing biodiversity (removal of threats), time-lag effects, and the uncertainties and risks associated with actions such as revegetation.

Offsets may include enhancing habitat, reconstructing habitat in strategic areas to link areas of conservation value, or increasing buffer zones around areas of conservation value and removal of threats by conservation agreements or reservation.

As above, this is incorporated in Sections I.2 and I.3 of this strategy.

7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.

As impacts on biodiversity are likely to be permanent, the offset should also be permanent and secured by a conservation agreement or reservation and management for biodiversity. Where land is donated to a public authority or a private conservation organisation and managed as a biodiversity offset, it should be accompanied by resources for its management. Offsetting should only proceed if an appropriate legal mechanism or instrument is used to secure the required actions.

The offset security for this development is required in perpetuity. This is discussed in Section I.4 of this strategy.

8. Offsets should be agreed prior to the impact occurring.

Offsets should minimise ecological risks from time-lags. The feasibility and in-principle agreements to the necessary offset actions should be demonstrated prior to the approval of the impact. Legal commitments to the offset actions should be entered into prior to the commencement of works under approval.

The strategy sets out a pathway to establish the offset site and its management. This strategy requires input from OEH and landholders prior to any impacts occurring.

The proponent will ensure that all offset arrangements be in order prior to operation. The offset plan will verify that the objectives set out in this strategy have been achieved.

9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated.

Offsets should be based on quantitative assessment of the loss in biodiversity from the clearing or other development and the gain in biodiversity from the offset. The methodology must be based on the best available science, be reliable and used for calculating both the loss from the development and the gain from the offset. The methodology should include:

- the area of impact
- the types of ecological communities and habitat/species affected
- connectivity with other areas of habitat/corridors
- the condition of habitat
- the conservation status and/or scarcity/rarity of ecological communities
- management actions
- level of security afforded to the offset site

The first five points have been addressed in the Terrestrial and Aquatic Flora and Fauna Impact Assessment. The final two points are addressed in Sections I.3 and I.4 of this strategy.

The best available information/data should be used when assessing impacts of biodiversity loss and gains from offsets. Offsets will be of greater value where:

- they protect land with high conservation significance
- management actions have greater benefits for biodiversity
- the offset areas are not isolated or fragmented
- the management for biodiversity is in perpetuity (e.g. secured through a conservation agreement)

Extensive field assessment by experts has ensured that the best information and data has been used in assessing the impacts of the Project. A similar level of detailed assessment would be afforded to the offset site once selected. The definition of the offset site will be done according to Section I.2.3, to ensure like for like (or better) and will consider ways to enhance landscape connectivity. Section I.4 addresses perpetuity.

Management actions must be deliverable and enforceable

The management plan for the offset site is discussed in Section I.3. This guidance information is intended to ensure that the actions achieve their objectives, to improve biodiversity values at the offset site.

10. Offsets must be targeted.

They must offset impacts on the basis of like-for-like or better conservation outcome. Offsets should be targeted according to biodiversity priorities in the area, based on the conservation status of the ecological community, the presence of threatened species or their habitat, connectivity and the potential to enhance condition by management actions and the removal of threats. Only ecological communities that are equal or greater in conservation status to the type of ecological community lost can be used for offsets. One type of environmental benefit cannot be traded for another: for example, biodiversity offsets may also result in improvements in water quality or salinity but these benefits do not reduce the biodiversity offset requirements.

Offsets will be selected based on biodiversity values and achieve a like for like or like for better outcome as outlined in Section I.2.3.

11. Offsets must be located appropriately.

Wherever possible, offsets should be located in areas that have the same or similar ecological characteristics as the area affected by the development.

Current options for offsetting include areas adjacent to the study site. Investigations undertaken within a 1 km radius of the area to be impacted as part of the Terrestrial and Aquatic Flora and Fauna Impact Assessment, suggest that it is likely that the offset site would contain the same or similar ecological characteristics as the areas to be affected by the Project.

12. Offsets must be supplementary.

They must be beyond existing requirements and not already funded under another scheme. Areas that have received incentive funds cannot be used for offsets. Existing protected areas on private land cannot be used for offsets unless additional security or management actions are implemented. Areas already managed by the government, such as national parks, flora reserves and public open space cannot be used as offsets.

This point has been considered in Section I.2.3.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

Offsets must be audited to ensure that the actions have been carried out, and monitored to determine that the actions are leading to positive biodiversity outcomes.

The establishment of the measures outlined in Section I.4 would ensure in-perpetuity security and management for the offset site. Management actions would be shared between the developer (for the life of the impact) and the landowner (post development), as discussed in Section I.3.

I.6 COMMONWEALTH OFFSET POLICY

The EPBC Act Environmental Offsets Policy (EOP) (DSEWPaC 2012) outlines the Australian Government's approach to the use of environmental offsets ('offsets') under the EPBC Act. It replaces the draft policy statement *Use of environmental offsets under the* EPBC Act (2007). This policy relates to all matters protected under the EPBC Act and includes the EPBC listed White Box Yellow Box Blakely's Red Gum Grassy Woodland community that occurs at the site.

Offsets are defined as measures that compensate for the residual adverse impacts of an action on the environment. Where appropriate, offsets are considered during the assessment phase of an environmental impact assessment under the EPBC Act.

The offset principles outlined in the EPBC Act EOP would further guide the development of an Offset Strategy. These principles are presented below.

Suitable offsets must:

1. Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action

The Project will impact on up to 10 ha of vegetation considered to comprise Box-gum grassy woodland CEEC. The areas within 1 km of the study site contain approximately 506 ha of this community providing ample opportunity to deliver an overall conservation outcome that meets the requirements of the offset assessment guide. There are areas of the community within this 1 km radius that are in similar and degraded condition that would enable the Project, through appropriate management measures (such as those outlined in Section I.3), to either maintain or improve the viability of the Box-gum grassy woodland community in the locality.

2. Be built around direct offsets but may include other compensatory measures

Based on the preliminary scenarios run using the offset assessment guide, there is adequate offset area available to provide a 100 % direct offset.

3. Be in proportion to the level of statutory protection that applies to the protected matter

The offsets required for protected matters with higher conservation status must be greater than those with a lower status. For listed threatened species and ecological communities, this is calculated in the Offsets assessment guide by using International Union for Conservation of Nature data on the probability of annual extinction for different categories of threatened species. Based on the preliminary scenarios run using the offset assessment guide, there is adequate offset area available to provide a 100 % direct offset for the level of statutory protection applied to Box-gum grassy woodland CEEC.

4. Be of a size and scale proportionate to the residual impacts on the protected matter

As discussed in point 1. and 2. above, there are sufficient offset areas available of a size and scale proportionate to the residual impacts on Box-gum grassy woodland EEC.

5. Effectively account for and manage the risks of the offset not succeeding

The potential offset areas for Box-gum grassy woodland could provide a 100 % direct offset. It is recognised in the EPBC Environmental Offsets Policy that direct offsets present a lower risk than other compensatory measures as they are more likely to result in a conservation gain for a protected matter. The direct offset will be managed in perpetuity for biodiversity under a legally binding agreement which provides surety of the offset succeeding for the long-term.

6. Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or Territory offsets that may be suitable as offsets under the EPBC Act for the same action, see section 7.6)

An Offset Plan will be produced according to the BioBanking methodology which is a methodology endorsed by the NSW OEH. As stated in the EPBC Environmental Offsets Policy, a state or territory offset will count toward an offset under the EPBC Act to the extent that it compensates for the residual impact to the protected matter identified under the EPBC Act. The potential offset areas for Box-gum grassy woodland could provide a 100 % direct offset. No additional offsets are considered likely to be required to account for any residual impact.

7. Be efficient, effective, timely, transparent, scientifically robust and reasonable

An Offset Plan will be prepared in accordance with the requirements of the NSW OEH. This Offset Plan will provide efficiencies by also satisfying the direct requirements of the EPBC Environmental Offsets Policy.

The Offset Plan will be effective, being implemented immediately after the impact arising from the action.

The Offset Plan will be based on the BioBanking methodology, a scientifically robust and transparent methodology endorsed by the NSW OEH.

8. Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

A Conservation Property Vegetation Plan (CPVP) is recommended within this offset strategy for securing and managing the direct offset. This ensures that the site is protected in perpetuity and that restrictions on land use that apply will be attached to the title, as will management measures.

During the operational life of the dam, the management of the offset site will be auditable through the project's annual report, as the offset is likely to form part of the consent conditions of the approved development.

I.7 CONCLUSION

This Offset Strategy sets out a methodology to identify, manage and secure an offset site in perpetuity to offset the impacts of the augmentation of Chaffey Dam. A site has yet to be identified, but there is adequate land of suitable type owned by State Water which would likely be available for offsetting. This strategy addresses the *Principle for the use of Biodiversity Offsets in NSW* and the *EPBC Environmental Offsets Policy* and provides incentives, in the form of potential offset requirements, for the proponent to further minimise impacts and thereby reduce the offset requirement for the proposal.