



# **Bathurst Regional Council**

## **EIA for Sofala Flood Mitigation Works**

October 2016

# Executive summary

## *Introduction*

The village of Sofala is located approximately 40 km north-east of Bathurst in the Bathurst local government area. The Turon River, a tributary of the Macquarie River runs next to Sofala and results in periodic flooding of the village, including large floods in 1986 and 1990. GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council to prepare an environmental impact assessment (EIA) in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for proposed flood mitigation works ('the proposal').

## *Need for the proposal*

The village of Sofala is subject to flooding from the Turon River which runs through the town. A known cause of the flooding is woody debris blocking the discharge of water under the Crossley Bridge. The bridge has suffered historical damage from the debris.

Previous studies have investigated options to alleviate the flood risk to properties in Sofala from the Turon River. Many of the typical structural or engineered flood risk management options are not considered suitable due to lack of space, excessive cost or lack of community support.

The proposal was selected as the most appropriate option to address the flood risks from the Turon River.

## *The proposal*

The proposal involves the following key aspects:

- Selective thinning of River Oak (*Casuarina cunninghamia*) to reduce the density of native riparian vegetation along two kilometres of riparian zone along the Turon River. The objective of this thinning program would be to maintain a stem density of less than 720 stems per hectare.
- A targeted weed removal and bush regeneration program to improve the condition of retained riparian vegetation.
- Revegetation with a more diverse and suitable species composition in the disturbed area near Crossley Bridge (southern side of the river).

## *Statutory planning context*

State Environmental Planning Policy (Infrastructure) 2007 permits development for the purpose of flood mitigation works carried out by or on behalf of a public authority without consent. The proposal is flood mitigation works and therefore is permitted without consent. That is, the proposal does not require development consent under Part 4 of the EP&A Act.

A proposal can be assessed under Part 5 of the EP&A Act if it may be carried out without development consent and is carried out, or approved, by a determining authority.

Bathurst Regional Council is both the proponent and the determining authority for the proposal under Part 5 of the EP&A Act.

This EIA provides an assessment of the proposal in accordance with Part 5 of the EP&A Act. Other legislation considered in this EIA includes:

- *Environmental Protection and Biodiversity Conservation Act 1999*
- State Environmental Planning Policy 44 – Koala Habitat Protection

- *Threatened Species Conservation Act 1995*
- *Fisheries Management Act 1994*
- *Water Management Act 2000*
- *National parks and Wildlife Act 1979*
- *Heritage Act 1977*
- *Native Vegetation Act 2003*
- *Noxious Weeds Act 1993*

### ***Stakeholder consultation***

Council has undertaken consultation prior to preparation of this EIA to determine what permits are required for the proposal, and whether the departments had any specific concerns about the proposal. The following stakeholders were consulted:

- Fisheries NSW
- Office of Environment and Heritage (OEH)
- Department of Primary Industries – Office of Water
- Department of Planning and Environment
- NSW Environment Protection Authority (EPA)
- Local Land Services (LLS)
- Essential Energy
- Mid-Western Regional Council (Director Mid-Western Operations)
- Mid-Western Regional Council (Director Development and Community Services)
- Bathurst Local Aboriginal Land Council (BLALC)
- Roads and Maritime Services (RMS)
- Telstra
- The Sofala community

The issues raised by stakeholders during consultation have been addressed in the EIA.

### ***Impact assessment***

The EIA has identified that there would not be any significant adverse environmental impacts on the environment or community.

There may be some temporary impacts to noise, air quality and visual amenity related to construction activities, and there would be reduced access to rest and recreational area. These potential impacts would be minor, short term in nature and would be managed by implementing appropriate mitigation measures.

The proposal would result in some minor impacts to flora and fauna during thinning works. Assessments of significance were undertaken for potentially affected biota, and these assessments concluded that impacts would not be significant and that there would be no long term negative effects on ecosystems in the vicinity of the proposal. A number of mitigation measures would also be implemented to minimise the potential for flora and fauna impacts.

The proposal would also result in some localised potential hydraulic and morphologic risks including an increased risk of erosion in the area upstream of Section 1179, a potential for

channel bed aggregation and an increased flooding risk for buildings adjacent to the Turon River approximately 200 to 300 metres upstream of the Crossley Bridge. However a monitoring program would be implemented to assess the morphological responses and risks would be managed through the implementation of a number of mitigation measures.

A construction environmental management plan would be prepared and implemented during the works which captures the mitigation measures proposed in this EIA. Implementation of these mitigation measures will reduce the potential impacts arising from the proposal.

### ***Conclusion***

This EIA has been prepared in accordance with part 5 of the EP&A Act. The assessment identified that the proposal would result in the potential for minor impacts. However, the assessments undertaken as part of the EIA confirm that with the implementation of the proposed mitigation measures, the identified potential proposal impacts are unlikely to be significant and therefore no EIS or EPBC Act referral is required.



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# 1. Introduction

## 1.1 Overview

The village of Sofala is located approximately 40 km north-east of Bathurst in the Bathurst local government area. The Turon River, a tributary of the Macquarie River runs next to Sofala and results in flooding of the village, including large floods in 1986 and 1990. GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council to prepare an environmental impact assessment in accordance with Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) for the proposed flood mitigation works. This is referred to as 'the proposal' for the purposes of this document.

Previous studies have investigated options to alleviate the flood risk to properties in Sofala from being flooded by the river. It is understood that many of the typical structural or engineered flood risk management options are not considered suitable for Sofala due to lack of space, excessive cost or lack of community support. Options were considered (discussed in Section 2.3), and the proposal was chosen as it best meets the objectives of the project (discussed in Section 2.2). The proposal involves the following key aspects (discussed further in Section 3):

- Selective thinning of River Oak (*Casuarina cunninghamia*) to reduce the density of native riparian vegetation from two kilometres of riparian zone along the Turon River. The objective of this thinning program would be to maintain a stem density of less than 720 stems per hectare throughout the study area.
- A targeted weed removal and bush regeneration program to improve the condition of retained remnant vegetation.
- Revegetation with a more diverse and suitable species composition in the disturbed area near Crossley Bridge (southern side of the river).

The following terms are used in this environmental assessment:

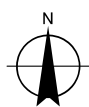
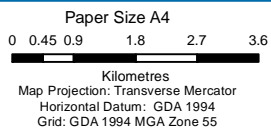
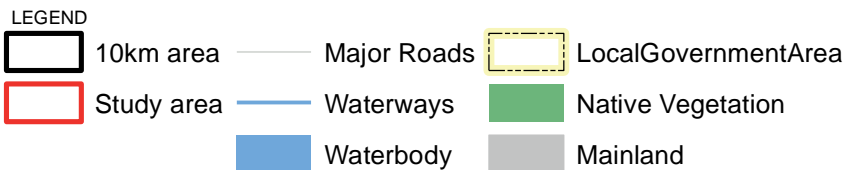
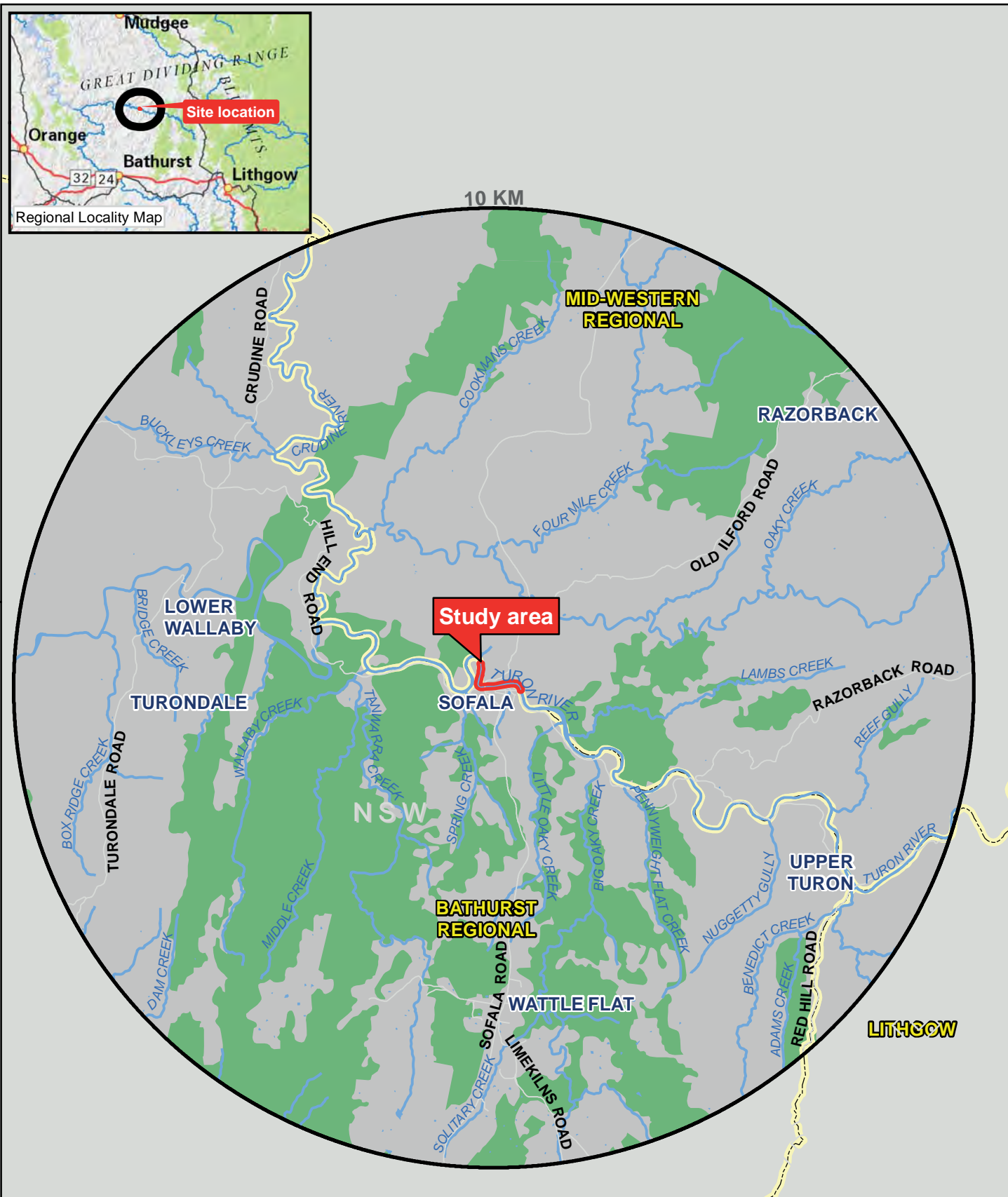
- *The proposal*: proposed flood mitigation works at Sofala, including thinning of vegetation along the Turon River and revegetation.
- *Subject site*: the area of land directly impacted by the proposal, extending approximately 1,500 metres upstream and 500 metres downstream of the Crossley Bridge at Sofala.
- *Study area*: the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.

Bathurst Regional Council is a public authority, and as such is a determining authority under Part 5 of the Act. Under section 111 of the EP&A Act, Bathurst Regional Council (hereby referred to as 'Council') is responsible for assessing all matters affecting or likely to affect the environment from this activity. This report provides an assessment of the potential environmental impacts associated with the proposal.

Council has consulted relevant stakeholders to determine permit requirements and specific project concerns. In summary, local authorities generally support the proposal, as discussed in Section 5.

The potential impacts of the proposal have been considered in accordance with the scope and method of work proposed and the matters listed in clause 228 of the *Environmental Planning and Assessment Regulation 2000* (summarised in Appendix A of this EIA).

This report specifies the measures that would be implemented to avoid or reduce potential environmental impacts from the proposal.



Sofala Flood Mitigation Project  
 Bathurst Regional Council

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Regional location

Figure 1.1





**Figure 1.2 The proposal**



## 2. Need and alternatives

### 2.1 Proposal background and proposal need

The village of Sofala is subject to flooding from the Turon River which runs through the town. A known cause of the flooding is woody debris blocking the discharge of water under the Crossley Bridge. The bridge has suffered historical damage from the debris.

An initial flood scoping study was undertaken in 2003 (SMEC, 2003). Incorporated into the scoping study was a public participation session in the form a public meeting held in Sofala for the local community to raise their concerns. Three areas of concern (documented by Cardno Willing, 2007) were raised at the initial public meeting, being:

- Vegetation growth and the build-up of gravel within the river bed are viewed by the community as the major cause of flooding in Sofala.
- The road bridge (Crossley Bridge) and its approaches may be an obstruction to flow.
- Debris collecting on the bridge may exacerbate flooding.

Following the initial report, other studies of significance have been commissioned including:

- “Sofala Floodplain Risk Management Study, Prepared for the Bathurst Regional Council, Final Report,” *Cardno Willing, 2007*.
- “Sofala Floodplain Risk Management Plan” Bathurst Regional Council, 2008.
- “Bathurst Regional Council – Sofala Vegetation Management Plan” GHD 2011.
- “Bathurst Regional Council – Sofala Works Implementation Plan” GHD 2012.
- “Bathurst Regional Council – Sofala Flood Mitigation Project Hydraulic and Geomorphic Impact Assessment” GHD 2015.
- “Bathurst Regional Council – Sofala Flood Mitigation Project Ecological Impact Assessment” GHD 2015.

The Sofala Floodplain Risk Management Study (Cardno Willing, 2007) recommended the removal of River Oaks (*Casuarina cunninghamia*) along the river as the most efficient method to manage flood risks to the Sofala community. The study recommended the removal of River Oaks in the immediate upstream vicinity of the Crossley Bridge, so as to help mitigate structural damage to the bridge during large flooding events (Cardno Willing, 2007). GHD (2011) recommended that the River Oaks be thinned to maintain a stems per hectare ratio that would be at the lower end of the benchmark for that vegetation type. This allows for a more balanced outcome by reducing the impact of flooding and also maintaining a functioning ecosystem.

### 2.2 Project objectives

The objectives of the project are to:

- Minimise the potential for flooding in the village of Sofala during high flow levels in the Turon River;
- Reduce the build-up of material at the Crossley Bridge during high river flow events;
- Minimise impacts on the environment and properties; and
- Integrate with the current and future character of the area.

## **2.3 Identification and analysis of alternatives**

Based on the nature of flooding as identified by past modelling, and on community consultation, a range of suitable management options were identified (Cardno, 2007). These are summarised below.

### **2.3.1 Option 1 - Do nothing**

#### *Identification*

The 'do nothing' option involves not undertaking the proposal.

#### *Analysis*

Option 1 (do nothing) would not meet the objectives of the proposal. It would involve retaining a riparian zone which would slow water flow in the study area and increase the accumulation of debris under the Crossley Bridge, considered to be a major contributing factor of flooding during high-flow events.

### **2.3.2 Option 2 – Construction of levee banks**

#### *Identification*

Option 2 involves the construction of levees or flood walls along the river.

#### *Analysis*

This option was not considered to be a viable management option as there is insufficient land to accommodate a levee or flood wall on the south bank of the river. This option would also impact on the heritage character of the village.

### **2.3.3 Option 3 - Construction of detention basins**

#### *Identification*

Option 3 involves construction of a detention basin upstream of Sofala.

#### *Analysis*

This option was not considered to be a viable option since to be of any significant benefit, the basin would have to take the form of a large dam upstream of the village. The limitations of detention basins in this situation are as follows:

- Very high cost, which could not economically be justified,
- Impacts on upstream landowners, as to be effective the basins would need to occupy a large land area, and
- The Office of Environment and Heritage does not support the use of on-line basins on major watercourses due to their ecological impact.

### **2.3.4 Option 4 – Replacement of Crossley Bridge**

#### *Identification*

Option 4 involves replacing the Crossley Bridge.

### *Analysis*

This option was not considered viable due to its high cost. The concrete bridge is aging however is in a fair to average condition. However, when it does require replacement, the opportunity should be taken in the design to reduce its risk of blockage and hydraulic impact on surrounding properties.

### **2.3.5 Option 5 – Thinning of vegetation**

#### *Identification*

Option 5 involves a recommendation from the Sofala Floodplain Risk Management Study (Cardno Wiling 2007) that a 'thinning' of vegetation (native and introduced) within the riparian corridor would reduce flooding impacts in large events.

#### *Analysis*

Option 5 maximises use of the existing and future character of the area and minimises property and community impacts. It would have a comparatively lower impact on private properties and utility services. The option was also considered to be the most cost effective option.

### **2.4 Preferred option ('the proposal')**

Option 5 was selected as the preferred option as it is considered to best meet a number of the objectives of the proposal.

Thinning would reduce the hydraulic roughness of the main channel and over the banks, thereby reducing flood levels.

## 3. Description of the proposal

### 3.1 Location and site description

The subject site is located in the Village of Sofala. The township of Sofala is located approximately 42 kilometres north of Bathurst and is located within the Bathurst local government area (refer Figure 1.1). The subject site is defined as the riparian zone of the Turon River from Golden Point, 1,500 metres upstream of the Crossly Bridge at Sofala to 500 metres downstream of the bridge.

The planning and cadastral details of the subject site are provided below in Table 3.1.

**Table 3.1 Legal description**

Attribute	Description
Title information	Lot 7021 DP1124360 and various strips of Crown Land with no Lot and DP number
Ownership	Bathurst Regional Council and Mid-Western Regional Council
Location	Sofala, NSW
Total area	Approximately 2,000 metres of riparian land
Zoning	Bathurst Regional Local Environmental Plan 2014 and Mid-Western Regional Local Environmental Plan 2012 - RU1 – Primary production

The Turon River is a tributary of the Macquarie River and has a gravel bed from which casuarinas and some exotics grow (shown on Figure 3.1). The southern bank of the subject site is owned and maintained by Bathurst Regional Council. The northern bank is owned and maintained by the Mid-Western Regional Council.

The upstream catchment of the Turon River comprises largely forest and rural areas. The Turon River has a history of flooding and the largest recorded flood occurred in August 1986. During this event, a large build up of debris occurred in the vicinity of the bridge.

The subject site is accessible via the surrounding local roads, including Deniston Street, Sofala Road and Hill End Road. The subject site has a moderate slope towards the river. The closest sensitive receivers are residential properties located approximately 20 metres north of the southern bank.



**Figure 3.1 View of the Turon River (facing east on the northern bank)**

### **3.2 Key construction activities**

The proposal comprises the key activities:

1. **Erection of safety fencing.** Safety fencing would be installed around the whole site prior to thinning works commencing.
2. **Seed collection.** A seed collection licence would be obtained once the contractor has been appointed. Prior to vegetation removal, seeds of target species will be collected in accordance with *Florabank Guideline 6 – Native Seed Collection Methods*.
3. ***Casuarina cunninghamiana* thinning.** Selective thinning of *Casuarina cunninghamiana* (River Oak) will be completed in the riparian zone, concentrating on area upstream (north) of the Crossley Bridge where stem densities are above 720 stems per hectare. The works will be staged over 10 weeks (2 days per week) with up to eight people on site at any one time as follows, and begin in spring:
  - Works will commence in the upper most limit of the study area, upstream of the Crossley Bridge.
  - Delineate areas to be worked over the allocated time. Spring is suggested, when the growth of new seedlings and saplings is high and when chance of rain is lower. This allows for natural regeneration to occur over spring.
  - Delineated areas will have to be calculated to maintain the benchmark stem count for the River Oak. Depending on the contractors chosen approach to the proposal, it is anticipated that the work areas will be divided into 0.5 hectare areas (of 360 stems).
  - Select trees with a diameter at breast height of less than 20 centimetres within the delineated area (cell) by flagging these with high visibility tape.

- Cells would be developed in a matrix such that no two cells are side by side or are opposite each other on opposite sides of the bank. This would avoid erosion.
  - No works would be completed if it is raining, or post heavy rain events.
4. **Erection of temporary fencing.** After thinning of River Oaks, temporary fencing would be installed around recently worked area to prevent stock access and to delineate area where traffic should be limited to prevent further erosion.
  5. **Native seed dispersal.** Native seeds would be dispersed after the thinning works, by casting out seeds by hand in areas where there is bare soil. Where possible, seeds would be dispersed after rainfall (approximately two days of rainfall to allow adequate soil moisture), at a depth of no less than five millimetres. Hand broadcasting larger seeds or those with awns that bury into the soil (i.e. *Microlaena stipoides*) and in areas where there is a layer of surface mulch will offer greater success rates. Broadcast seed can be lightly buried by raking or harrowing to improve the connectivity between the soil and the seed.
  6. **Removal of willows.** Willows would be selectively removed in the upper section of the study area and downstream of the bridge for approximately 500 metres. Willows would be removed from the inside bends of the river, which are more stable. A similar method of willow removal would occur as for the river oak thinning, to minimise the bank becoming unstable.

Trees identified as 'seed' producing trees would be tagged with conspicuous plastic ribbon that can withstand flooding and grazing animals. Most seed producing trees flower between September and November, and as such, surveys would be completed during this time.

The following control methods would be followed:

- Hand pulling of seedlings less than 0.5 centimetres in height
- Chainsaw saplings off at the base and apply selective herbicide to cut
- Stem injection of large trees. Make cuts into sapwood approximately 20-30 millimetres deep and inject with selective herbicide.
- Leave willow trees in situ for approximately 12 months to ensure successful kill and allow for other naturally regenerating/hand planted/hand broadcast native species to establish.

All seedlings, branches and twigs would be bagged and taken off-site to be disposed of so that sprouting does not occur. Trees would be removed from site and taken to an appropriately licenced facility for recovery or disposal.

Machinery would be excluded from the river bed and within three metres of the banks. In these areas, thinning of trees would be undertaken by hand. Mobile plant would be used for removal of large tree trunks. Root balls would be retained which would reduce the risk of disturbance of sediments and maintain stability of the creek banks.

7. **Targeted weed control.** Listed noxious weeds would be controlled through an integrated weed control program which includes physical and chemical control. Treatment would occur in late summer / early autumn, and would be completed over four weeks, three days a week, with a team of four. Target weed control will be concentrated in areas of high weed infestation, with the focus east of the Crossley Bridge.
8. **Bush regeneration.** A structured bush regeneration program will be implemented along sections of the river, concentrating on follow-up treatment of willows, noxious weeds as listed in the VMP and areas of environmental weeds. The majority of the program will focus



on the control of perennial and annual weeds. The subject site has only scattered specimens of woody weeds, with greatest densities being west of the Crossley Bridge and these will be treated as part of the target weed control activities. Weeds to be targeted include large woody weeds such as Large-leaved Privet and Blackberry and a variety of other herbaceous weeds, including Cobblers Peg, Hemlock, Bridal Creeper and Fleabane.

The bush regeneration program for the subject site would be completed as follows:

- Hand weeding, with minimal soil disturbance (as other weeds will quickly redistribute themselves when the soil is disturbed). Plants with bulbous or truncated roots these can be levered out with appropriate tools to remove the whole plant.

All plant material would be bagged and taken off site or left in a mulch pile to gradually break down. The location of the pile would be located away from the river.

- Herbicide treatment would involve
  - Backpack spraying with appropriate herbicide
  - ‘Cut and paint’ technique of applying appropriate herbicide to base of plant
  - Stem injection (as per Willows) on larger plants.
- Primary bush regeneration will be concentrated in areas of high weed infestation, with the focus east of the Crossley Bridge.
- Secondary bush regeneration will occur throughout the subject site, with a focus on areas already worked and areas where river oak thinning has taken place.

In order to accurately evaluate the success of the restoration works, GHD recommends an initial report be prepared at ‘Practical Completion’ of the works and then summary reports be prepared annually throughout the maintenance period.

### **3.3 Construction plant and equipment**

A range of plant and equipment would be used during construction. The final equipment and plant requirements would be determined by the construction contractor. An indicative list of plant and equipment is provided below:

- Tipper trucks for delivery of equipment and removal of trees and vegetation.
- Backhoe or excavator to remove trees and vegetation.
- Hand tools for removal of trees and vegetation from the river bed and within three metres of the banks.

Machinery would be excluded from the river bed and within three metres of the banks and so felling of trees would be carried out by hand to minimise ground disturbance in these areas. Small mobile plant and equipment would be used outside these area as well as to remove felled trees from the subject site. Access would be via an existing access track within the Sofala township on the southern side of the river and where possible, existing access tracks on the northern side of the river.

#### **3.3.1 Construction hours**

Construction would be completed during standard construction working hours in accordance with the EPA *Interim Construction Noise Guideline* (DECC, 2009), being Monday to Friday: 7 am to 6 pm. No works would be completed on weekends or public holidays.



### **3.3.2 Construction workforce**

It is anticipated that a workforce of approximately eight people would be required during construction. This number would be confirmed by the construction contractor.

### **3.3.3 Timing**

It is estimated that the River Oak thinning works would take approximately ten weeks to complete. This would be confirmed by the construction contractor. Removal of willows would take place as part of the target weed control program and occur over four weeks in Summer/early Autumn.

## 4. Statutory planning context

The EIA for Sofala has been prepared in accordance with the provisions contained in relevant legislation and policy guidelines, including but not limited to the following:

### 4.1 Commonwealth legislation

#### 4.1.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' undergo an assessment and approval process. Under the EPBC Act, an action includes a proposal, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things (DotE, 2013). An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Australian Government Environment Minister (the minister).

The EPBC Act identifies Matters of National Environmental Significance (MNES) as:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mining).
- A water resource, in relation to coal seam gas development and large coal mining development.

Other matters protected include:

- The environment, where actions proposed are on, or will affect Commonwealth land and the environment
- The environment, where Commonwealth agencies are proposing to take an action.

All of these factors have been considered (refer Section 6.1 and Appendix A) and they do not apply to the proposal and/or no significant impact is considered likely. Therefore, an EPBC Act referral is not required.

### 4.2 NSW legislation

#### 4.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environmental Planning and Assessment Regulation 2000* (the Regulation) provide the statutory basis for planning and environmental assessment in NSW. The EP&A Act and the Regulation provide the framework for environmental planning and development approvals, and include provisions to

ensure that the potential environmental impacts of a development are assessed and considered in the decision making process.

The EP&A Act contains three parts that impose requirements for planning approval. These are generally as follows:

- Part 4 provides for control and assessment of local, regional or State significant development that requires development consent.
- Part 5 provides for control and assessment of 'activities' that do not require development consent or the approval of the Minister for Planning.
- Part 5.1 provides for control and assessment of State significant infrastructure.

The need or otherwise for development consent is set out in environmental planning instruments – State environmental planning policies (SEPPs) and local environmental plans (LEPs).

Further information on these and other potentially relevant SEPPs is provided below.

As discussed in Section 4.3.1, State Environmental Planning Policy (Infrastructure) 2007 permits development for the purpose of flood mitigation works carried out by or on behalf of a public authority without consent. The proposal is flood mitigation works and therefore is permitted without consent. That is, the proposal does not require development consent under Part 4 of the EP&A Act.

Under Section 111 of the EP&A Act, Council is required to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of its activities.

Under Section 112 of the EP&A Act, Council is not carry out an activity, or grant an approval in relation to an activity, being an activity that is a prescribed activity, an activity of a prescribed kind or an activity that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, unless Council considers the impact is likely to be significant, an EIS is required.

Clause 228 of the EP&A Regulation identifies factors to be considered by Council in order to assess the likely impacts of the project on the natural and built environment in producing the EIA. Clause 228 factors are discussed in Appendix A.

Provided the mitigation measures outlined in this EIA are implemented, the proposal is unlikely to have a significant impact on the environment and is unlikely to result in a significant impact on threatened species, population or ecological communities

#### **4.2.2 Local Environmental Plans**

The *Bathurst Regional Local Environmental Plan 2014* (Bathurst LEP) is the relevant local environmental plan for land south of the Turon River (including Sofala) and the *Mid-Western Regional Local Environmental Plan 2012* (Mid-Western LEP) north of the River. The subject site is zoned RU1 Primary Production in both Council areas.

The RU1 Primary production zone generally aims to:

- To encourage sustainable primary industry production by maintaining and enhancing the natural resource base.
- To encourage diversity in primary industry enterprises and systems appropriate for the area.

- To minimise the fragmentation and alienation of resource lands.
- To minimise conflict between land uses within this zone and land uses within adjoining zones.

The permissibility of the proposal is shown on Table 4.1. Note that owing to the action of ISEPP, the permissibility of the works outlined in the table below is not relevant to the ability of Council to determine and implement the project.

**Table 4.1 LEP permissibility**

Permissibility	Bathurst LEP	Mid-Western LEP
Flood mitigation works	Permitted with consent	Permitted with consent
Environmental facility (including walking track)	Permitted with consent	Permitted with consent

Clause 5.12 of both local environmental plans states that the local environmental plans do not restrict or prohibit, or enable the restriction or prohibition of, the carrying out of any development, by or on behalf of a public authority, that is permitted to be carried out with or without development consent, or that is exempt development, under *State Environmental Planning Policy (Infrastructure) 2007* (as discussed in Section 4.3.1). As the proposal is permitted without consent in accordance with *State Environmental Planning Policy (Infrastructure) 2007*, the consent provisions of the local environmental plans do not apply and the proposal will be assessed under Part 5 of the EP&A Act with Bathurst Regional Council as the determining authority.

The majority of the subject site is mapped as groundwater vulnerable under the Bathurst LEP.

### 4.3 Environmental planning instruments made under the EP&A Act

#### 4.3.1 State Environmental Planning Policy (Infrastructure) 2007 (ISEPP)

The Infrastructure SEPP clarifies the consent arrangements for infrastructure projects. Clause 49 of the Infrastructure SEPP permits development for the purpose of ‘flood mitigation work’ which includes work ‘...*designed and constructed for the express purpose of mitigating flood impacts.... Types of works may include excavation, construction or enlargement of any fill, wall or levee that will alter riverine flood behaviour, local overland flooding, or tidal action so as to mitigate flood impacts.*

The proposal involves thinning trees along the riverbank in Sofala to reduce local overland flooding, and as such meets the above definition.

Clause 50(1) of ISEPP states that *development for the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land.* As such, under ISEPP, the proposal is permitted without consent and therefore it can be assessed under Part 5 of the EP&A Act and Bathurst Regional Council will be the determining authority.

Part 2 Division 1 outlines the requirements for consultation with Council and other public authorities. As Bathurst Regional Council is the determining authority, clauses 13-15 do not apply, pursuant to clause 17 of ISEPP.

Consultation with Bathurst Regional Council on local heritage items is not required given that no impacts are expected to occur on heritage items. Refer to section 5 for more information on consultation and section 6.9 for impacts on heritage.

### **4.3.2 State Environmental Planning Policy 44 Koala Habitat Protection (SEPP 44)**

The purpose of SEPP 44 is to encourage the conservation and management of koala habitat to ensure permanent, free living populations are maintained over their present range. Under the policy, consent for a development cannot be issued without an investigation for core koala habitat. SEPP 44 provides a State-wide approach ensuring appropriate development can continue, while protecting koalas and their habitat.

SEPP 44 applies to the Bathurst LGA and therefore the provisions of SEPP 44 have been considered in the EIA. Koalas may be present in Sofala and may feed on trees present along the riparian corridor. No eucalypts trees would be removed during construction. The Ecological Impact Assessment (Appendix B) summarised in Section 6.1 considered koalas unlikely to be impacted by the proposal.

## **4.4 Other considerations**

### **4.4.1 Threatened Species Conservation Act 1995 (TSC Act)**

The TSC Act is administered by the OEHS and provides for the protection of threatened species, populations, ecological communities and their habitat, and critical habitat within NSW. The primary aims of the TSC Act are to protect, conserve and, where applicable, manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities. Schedules 1 and 2 of the Act list threatened species, populations and ecological communities that are classified as endangered or vulnerable.

An Ecological Impact Assessment was completed and identified no threatened ecological communities are present in the subject site or study area, and no threatened flora species listed under the TSC Act are likely to occur (see Section 6.1, Appendix B).

### **4.4.2 Fisheries Management Act 1994 (FM Act)**

The FM Act provides for the conservation of the State's aquatic resources and is administered by the Department of Primary Industries. The Act requires that potential impacts on threatened species and aquatic habitat be addressed during the environmental planning and assessment process.

The proposal would not comprise dredging, would not temporarily or permanently block fish passage, and would not impact any marine vegetation listed under the FM Act.

The removal of snags is considered 'dredging' under the FM Act and public authorities are required to notify the Minister of any proposal to remove or relocate snags, in particular fallen trees or rocks. In order of preference, DPI prefers lopping of snags, realignment of snags and finally relocation of snags. The proposal is unlikely to result in desnagging or disturbance of snags. Some fallen trees may be removed from within the riparian vegetation which may act as snags during high flow periods or during floods.

### **4.4.3 Water Management Act 2000 (WM Act)**

The WM Act controls the carrying out of activities in or near water sources in NSW. 'Water sources' are defined very broadly and include any river, lake, estuary or place where water occurs naturally on or below the surface of the ground, and NSW coastal waters.

Under section 91E(1) of the WM Act, it is an offence to harm waterfront land. 'Waterfront land' is defined as land within 40 metres of a river, lake, estuary or shoreline. A river includes 'any

watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved’.

The *Water Management (General) Regulation 2011* sets out a number of exemptions in relation to controlled activities (*Water Management (General) Regulation 2011* Part 3, Division 2, Subdivision 4). A public authority is exempt from section 91E (1) of the Act in relation to all controlled activities that it carries out in, on or under waterfront land.

Notwithstanding the exemption from obtaining a controlled activity approval, the Ecological Impact Assessment has taken into account the objectives and principles of the WM Act. The proposal would ensure that the quality of riparian vegetation is improved in the long term, which in turn would improve water quality. Mitigation measures provided in Section 6.1 would be implemented to ensure that potential impacts on the environment would be minimised.

#### **4.4.4 National Parks and Wildlife Act 1979 (NPW Act)**

The NPW Act provides the basis for the legal protection of native animals and plants in NSW. A wildlife licence is required under the NPW Act to harm or pick protected fauna and flora. All surveys were carried out under a Section 132C scientific licence (SL100146).

The *National Parks and Wildlife Act 1974* (NPW Act) provides the basis for the legal protection and management of Aboriginal sites and objects in NSW. The implementation of the Aboriginal heritage provisions in the Act is the responsibility of the NSW Office of Environment and Heritage. The NPW Act was amended in 2010 with the major changes relating to due diligence and liability associated with impacts on items of Aboriginal heritage significance.

The NPW Act includes a strict liability offence relating to harming Aboriginal objects and there are a number of defences against prosecution for this offence, including the statutory defence of due diligence, which can include compliance with an adopted industry code of practice. The need to follow a due diligence process is removed if the proponent is carrying out a low impact activity as defined in the *National Parks and Wildlife Regulation 2009*.

Assessment of the subject site was undertaken in line with the *Due Diligence Code of Practice* (DECCW 2010). The assessment Appendix C (undertaken by Bathurst Local Aboriginal Land Council) concluded the subject site was not in a high risk area and that impacts were unlikely and that further assessment was not required. As a result of the abovementioned assessments, it was determined that there was no need to apply for an Aboriginal Heritage Impact Permit for the subject site.

#### **4.4.5 Heritage Act 1977**

The *Heritage Act 1977* was introduced to conserve the environmental heritage of NSW. Environmental heritage is defined as including buildings, works, relics or places which are of historic, scientific, cultural, social, archaeological, architectural, natural or aesthetic significance to the State.

Heritage places and items of particular importance to the people of NSW are listed on the NSW State Heritage Register. There are no State Heritage items (or items listed on the section 170 register) located in the subject site.

Section 139 of the *Heritage Act 1977* prohibits a person from disturbing or excavating any land on which the person has discovered or exposed a relic, except in accordance with an excavation permit or a notification granting exception for the permit. There are no known relics within the subject site.

#### **4.4.6 Native Vegetation Act 2003 (NV Act)**

The NV Act was established to regulate the clearing of native vegetation in NSW apart from the Sydney Basin. The main objectives of the NV Act are:

- to provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State,
- to prevent broad scale clearing unless it improves or maintains environmental outcomes,
- to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation,
- to improve the condition of existing native vegetation, particularly where it has high conservation value,
- to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation, in accordance with the principles of ecologically sustainable development.

One native vegetation type is present in the study area: River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions. The proposal does not constitute clearing of native vegetation. Vegetation management measures as part of a CEMP would minimise impacts on native vegetation and to improve the condition of currently disturbed areas (discussed in Section 6.1).

#### **4.4.7 Noxious Weeds Act 1993 (NW Act)**

The purpose of the NW Act is to identify noxious weed areas where particular control measures need to be taken, to specify those control measures, and to specify the duties of public and private landholders for the control of noxious weeds. The Act categorises noxious weeds into four divisions according to the requirements for their control. Section 13 of the Act states that:

*“a public authority that is an occupier of land must control noxious weeds on the land, as required under the control category or categories specified in relation to the weeds concerned, to the extent necessary to prevent the weeds from spreading to adjoining land”.*

The proposal would not require any approvals under the Act. There are six noxious weed species present in the study area which would require management during thinning and revegetation works, and may require ongoing control in the future (see Section 7.9 of Appendix E).

### **4.5 Licences and approvals**

A seed collection licence under section 91 of the TSC Act will be required prior to vegetation removal works being undertaken. The seed collection licence would be applied for as soon as possible so as to allow for enough lead time to pick endemic native species to be used in native seed dispersal and for growing of native plants for revegetation works.

OEH will assess the application to determine whether it is likely to have a significant impact on threatened species in accordance with the EP&A Act and may include conditions which limit any potential impacts to threatened species.



# 5. Stakeholder and community engagement

## 5.1 ISEPP consultation

Clauses 13, 14, 15 and 16 of the ISEPP require public authorities to undertake consultation with councils and other agencies when proposing to carry out development without consent.

The works would be undertaken by Bathurst Regional Council. While the works would occur within a local heritage listed conservation area (see Section 6.9), consultation is not required pursuant to clause 17(1). The proposal does not trigger other ISEPP consultation requirements.

## 5.2 Government agency and stakeholder involvement

Council has undertaken consultation prior to preparation of this EIA to determine what permits are required for the proposal, and whether the departments had any specific concerns about the proposal. The following stakeholders were consulted:

- Fisheries NSW
- Office of Environment and Heritage (OEH)
- Department of Primary Industries – Office of Water
- Department of Planning and Environment
- NSW Environment Protection Authority (EPA)
- Local Land Services (LLS)
- Essential Energy
- Mid-Western Regional Council (Director Mid-Western Operations)
- Mid-Western Regional Council (Director Development and Community Services)
- Bathurst Local Aboriginal Land Council (BLALC)
- Roads and Maritime Services (RMS)
- Telstra
- The Sofala community

Table 5.1 outlines the issues raised during consultation and where the issues raised have been addressed in this report.

## 5.3 Community engagement

Due to historical engagement of the Sofala community and feedback given by the community, limited consultation with the community has occurred since 2007 however community representation has been included as instructed by OEH. The community would be notified prior to works commencing, via newspaper advertisements and letterbox notifications.

**Table 5.1 Summary of issues raised by Stakeholders**

Authority	Issue raised	Where addressed
Fisheries NSW	<p>Whilst the department may support the thinning of young casuarinas in some areas, it is imperative that the larger casuarinas which form a thin riparian corridor along the very edge of the low flow channel are maintained as these are important for stabilising the bed and banks of the river.</p> <p>An aquatic threatened species assessment would be required to address whether there are likely to be any significant impacts on threatened species, populations or ecological communities under the <i>Fisheries Management Act 1994</i>.</p> <p>Species, populations and ecological communities likely to be present within this region include:</p> <ul style="list-style-type: none"> <li>• Purple-spotted gudgeon (<i>Mogurnda adspersa</i>), listed under Schedule 4, (Endangered species)</li> <li>• Trout cod (<i>Maccullochella macquariensis</i>), listed under Schedule 4, (Endangered species)</li> <li>• Eel tail catfish (<i>Tandanus tandanus</i>), listed under Schedule 4, (Endangered population)</li> <li>• Macquarie perch, (<i>Macquaria australasica</i>) listed under Schedule 5 (Vulnerable species)</li> <li>• Murray cod (<i>Maccullochella peelii</i>) nationally listed as vulnerable under the EPBC Act.</li> </ul>	Section 4.4.2
Office of Environment and Heritage	<p>Given the sensitive nature of the subject site, it is requested that the EIA address how disturbance to the river bed and banks and non-target vegetation during the vegetation removal process will be minimised. In addition an explanation should be provided as to how bank erosion and scouring of the river bed will be managed once the vegetation has been removed.</p>	Section 6.1 and 6.2
NSW Office of Water	<p>The NSW Office of Water require the following:</p> <ul style="list-style-type: none"> <li>• Hydrological modelling of existing watercourse.</li> <li>• Description of objectives to be achieved through alterations to flow regime.</li> <li>• Geomorphic analysis of channel including identification of controls for stability such as vegetation, bedforms and bedrock.</li> <li>• Geomorphic analysis of existing instability such as bed and bank erosion and sediment movement during bankfull flows.</li> <li>• Identification of potential measures to address desired objectives.</li> </ul>	Sections 6.1 and 6.2

	<ul style="list-style-type: none"> <li>Hydrological and geomorphic analysis of potential measures to ensure bed and bank stability is maintained within the subject site, in addition to upstream and downstream reaches.</li> <li>Address the requirements of the guidelines for Controlled Activities on Waterfront Land (2012).</li> <li>Appropriate stabilisation if mechanical removal is undertaken and/or root-balls are excavated.</li> <li>Any issues identified under NSW Office of Water – General Environmental Assessment Requirements.</li> </ul> <p>Comments were previously submitted to Bathurst Regional Council on the 'Sofala Vegetation Management Plan' (GHD, 2011), including the following:</p> <ul style="list-style-type: none"> <li>NOW acknowledges that vegetation thinning will be undertaken by hand, specifically trees will be cut off at the base and root-balls will remain in-situ. NOW supports this method of removal.</li> <li>If mechanical removal is undertaken in any areas, and/or root-balls are excavated appropriate stabilisation techniques must be implemented, which may include (but not be limited to) revegetation, jute matting, use of erosion and sediment control fencing etc.</li> <li>Hand planting of native species around the root balls of removed willows and casuarinas and broadcasting of native seeds and/or supplementary planting in 'thinned' areas in support by NOW.</li> <li>NOW supports the inclusion of a maintenance plan, comprising quarterly inspections during the initial 2 years of the maintenance period, and three visits per year for the final 3 years of the plan. NOW also recommends that additional inspections be included in the plan on an 'as needs' basis if high flows occur and inundate the study area.</li> </ul>	
<p>Department of Planning and Environment</p> <p>NSW Environment Protection Authority (EPA)</p>	<p>The Department of Planning and Environment enquired as to whether consultation had been undertaken with OEH.</p> <p>The EPA recommends that the following issues be considered in the impact assessment:</p> <ul style="list-style-type: none"> <li>Noise – identify potential noise impacts and identify appropriate mitigation or management strategies.</li> <li>Air Quality and Odour – identify potential air quality impacts (point source emissions from plant and equipment and/or fugitive dust emissions) and identify mitigation strategies to minimise point and/or fugitive emissions.</li> </ul>	<p>Refer this table</p> <p>Sections 6.6, 6.5, 6.2 and 6.7.</p>

	<ul style="list-style-type: none"> <li>Water Contamination – identify potential impacts to surface water and identify appropriate pollution control systems/measures to protect surface water resources, particularly erosion and sediment controls during woody weed removal and the rehabilitation stage. It is recommended that priority should be given to achieving a high standard of erosion and sediment control and general site housekeeping throughout the construction period. BRC or any contractor engaged by BRC, should develop and implement activities associated with the Proposal in accordance with relevant guidelines, particularly the EPA endorsed publication “Managing Urban Stormwater – Soils and Construction, 4th Edition” (Landcom, 2004) (or any revision).</li> <li>Waste Management – identify options and strategies for waste minimisation; reuse and recycling and appropriate disposal options.</li> <li>Storage of Chemicals/Fuels - ensure adequate control measures are in place for storages to reduce the risk of spills contaminating waterways and land.</li> <li>Incident Management Procedures - adequate procedures should be established including notification requirements to the Appropriate Regulatory Authority and other relevant authorities for incidents that cause, or have the potential to cause material harm to the environment (Part 5.7 of the POEO Act).</li> <li>Use of Pesticides – any use of Pesticides for weed/woody weed control must be undertaken in accordance with the <i>Pesticides Act 1999</i> and <i>Pesticides Regulation 2009</i>.</li> </ul>	
Local Land Services (LLS)	<p>Any removal of native vegetation is likely to have some adverse effects on the aquatic habitat features and values throughout the study area.</p> <p>The Central Tablelands LLS supports the staged removal of willows and other woody weeds and would suggest priority on this clearing activity above the thinning of native vegetation.</p>	The proposal includes both vegetation thinning and removal of willows. Refer Section 3.2.
Essential Energy	<p>No vegetation issues affecting the electricity distribution network, exist in this location, however Essential Energy would welcome any vegetation thinning, in the proposed two kilometre section of the Turon River from Golden Point, 1,500 metres upstream of Crossley Bridge at Sofala, to 500 metres downstream of the bridge.</p>	The proposal addresses this section of river.
Mid-Western Regional Council (Director Mid-Western Operations)	<p>No concerns raised.</p>	-

Mid-Western Regional Council (Director Development and Community Services)	No concerns raised	-
Bathurst Local Aboriginal Land Council (BLALC)	Feel that it is appropriate to have an Aboriginal Assessment completed to rule out if there are any aboriginal artefacts in the mapped area. The Turon River is of great significance to the Aboriginal people as roamed and settled in that area and surrounds.	Section 6.8 and Appendix C
Community (R.Heferen)	Do not spend any more on studies, clean the river flow this is been going on to long, please let me know when are they going to start.	
Community (S.Tomkinson)	Agrees with works proposed, would like to add that council put a plan in place for maintenance once work is complete.	Follow up weed control would be conducted as part of the structured bush regeneration program. Details are provided in Appendix D.

# 6. Environmental impact assessment

## 6.1 Ecology

An ecological assessment report was prepared by GHD to assess the potential impacts of the proposal. The report is attached in Appendix B and is summarised below.

For the purpose of the ecological assessment, 'locality' refers to the area within a 10 kilometre radius of the subject site. 'Threatened and migratory biota' refers to threatened species, populations and ecological communities that are listed under the TSC Act, FM Act and/or the EPBC Act and migratory species listed under the EPBC Act.

### 6.1.1 Methodology

#### Desktop assessment

A desktop database review was undertaken to identify threatened flora and fauna species prior to conducting site surveys, populations and ecological communities (biota) listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the locality (i.e. within a 10 kilometre radius of the subject site), based on previous records, known distribution ranges, and habitats present.

The following biodiversity databases and literature were searched and reviewed prior to field investigations:

- The Commonwealth Department of the Environment (DotE) Protected Matters Search Tool, for all MNES - online database selected for a 10 kilometre radius of the proposal (DotE, 2014a).
- DotE online species profiles and threats database (DotE, 2014b).
- Office of Environment and Heritage Wildlife Atlas database (licensed) for records of threatened species, populations and endangered ecological communities listed under the TSC Act that have been recorded within the locality of the proposal (OEH, 2014a).
- Office of Environment and Heritage threatened biota profiles for descriptions of the distribution and habitat requirements of threatened biota (OEH, 2014b). This resource was used to identify the suite of threatened ecological communities (TECs) that could potentially be affected by the proposal and to inform habitat assessments.
- The NSW vegetation types database (OEH, 2014c) to identify vegetation communities present in the study area.
- NSW Department of Primary Industries online protected species viewer for records of threatened aquatic species in the locality (DPI, 2014a).
- The NSW Department of Primary Industries 'Threatened Fish and Marine Vegetation – Find a Species by Geographic Region' online search tool for Central West catchment area (DPI, 2014b).

The habitat resources present at the subject site (determined during the site inspection) were compared with the known habitat associations/requirements of the threatened and migratory biota highlighted by the desktop review. This was used to determine the likelihood of each threatened ecological community, endangered population and threatened or migratory species occurring within the study area.

## Previous reports

A review of previously prepared reports was completed prior to field surveys to contribute to the ecological assessment, including:

- Sofala Works Implementation Plan (GHD 2012).
- Sofala Vegetation Management Plan (GHD 2011).
- Sofala Floodplain Risk Management Study (Cardno 1997).

## Field surveys

Field surveys for the study area were conducted by three ecologists between 14-16 January 2015. The survey methodology for terrestrial and aquatic flora and fauna surveys is described below. The survey methodology was designed to build on the previous surveys undertaken by GHD (2011) through undertaking additional field surveys targeting fauna and aquatic habitats, as this had not been part of the scope of the original survey. Further details of the field survey methods can be found in Section 3.4 of the ecology report in Appendix B.

The following flora and vegetation surveys were completed:

- Ground-truthing of vegetation mapping – Previous vegetation mapping prepared by GHD in 2011 was ground-truthed to verify the current location and extent of vegetation. Any necessary adjustments were made to the mapping.
- Targeted threatened flora surveys - The habitat requirements for threatened flora predicted to occur by the desktop assessment were identified prior to the field survey. Those requirements were then compared with the habitats present within the subject site during the field survey and an assessment of the likelihood of occurrence was completed based on consideration of known distributions, previous records in the locality and habitat requirements for each species. It is noted that the timing of field surveys (January 2015 - summer) was not ideal for the detection/identification of some cryptic species e.g. those that flower in spring or which require specific climatic events to trigger flowering (if present).

The habitat assessment conducted for the study area allowed for identification of potential habitat for cryptic species, in order to make an assessment of their likelihood of occurring within the proposal footprint. As such, the survey was not designed to detect all species, rather to provide an overall assessment of the ecological values within the study area in order to predict potential impacts of the proposal, with particular emphasis on threatened biota and their habitats.

## Likelihood of occurrence assessment

The likelihood of threatened and migratory biota occurring in the study area was assessed based on presence of records from the locality since 1990, species distribution and habitat preferences, and the potential suitability of habitat in the study area assessed during the field survey.

Based on the desktop assessment, the following threatened biota and MNES are known or predicted to occur in the locality:

- Five threatened ecological communities (TECs)
- 10 threatened flora species, comprising seven species listed under the TSC Act and nine species listed under the EPBC Act
- 30 threatened fauna species, including 24 species listed under the TSC Act, 17 species listed under the EPBC Act and six species listed under the FM Act



- 11 migratory species.

### 6.1.2 Existing environment

#### Vegetation communities

One native vegetation type is present in the study area: River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions. This vegetation forms part of the 'Eastern Riverine Forests' vegetation class and 'Forested Wetlands' vegetation formation.

#### Flora

A total of 38 native plant species and 79 exotic species were observed within the native vegetation of the study area (refer to Appendix B). The *Poaceae* (grasses, 23 species, 11 native) and *Asteraceae* (daisies; flowering herbs and sub-shrubs, 16 species, three native) were the most diverse families recorded. No threatened flora species were recorded.

Blackberry complex (*Rubus fruticosus* sp. agg.), a Class 4 declared noxious weed within the Upper Macquarie County Council control area, was abundant throughout much of the study area.

#### Fauna

Two threatened fauna species have been positively recorded within the study area: the Booroolong Frog (*Litoria booroolongensis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). One additional threatened species has possibly been recorded from recorded echolocation calls: the Eastern Cave Bat (*Vespadelus troughtoni*). The Gang-gang Cockatoo (*Callocephalon fimbriatum*), was recorded outside the study area.

The Murray Cod (*Maccullochella peelii*), listed as a vulnerable species under the EBPC Act, was recorded in the study area. The presence of Murray Cod is likely to be a result of recent fish stocking.

#### Migratory species

A number of migratory species have the potential to occur within the subject site on an occasional or transient basis, given the presence of potentially suitable habitat. These include the Satin Flycatcher (*Myiagra cyanoleuca*), Rufous Fantail (*Ripidura rufifrons*) and Rainbow Bee-eater (*Merops ornatus*).

### 6.1.3 Impact assessment

#### Potential direct impacts

Direct impacts at the subject site include the following:

- The loss of River Oaks and Willows would remove foraging and resting habitat for a range of bird and bat species. No foraging habitat for the Gang-gang Cockatoo would be removed. No hollow-bearing trees or trees with flaking bark would be removed. Retention of these trees would minimise impacts on nesting or denning fauna. These resources are scarce and limiting given the time it takes for hollows to develop.
- Removal of dense thickets of weeds for the walking trails would have the potential to impact on small birds that use these for refuge/nesting and foraging. Large areas of alternate habitat are present. Revegetation would restore this habitat in the long-term.
- Removal of weeds and small shrubs for the walking tracks has the potential to result in the injury or mortality of small birds, particularly species such as the Superb Fairy-wren which nests in these areas.

## Potential indirect impacts

### *Erosion and sedimentation*

Exposed soils may adversely affect aquatic life by altering water quality and filling aquatic habitat with fine sediment. This may reduce the habitat value of the Turon River adjacent to the subject site for aquatic flora and fauna.

Some sedimentation may occur as a result of the proposed works, although these are likely to be minimal given the method for thinning and the measures to control/manage erosion and sediment release into the river. The geographical and temporal extent of potential impacts is likely to be negligible for threatened fish. Infilling of cobble banks with sediment could impact the shelter and breeding habitat of the threatened Booroolong Frog, however, as with threatened fish, the geographical and temporal extent of potential impacts is likely to be negligible for this species in the locality.

The main risk of disturbance of sediments is from movement of mobile plant along the river banks, and clearing of large areas of herby weeds. The Turon River riparian area is regularly subjected to flood events, which currently cause moderate erosion and sedimentation along the river. The retention of root balls would help maintain bank stability during these events. Mitigation measures are recommended in Section 6.1.4.

Removal of weed thickets also has the potential for soil erosion and sediment movement. Soils would be stabilised after removal and staged removal would also be undertaken to reduce the amount of unstable areas at any time. To minimise the risk of sedimentation, mitigation measures (including the broadcast of native seed or supplementary planting to stabilise exposed surfaces) would also be implemented, as identified in Section 6.1.4.

### *Contamination*

Accidental spills of oils or other chemicals during the thinning process or revegetation activities could result in a decline in flora and fauna habitat and potential mortality to individuals. Contamination impacts would be minimised by implemented mitigation measures identified in Section 6.1.4.

### *Noise pollution*

The subject site is located near roads and the Sofala township. Habitats adjacent to the subject site therefore already experience some noise, light and vibration disturbance. There would be additional noise and vibration as a result of thinning activities. Works would occur during the day only, and would be short-term. Most of the species that are likely to nest or roost in the study area would be habituated to noise to a large extent, and would not be impacted substantially by the additional temporary noise and vibration.

### *Weed invasion and edge effects*

Construction of walking trails and thinning of vegetation has the potential to increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water) and via workers shoes and clothing and through construction vehicles. Given the high levels of weeds present, this is unlikely. Removal of weeds and revegetation would reduce weeds in the long-term.

### *Introduction of pests and pathogens*

Thinning activities within the subject site have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) in the study area through vegetation disturbance and increased visitation. There is little available information about the distribution of

these pathogens within the locality, and no evidence of these pathogens was observed during surveys.

### Spills

Accidental spills of oils or other chemicals during the thinning process or revegetation activities could result in a decline in flora and fauna habitat and potential mortality to individuals.

### Cumulative Impacts

Cumulative impacts arising from the proposal are considered unlikely to cross any critical threshold for impacts that would have a significant adverse effect on local populations of any native biota.

### Key threatening processes

A key threatening process (KTP) is defined in the TSC Act as an action, activity or proposal that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

KTPs are listed under the TSC Act, the FM Act and also under the EPBC Act. A number of KTPs are listed under more than one Act. Those potentially relevant to this proposal are discussed in Table 6.1 below. Mitigation measures to limit the impacts of these KTPs are discussed in Section 6.1.4.

**Table 6.1 Key threatening processes**

Key Threatening Process	Status	Comment
Clearing of native vegetation	TSCV Act: EPBC Act	The proposal would comprise the thinning of River Oaks ( <i>Casuarina cunninghamiana</i> ) to a density of less than 720 stems per hectare throughout the study area, with root balls being left in situ. No area of native vegetation would be entirely removed. Clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation. As such, the proposal does not constitute clearing of native vegetation. Vegetation management measures as part of a CEMP are recommended to minimise impacts on native vegetation and to improve the condition of currently disturbed areas.
Loss of hollow-bearing trees	TSC Act	The proposal is unlikely to result in the removal of hollow-bearing trees. Management measures as part of a CEMP are recommended to minimise impacts on hollow-bearing trees and any resident fauna (see Section 6.1.4).
Removal of dead wood and dead trees	TSC Act	There are occasional dead trees and large quantities of fallen timber within the riparian zone that would provide habitat resources for native fauna. The proposal may result in the removal of some dead trees. Removal of fallen timber should be avoided if possible as this provides habitat for terrestrial fauna and contributes to snags in the river during and following flood events. Management measures as part of a CEMP are recommended to minimise impacts on hollow-bearing trees and fallen timber (see Section 6.1.4).
Invasion of plant communities by	TSC Act	The study area features moderate to severe infestation with perennial exotic grasses. The proposal would

Key Threatening Process	Status	Comment
perennial exotic grasses		include environmental management measures, including weed management (refer Section 6.1.4). These mitigation measures would limit the potential to increase the operation of this KTP.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	TSC Act	The study area features moderate to severe of garden plants. The proposal would include environmental management measures, including weed management (refer Section 6.1.4). These mitigation measures would limit the potential to increase the operation of this KTP
Infection of native plants by <i>Phytophthora cinnamomi</i>	TSC Act; EPBC Act	Thinning activities have the potential to introduce <i>Phytophthora</i> into the study area, through the transport and movement of plant, machinery and vehicles, as well as through any landscaping works following construction. The proposal would include environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6.1.4). The proposal is unlikely to increase the operation of this KTP
Introduction and establishment of Exotic Rust Fungi of the order <i>Pucciniales</i> pathogenic on plants of the family Myrtaceae	TSC Act	Thinning activities have the potential to introduce Myrtle Rust to the study area. The proposal would include environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6.1.4). The proposal is unlikely to increase the operation of this KTP.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Thinning activities have the potential to introduce amphibian chytrid to the study area, which could lead to death of local frogs. The proposal would include environmental management measures including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6.1.4). The proposal is unlikely to increase the operation of this KTP.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act; FM Act	There would be no activities within the Turon River. The proposal would thin trees within the riparian zone to minimise flood risk and damage to Sofala township. Flood intensity in the vicinity of Sofala may be reduced. The proposal would not result in an increase in the operation of this KTP
The removal of large woody debris from NSW rivers and streams	FM Act	No large woody debris would be removed from within the Turon River. Some fallen timber may be removed from along the riparian zone, which could occur as snags during high flow periods. The proposal would result in a minor increase in the operation of this KTP. Management measures as part of a CEMP are recommended to minimise the removal or disturbance of snags and fallen timber (see Section 6.1.4).

### Assessments of significance

The desktop assessment, field surveys and habitat assessments described above have been used to identify the suite of threatened biota that may be affected by the proposal, through either direct or indirect impacts. A number of threatened species may occur in the study area or have been recorded in the study area, but are unlikely to be impacted by the proposal, or the

impact would be negligible. These are discussed in section 5.4.2 of Appendix B. Threatened species that are likely to be impacted by the proposal (affected biota) are discussed in section 5.4.3 of Appendix B.

#### 6.1.4 Mitigation measures

A Vegetation Management Plan (VMP) has been prepared for vegetation in the subject site (Appendix E). The VMP specifies management actions to reduce flood risk, maintain and enhance the biodiversity values of native vegetation, roles and responsibilities, timing and costs of actions.

In addition, the Construction Environmental Management Plan (CEMP) for the proposal would include as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures including the procedures outlined below. The CEMP would be prepared and implemented by the contractor.

The CEMP would be required to address the following as a minimum:

Impact	Environmental safeguards	Responsibility	Timing
Erosion and sedimentation	<ul style="list-style-type: none"> <li>• Installation of erosion and sediment control measures prior to works</li> <li>• Communication with personnel involved in works of the conservation value of surrounding vegetation and their responsibilities with regards to protecting vegetation and fauna habitats during works.</li> <li>• All equipment must be refuelled at least 20 metres away from the river and all fuel and chemical storages should be bunded.</li> </ul>	Construction contractor	Construction
Vegetation disturbance and weeds	<ul style="list-style-type: none"> <li>• Installation of temporary fencing to clearly delineate work zones and areas of vegetation to be retained</li> <li>• Washing of vehicles and plant prior to work on site to prevent the spread of Phytophthora (<i>Phytophthora cinnamomi</i>) and Myrtle Rust (<i>Pucciniales fungi</i>) in line with the national best practice guidelines for Phytophthora (DEH 2006) and Myrtle Rust factsheet (DPI 2011) for hygiene control</li> <li>• Herbaceous weeds to be controlled with the application of Roundup® Biactive herbicides applied using 'back packs' where revegetation activities are dominated by hand planting by suitably qualified and experienced contractors</li> <li>• Weed disposal protocols such as the removal of large environmental woody weeds as part of a staged program</li> <li>• Staged removal of willow and other woody weeds commencing in the upper reaches of the catchment and working down with the root ball of these species left in situ removal of saplings and emergent seedlings by hand with root systems left in situ.</li> </ul>	Construction contractor	Construction
Fauna	<ul style="list-style-type: none"> <li>• Machinery is to be excluded from the river bed and from within 3 metres of the banks to protect Booroolong Frog habitat</li> </ul>	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	<ul style="list-style-type: none"> <li>Avoid the removal of hollow-bearing trees and trees with flaking bark</li> <li>Avoid the removal of fallen timber</li> <li>A fauna management protocol, including pre-clearing surveys for nests or sheltering terrestrial fauna and rescue and salvage of fauna where possible</li> <li>Protocols to prevent introduction or spread of chytrid fungus following OEH Hygiene protocol for the control of disease in frogs (DECCW, 2008) must be implemented.</li> </ul>		
Aquatic habitat	<ul style="list-style-type: none"> <li>Minimise and control sediment movement as a result of proposed works to limit sedimentation and maintain water quality as described above</li> <li>Maintain root balls for any trees close to the water line to ensure bank stability and provide consistent habitat for fish and macroinvertebrates.</li> </ul>	Construction contractor	Construction

## 6.2 Hydraulic and geomorphic impacts

### 6.2.1 Methodology

A hydraulic and geomorphic impact assessment was prepared by GHD to assess the impacts of the proposal. The report is attached in Appendix F and is summarised below.

During the impact assessment process, consultation was undertaken with the NSW Office of Water, as discussed in Section 5.2. To address the geomorphological assessment requirements as requested by the Office of Water, the following activities were undertaken:

- Desktop assessment
- Site investigation
- Hydrologic and hydraulic assessment of existing and proposed conditions

The assessment provides recommendations for the mitigation and future remediation of any identified impacts.

### 6.2.2 Existing environment

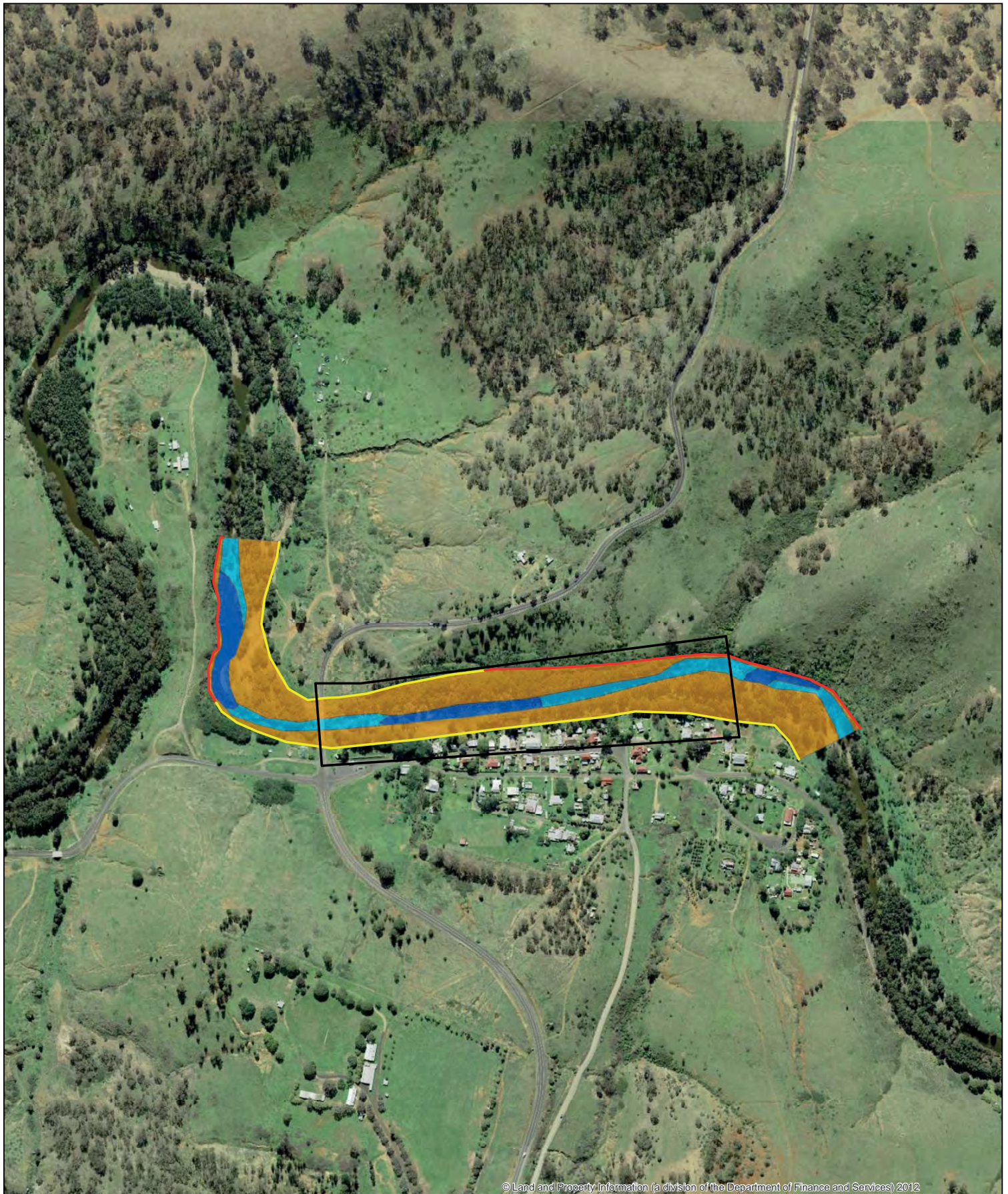
#### Waterway morphology

The Turon River through the subject site exhibits an active low flow channel inset within a broader macro-channel. The macro-channel margins comprise of either bedrock or terrace materials composed of either colluvial (hillslope derived fan deposits) or alluvial sediments. The more significant geomorphic features within the macro-channel are the low flow channel and the inset bench/floodplain complexes (Figure 6.1).

The low flow channel is generally 10 to 20 metres wide and is characterised by a series of shallow pools (Photo A Figure 6.2) separated by riffles and runs (Photo B Figure 6.2). Deeper bedrock forced pools are located where the low flow channel abuts bedrock valley margins (Photo C Figure 6.2). Bank attached and mid-channel gravel bars are evident within the low flow channel of riffle zones (Photo B Figure 6.2).

A bench flood plain of 20 to 40 metres (either side of the flow channel) is typically densely vegetated with dominant River Oak (*Casuarina cunninghamiana*) n elevated one to three metres from the invert of the low flow channel. The southern bank adjacent to the township, is relatively steep, and is typically stable with exotic and native vegetation. Some sections exhibit evidence of past erosion of this bank which have been protected with loose rock.










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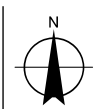
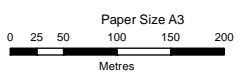
LEGEND  Project Site

**Macro-Channel Margins**

-  Alluvial/Colluvial
-  Bedrock

**Macro-Channel Features**

-  Inset Floodplain
-  Low Flow Channel - Pool
-  Low Flow Channel - Riffle/Run



Sofala Flood Mitigation Project  
Bathurst Regional Council

Job Number | 21-23439  
Revision | A  
Date | 23 Feb 2016

Key Geomorphic Features

Figure 6.1

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Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

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Data source: LPI, DTDB (2012) / Aerial imagery (2015). Created by: glampert





**Figure 6.2 Low flow channel photographs**

### 6.2.3 Impact assessment

#### Hydraulic modelling

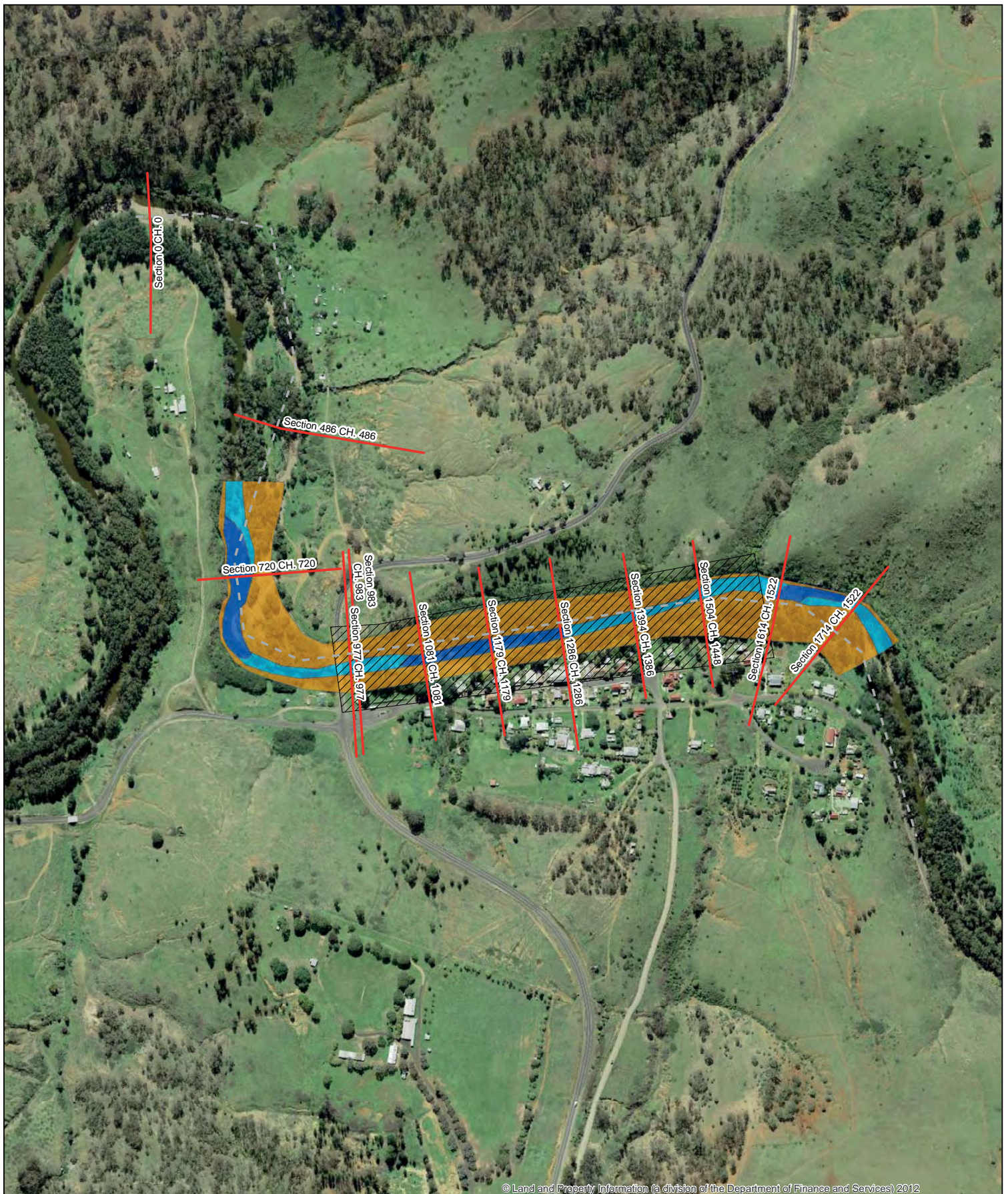
A HEC-RAS hydraulic model was developed by Cardno Willing (2007) to estimate changes between existing and proposed design flood event levels, velocities and shear stress through the subject site upstream of the Crossley Bridge. The layout (cross-sections) of the model is shown in Figure 6.3.

In reviewing the model, the following issues were identified and the model was modified accordingly:

- The bank stations that differentiate between the channel and over bank components of the cross-sections did not align with the proposed works. To better represent the proposal within the model, the bank stations were moved to align with the margins of the low flow channel to allow adjustment of the Manning's n values across the entire overbank areas.
- The Manning's n value used to represent the roughness of the overbank areas upstream of the bridge represented the conditions of the Turon River in 1986 and are considered low for the existing densely vegetated nature of the inset bench/floodplain complexes. In order to accurately estimate the potential change to flow velocities and shear stresses as

a result of the proposal, the Manning's n values represented existing and proposed conditions were updated.





**LEGEND**

- - - Model Centreline
- Model Cross Sections
- ▨ Project Site

**Macro-Channel Features**

- Inset Floodplain
- Low Flow Channel - Pool
- Low Flow Channel - Riffle/Run

Paper Size A3  
0 25 50 100 150 200  
Metres



Sofala Flood Mitigation Project  
Bathurst Regional Council

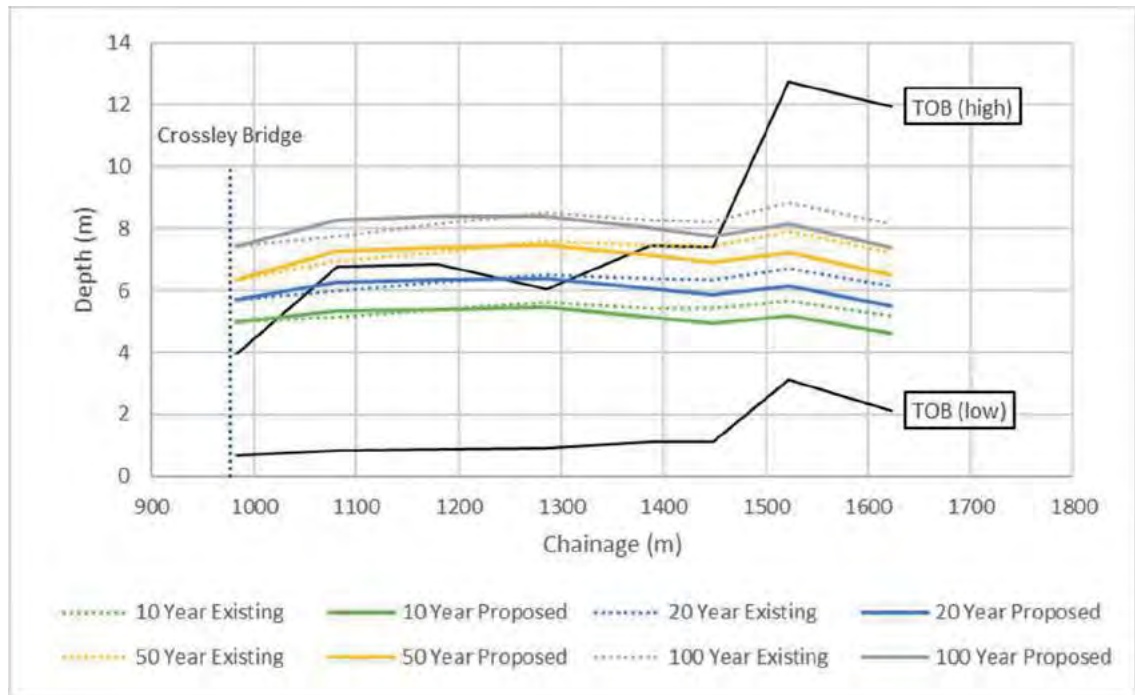
Job Number 21-23439  
Revision B  
Date 23 Feb 2016

Hydraulic Model Cross Sections

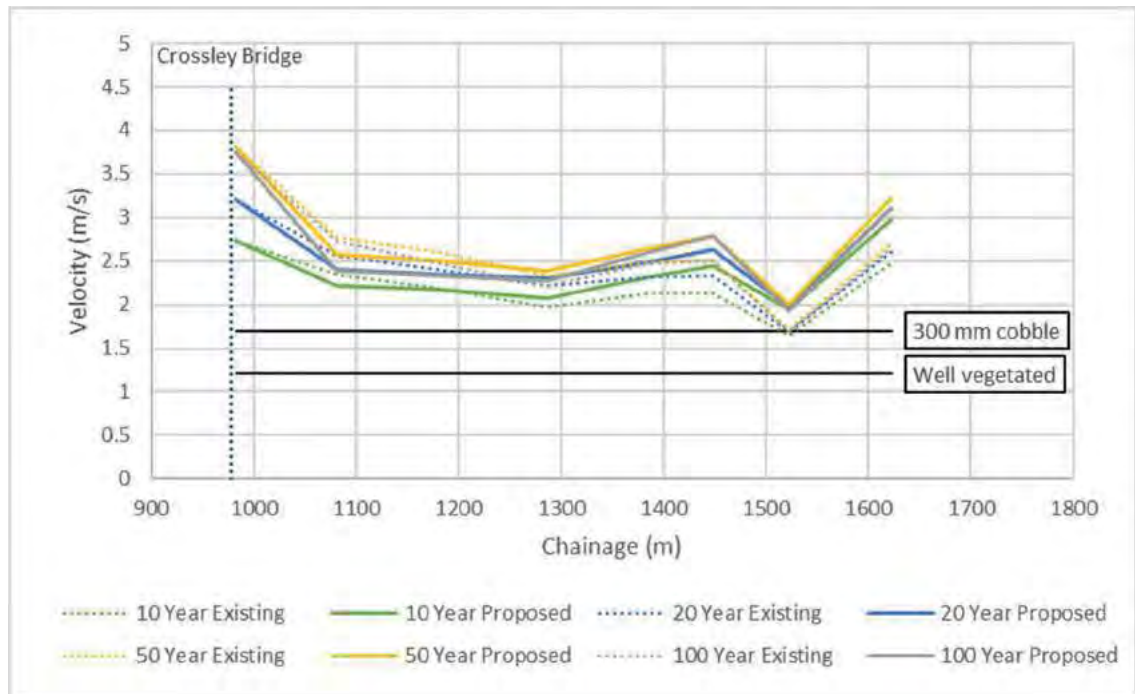
Figure 6.3



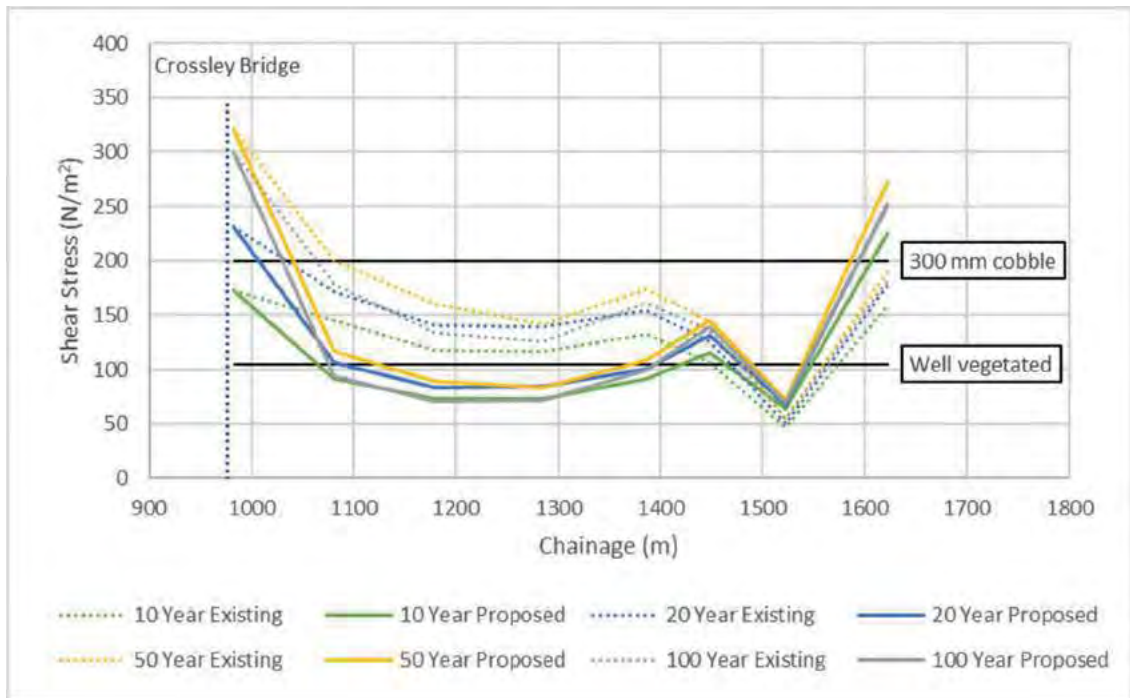
The maximum modelled depths, velocities and shear stresses upstream of the Crossley Bridge (using the updated HEC-RAS hydraulic model) for the existing and proposed conditions are summarised in Figure 6.4, Figure 6.5 and Figure 6.6 respectively.



**Figure 6.4 Maximum modelled flood depths upstream of Crossley Bridge**



**Figure 6.5 Maximum modelled flow velocities upstream of Crossley Bridge**



**Figure 6.6 Maximum modelled shear stresses upstream of Crossley Bridge**

In the immediate 200 to 300 metres upstream of the Crossley Bridge, the modelling indicates that the proposal may result in increased flow depths associated with reduced flow velocities (up to approximately 0.3 metres per second, refer Figure 6.5). Further upstream, flow depths are predicted to decrease in response to the proposal.

The modelling indicates that shear stresses are expected to be reduced for most of the modelled reaches (refer Figure 6.6). Within the upper reaches, the modelling indicates that the proposal would potentially increase the shear stress, however the increased stresses remain below the stability threshold estimated for the bed and bank material in these areas, which includes exposed bed rock within the channel banks.

### Hydraulic and morphologic risks

The estimated hydraulic and morphologic risks associated with the proposal are considered low for the majority of the modelled reach. However, there would be some localised potential hydraulic and morphologic risks including:

- An increased risk of erosion in the area upstream of Section 1179 as flow velocities are predicted to increase while modelled shear stresses increase further upstream at Section 1714 (chainage 1622)
- A potential for channel bed aggradation through much of the modelled reach as shear stress values are predicted to generally decrease, with the greatest reductions in the middle to downstream sections of the proposal site. If bed aggradation did occur, this may also increase maximum flood flow levels. Cardo (2007), however, determined flood levels upstream of Crossley Bridge were not very sensitive to bed level change and the impact of bed aggradation on flooding risk is considered limited.
- An increased flooding risk for buildings adjacent to the river approximately 200 to 300 metres upstream of Crossley Bridge as flow depths are predicted to increase.

Given the localised potential morphologic risks of erosion and aggradation outlined above, a monitoring program would be implemented to assess the morphological responses. To further reduce potential morphological changes, a number of mitigation measures are also proposed as outlined in Section 6.2.4.

With adoption of these measures, it is considered that there would be a low risk for substantial morphological change along the modelled sections of the Turon River in response to the proposal.

While the morphological risks would be low, the potential increased flooding risk upstream of Crossley Bridge is most likely due to reduced attenuation of flood flows within the proposal site. In addition, modelling indicates that no change in flood depths is expected to occur downstream of Crossley Bridge. This indicates that Crossley Bridge is likely to act as a hydraulic control, limiting flow rates entering the downstream reaches. As a result, mitigation of the increased upstream flood risk is unlikely to be realised without substantial modification of the bridge.

#### 6.2.4 Mitigation measures

The following mitigation measures would reduce the potential for morphological change in the study area.

Impact	Environmental safeguards	Responsibility	Timing
Erosion and sedimentation	Erosion and sediment control measures would be established prior to construction and would be implemented on slopes approaching the waterway to prevent sediment discharge to waterways. This may include the use of sediment traps, vegetation and diversion berms, etc., all of which would be appropriately maintained and inspected regularly.	Construction contractor	Construction
Sedimentation	All stockpiled material would be kept remote from the waterway to avoid sediment and debris entering the waterway.	Construction contractor	Construction
Soil disturbance	Disturbed areas would be stabilised and reinstated with appropriate vegetation as quickly as practicable after implementation of the works.	Construction contractor	Construction
Soil disturbance	Construction would be avoided during periods of heavy rainfall and flooding.	Construction contractor	Construction
Soil disturbance	The route used by any machinery into and out of the works site would be controlled.	Construction contractor	Construction
Soil disturbance	The need for access of heavy machinery to the works site would be avoided where practical.	Construction contractor	Construction
Channel banks	Disturbance of the channel banks by machinery would be avoided as far as possible.	Construction contractor	Construction
Vegetation	Mechanical removal of vegetation would be avoided as far as practicable.	Construction contractor	Construction
Vegetation	Clear vegetation by cutting trees as close as possible to the base of the trunk and retain root balls.	Construction contractor	Construction
Debris	All debris generated during construction would be removed and disposed of appropriately.	Construction contractor	Construction
Morphological changes	Immediately prior to construction and following flood events with peak discharge greater than 300 m <sup>3</sup> .sec, morphological responses in the river should be observed including:	Proponent	Pre-Construction



Impact	Environmental safeguards	Responsibility	Timing
	<ul style="list-style-type: none"> <li>• Survey of six cross-section transects located in the vicinity of the six hydraulic model Sections 1714 to 1063</li> <li>• Particle size analysis of bed sediments within the low flow channel at each of the six survey transects</li> <li>• Visual inspection including the establishment of fixed photograph monitoring locations.</li> </ul> <p>The results of the monitoring would be routinely reviewed to identify any morphological changes that may impact the hydraulic or ecological functioning of the river. In the event that substantial morphological changes are identified, guidance from appropriate river management professionals would be obtained to identify suitable remediation options.</p>		

## 6.3 Water quality

### 6.3.1 Existing environment

#### Surface water

The village of Sofala is relatively flat, although the subject site itself is moderately steep. Stormwater flows into the Turon River before reaching the Macquarie River, approximately 30 kilometres west of the subject site.

#### Water quality

Water quality data for the Turon River at Sofala is limited. The 'Bathurst State of the Environment Report 2011 Supplementary' (Bathurst Regional Council, 2011) indicates erosion is a significant land issue that influences water quality in the area. The Turon River has a gravel bed and is potentially subject to erosion during flood events.

General litter from stormwater runoff is also an issue in the Bathurst area, and livestock exclusions from river banks generally reduces further decreased water quality issues.

Current sediment levels and turbidity is relatively low in the Turon River. Sediment and turbidity would be very high during flood events.

#### Groundwater

A search of the NSW Department of Primary Industries All Water Data mapping, indicated the closest bore to the subject site is approximately 500 metres upstream, with a standing water table level of six metres below the ground surface. Given the location of the subject site adjacent to a waterway, the groundwater level is presumably at a level near to the river level.

The Bathurst LEP maps indicate a majority of the subject site as groundwater vulnerable. Groundwater vulnerability is a measure of how easy or hard it is for pollution or contamination at the land surface to reach a groundwater aquifer. A groundwater vulnerable site would have a risk of contamination of the aquifer due to the physical characteristics of the site such as depth to the water table, net recharge, aquifer and soil media, topography, impact of the vadose zone media and hydraulic conductivity of the aquifer.

### **6.3.2 Impact assessment**

The proposal has potential to disturb soils during construction works. There is therefore potential for increased sediment discharge to waterways during construction. During a flood event, there may be additional erosion and sedimentation arising from areas where trees have been removed, however this is unlikely to be noticeable given the very high levels of turbidity which would already be present in the river during a flood event.

A number of erosion and sediment control measures and other mitigation measures are proposed to reduce the likelihood of debris and sediments impacting on the waterway (Section 6.2.4).

The proposal is not expected to have any significant impact on surface or groundwater levels or groundwater quality.

### **6.3.3 Mitigation measures**

Section 6.2.4 outlines mitigation measures that would be implemented to reduce water quality impacts from the proposal.

## **6.4 Climate, landforms and soils**

### **6.4.1 Existing environment**

#### **Climate**

The Commonwealth Bureau of Meteorology website provides climatic information for the study area taken from Bathurst Airport weather station (closest station to the subject site). A review of this data indicates the mean rainfall peaks are in December, ranging from 31 to 73 mm. Mean daily maximum temperatures range from 26.3°C to 28.4°C in summer and 11.8°C to 13.4°C in winter. The mean minimum temperatures range from 11.5°C to 13.6°C in summer down to 1.0°C to 1.9°C in winter.

#### **Landforms and soils**

The landform surrounding the subject site varies from undulating hills to steep, rocky land. The immediate channel of the Turon River is characterised by gravel shoals that are mobile in flooding events with the defined channel moving in a lateral manner after such events.

The dominant underlying geology of the Bathurst region is the Bathurst Granite with basalt occurring at Mount Panorama and Mount Stewart. The Bathurst Granite is dominated by intermediate parent materials, which form such soils as the non-calcic brown soils and yellow soils in the less well drained locations (Terra Consulting, 2003).

The non-calcic brown soils are the dominant soils of Bathurst and occur on undulating to rolling hills on the Bathurst Granite. Topsoils range from sandy loam to loam. They have a moderate water holding capacity, are pH neutral, have moderate chemical fertility and have a moderate erosion hazard.

### **6.4.2 Impact assessment**

Potential impacts on soils and landform would be restricted to the construction phase. Minimal earthworks would be required, but there is potential for the following impacts:

- erosion of exposed soils
- dust generation from excavation works
- an increase in sediment loads entering the Turon River.

Exposure of soils would be minimised, with areas to be disturbed identified in the Works Implementation Plan (GHD 2012). Exposure of soils would be short term and would be managed through the implementation of erosion and sedimentation control measures.

Excavations would not alter local topography in the long term they would be backfilled and returned to the existing levels upon the completion of the work. The proposal is unlikely to have any adverse impacts on topography, geology and soils following completion of the works as the landscape would be returned to its existing state.

### 6.4.3 Mitigation measures

The mitigation measures proposed in section 6.2.4 include measures to address potential erosion and sedimentation.

## 6.5 Air quality

### 6.5.1 Existing environment

Air quality in the vicinity of the proposal is typical of a rural area. Local air quality is predominately influenced by motor vehicle emissions along Sofala Road, Ilford/Sofala Road and Upper Turon Road as well as emissions from the village of Sofala more generally.

The nearest residential receivers to the proposal are located approximately 20 m north of the southern bank of the Turon River.

### 6.5.2 Impact assessment

The proposal has the potential to impact air quality through the generation of dust by excavation.

The operation of construction plant and equipment would also result in additional exhaust emissions in the area.

Impacts due to the generation of dust and exhaust emissions would be short term and temporary. Limited excavation would be involved to undertake the proposal and given the distance from receivers, dust nuisance is not expected to be noticeable. Standard construction precautions will be taken and will reduce the potential for nuisance.

### 6.5.3 Mitigation measures

The following mitigation measures would be implemented to reduce the potential for air quality impacts during construction:

Impact	Environmental safeguards	Responsibility	Timing
Dust and particulates	Works are not to be carried out during strong winds or in weather conditions where high levels of dust or air borne particulates are likely.	Construction contractor	Construction
Odours and dust	Vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation.	Construction contractor	Construction
Emissions	Construction plant and equipment will be maintained in a good working condition in order to limit impacts on air quality.	Construction contractor	Construction
Emissions	Plant and machinery will be turned off when not in use and would not be left idling.	Construction contractor	Construction
Smoke	Vegetation or other materials will not be burnt on site.	Construction contractor	Construction

## 6.6 Noise and vibration

### 6.6.1 Existing environment

The area in the vicinity of the proposal has low ambient noise levels which can be attributed to the surrounding rural landscape. The most dominant influences on ambient noise is the village of Sofala and traffic along Sofala Road, Ilford/Sofala Road and Upper Turon Road.

The nearest residential receivers to the proposal are approximately 20 metres north of southern bank of the Turon River.

### 6.6.2 Impact assessment

Construction would cause a localised, short-term increase in background noise levels. Due to the distance to the nearest residential receiver and that works would be undertaken during standard construction hours, noise impacts are considered to be minimal. Mitigation measures would be implemented to reduce the potential for noise impacts.

No vibration impacts are expected.

### 6.6.3 Mitigation measures

A Construction Noise and Vibration Management Plan (CNVMP) will be prepared as part of the CEMP. This plan will include but not be limited to:

- A map indicating the locations of sensitive receivers including residential properties.
- Measures to minimise noise and vibration impacts during construction activities including those associated with truck movements.
- A process for assessing the performance of the implemented mitigation measures.
- A process for documenting and resolving issues and complaints.
- A process for updating the plan when activities affecting construction noise and vibration change.

The following mitigation measures will be implemented during construction.

Impact	Environmental safeguards	Responsibility	Timing
Construction noise	Works will be carried out during standard working hours (i.e. 7 am to 6 pm Monday to Friday; 8 am to 1 pm Saturdays). Any work that is performed outside normal work hours or on Sundays or public holidays is to minimise noise impacts.	Construction contractor	Construction
Construction noise	Construction compounds will be laid-out in such a way that the primary noise sources are at a maximum distance from residences, with solid structures (sheds, containers, etc.) placed between residences and noise sources (and as close to the noise sources as is practical).	Construction contractor	Construction
Plant and equipment noise	Compressors, generators, pumps and any other fixed plant will be located as far away from residences as possible and behind site structures.	Construction contractor	Construction
Truck noise	Material dumps, loading and unloading areas will be located as far as practical from the nearest residences.	Construction contractor	Construction

Plant and equipment noise	Ensure plant is regularly maintained and operating efficiently.	Construction contractor	Construction
Construction noise	All site workers will be briefed on the potential for noise and vibration impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This will include: <ul style="list-style-type: none"> <li>• Avoid the use of loud radios.</li> <li>• Avoid shouting and slamming doors.</li> <li>• Where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.</li> <li>• Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.</li> <li>• Minimise reversing.</li> <li>• All engine covers should be kept closed while equipment is operating.</li> </ul>	Construction contractor	Construction

## 6.7 Waste management

### 6.7.1 Policy setting

Under the *Protection of the Environment Operations Act 1997* (POEO Act), it is an offence to “without lawful authority, wilfully or negligently dispose of waste in a manner which harms or is likely to harm the environment”. Accordingly, the requirements of the POEO Act would be met during the proposal.

### 6.7.2 Impact assessment

#### Construction

Waste produced during the proposal would be managed in accordance with the waste management hierarchy, within which waste avoidance is a priority, followed by reuse and recycling/reprocessing, with disposal as a last resort.

The proposal has the potential to generate the following wastes:

- Green waste as result of vegetation clearing. Noxious weed material would be separated from native green waste.
- Surplus materials used during site establishment such as safety fencing and barriers which may include plastics and metal. The volume of waste is expected to be minimal as it is likely that prefabricated structures would be used.
- Domestic waste including food scraps, aluminium cans, glass bottles, plastic and paper containers, and putrescible waste generated by site construction personnel.
- Contaminated materials, fuel/oil leaks.
- Redundant erosion and sediment controls.

All waste would be removed from site for reuse, recovery or disposal at a licensed waste facility.

Most of the waste is expected to be organic waste (vegetation). All seedlings, branches and twigs would be bagged before being taken off-site to prevent sprouting. Trees would also be removed from the site.

Volumes of other waste types generated by the proposal are expected to be minimal.

All waste would be managed in accordance with the resource management hierarchy and safeguards provided in Section 6.7.3.

### 6.7.3 Mitigation measures

Mitigation measures provided below would be implemented to reduce waste generation and to ensure the appropriate management of wastes.

Impact	Environmental safeguards	Responsibility	Timing
Waste minimisation	The following resource management hierarchy principles will be followed: <ul style="list-style-type: none"> <li>• Avoid unnecessary resource consumption as a priority.</li> <li>• Avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery).</li> <li>• Disposal is undertaken as a last resort (in accordance with the <i>Waste Avoidance and Resource Recovery Act 2001</i>).</li> </ul>	Construction contractor	Construction
Waste management	Waste bins will be provided and recycling of materials encouraged. Waste will be transported to an appropriate waste disposal facility.	Construction contractor	Construction
	All wastes will be managed in accordance with the POEO Act.	Construction contractor	Construction
	Noxious weeds removed during construction will be managed in accordance with the requirements of the <i>Noxious Weeds Act 1993</i> .	Construction contractor	Construction
	All site personnel will be inducted prior to commencing work. The induction will include waste management protocols. Records of induction would be maintained by the Site Supervisor.	Construction contractor	Construction
	There is to be no disposal or re-use of construction waste on to other land.	Construction contractor	Construction
	All waste material would be removed from the subject site.	Construction contractor	Construction

## 6.8 Aboriginal heritage

### 6.8.1 Existing environment

A search of the Aboriginal Heritage Information Management System (AHIMS) was completed in July 2015. No items were identified as occurring in the subject site. A copy of the search is included in Appendix C. The subject site has also previously been disturbed by clearing, road and bridge construction in addition to flood events which erode the shoreline and deposit eroded material downstream.

A survey of the subject site by Amy Armstrong from the Bathurst Local Aboriginal Land Council on 18 August 2014 was completed to search for any unidentified Aboriginal artefacts. This search documented no signs of Aboriginal occupation within the subject site. The Bathurst Local Aboriginal Land Council has no objections to proceeding with the proposal. A copy of the correspondence is included in Appendix B.

## 6.8.2 Impact assessment

Aboriginal heritage items are unlikely to be discovered as none have previously been identified and no signs of Aboriginal occupation were identified during the site visit. Flooding over many decades is also likely to have removed any surface bearing deposits, although it is also possible that some may have been covered as well so could depend on the location.

Due to the previous disturbance on the subject site, Aboriginal heritage items are unlikely to be found during construction. An 'unexpected finds protocol' will be implemented as a mitigation measure to minimise impacts (see Section 6.8.3).

## 6.8.3 Mitigation measures

The following mitigation measures would be implemented to reduce the potential for impacts on Aboriginal heritage during construction:

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal heritage	Construction machinery and personnel will be restricted to the subject site.	Construction contractor	Construction
Unexpected find	If an Aboriginal object (or suspected object) of heritage significance is discovered during the work, all work in that area would cease and the environmental representative for the Contractor would inform BCCs heritage advisor and the OEH in accordance with section 89A of the NPW Act.	Construction contractor	Construction

## 6.9 Non-Aboriginal heritage

### 6.9.1 Existing environment

A desktop search of the following heritage registers was completed in July 2015:

- Australian Heritage Database (National Heritage List, Commonwealth Heritage List and Register of the National Estate)
- NSW State Heritage Register
- Bathurst Regional Local Environmental Plan 2014.

The results of the desktop search are summarised below:

- No items listed on the Australian Heritage Database or State Heritage Register were located in close proximity to the subject site.
- Two items, Sofala Conservation Area (C8), and Royal Hotel (26 Denison Street, I237) are located adjacent to the subject site.





**Figure 6.7 Location of local heritage in relation to the subject site**

### 6.9.2 Impact assessment

The works would take place only within the shoreline of the subject site along the banks of the Turon River and no works would take place outside this area including the identified heritage sites. The proposal would not impact the adjacent non-Aboriginal heritage items. Mitigation measures would be implemented to reduce the potential for impacts, as outlined in Section 6.9.3.

### 6.9.3 Mitigation measures

The following mitigation measures would be implemented to reduce the potential for impacts on non-Aboriginal heritage during construction.

Impact	Environmental safeguards	Responsibility	Timing
Non-Aboriginal heritage items	Works adjacent to the heritage items would be conducted in a manner that ensures there is no damage to the conservation area or Royal Hotel	Construction contractor	Construction
Unexpected find	Works will cease if an item (or suspected item) of non-Aboriginal heritage is discovered during the work, and informing the Contractor's environmental representative who would advise the Bathurst Regional Council Heritage Advisor as soon as possible to determine the subsequent course of action.	Construction contractor	Construction

## 6.10 Traffic and access

### 6.10.1 Existing environment

The proposal is located adjacent to the village of Sofala and Upper Turon Road. Sofala Road and Ilford/Sofala Road intersect the subject site and are joined by the Crossley Bridge, with a posted speed limit of 50 kilometres per hour in the vicinity of the proposal.

A passive recreation area runs parallel to the Turon River on the southern bank in the village of Sofala and the northern bank upon crossing the Crossley Bridge.

### 6.10.2 Impact assessment

#### *Construction traffic*

It is expected that a total of approximately eight heavy vehicle movements would be required for the proposal each day. These heavy vehicle movements would predominantly be required for the delivery of equipment to the proposal site and the removal of thinned vegetation.

A maximum of four workers would be required on the subject site at any one time during the program. This would result in a maximum of eight light vehicle movements to and from the subject site daily.

Total vehicle numbers and movements are expected to be low and the vehicles would be located at sites for short periods of time. The predicted volume of traffic movements associated with the proposal would not impact upon the capacity or operation of the road network.

#### *Access*

The proposal would not be located in close proximity to any private property access points and therefore the proposal is unlikely to impact access to any properties. Pedestrian access during thinning operations would be possible outside of the direct impact area which will be delineated and signposted.

#### *Cyclist and pedestrians*

Where cycle/pedestrian paths exist, they would remain open during construction as far as reasonably possible. If cycle/pedestrian paths need to be closed due to activities for any period of time barrier tape and detour signs would be erected.

### 6.10.3 Mitigation measures

Mitigation measures provided below would be implemented to reduce potential traffic and access impacts.

Impact	Environmental safeguards	Responsibility	Timing
Closure of cycle/pedestrian paths	If cycle/pedestrian paths need to be closed due to activities for any period of time, barrier tape and detour signs would be erected.	Construction contractor	Construction

## 6.11 Hazards and risks

### 6.11.1 Existing environment

The subject site is identified as containing Category 1 and 2 Bushfire Prone Land in the Bathurst Regional Local Environmental Plan 2014.

The subject site has a moderate slope towards the river, with vegetation growing on the river bed and banks.

### 6.11.2 Impact assessment

The proposal is considered unlikely to result in an increase of the risk of bushfire as construction is unlikely to require any hot work which has the potential to ignite nearby vegetation. In addition, smoking would be prohibited on site, with inclusion of this requirement as part of the induction for construction personnel.

Other potential hazards associated with the proposal include:

- Vehicle interactions with personnel or other plant – personal injury or damage to plant/equipment
- Manual handling
- Slips, trips, falls, collisions
- Flash flooding due to works on the river bank

A number of mitigation measures are proposed which would reduce the potential hazards and risks.

### 6.11.3 Mitigation measures

Mitigation measures provided below would be implemented:

Impact	Environmental safeguards	Responsibility	Timing
General fire safety	Providing suitable fire suppression equipment (extinguishers, pumps, hoses etc) on site for the duration of work	Construction contractor	Construction
	Prohibit smoking on site and include in the induction	Construction contractor	Construction
	Incident management procedures to include evacuation procedures in the event of a bushfire or other contingency event	Construction contractor	Construction
Accidental spills	Spill kit on site	Construction contractor	Construction
Heavy vehicle interactions and collisions	Safe work method statements for vehicle use in vicinity of personnel Machine inductions/licensing Reversing alarms High visibility PPE	Construction contractor	Construction
Manual handling	Use of appropriate equipment for manual tasks Rotation of job roles where appropriate	Construction contractor	Construction
Slips, trips, falls	Safe work method statements for works on river bank and surrounding areas PPE including appropriate footwear and clothing	Construction contractor	Construction
Flash flooding	Incident management procedures to include procedures in the event of a flash flood event	Construction contractor	Construction

## 6.12 Visual

### 6.12.1 Existing environment

The visual landscape in the vicinity of the proposal is dominated by vegetation generally associated with the Turon River and its riparian zone.

The subject site is visible to motorists on Crossley Bridge and to residents of Sofala backing on to the river or with views of the river.

### 6.12.2 Impact assessment

Construction of the proposal is expected to impact temporarily on the visual amenity of the local environment, including:

- clearing of vegetation
- temporary stockpiles of vegetation
- use and storage of machinery, equipment and work vehicles

### 6.12.3 Mitigation measures

The following mitigation measures are proposed:

Impact	Environmental safeguards	Responsibility	Timing
Clearing of vegetation	Native seed dispersal to assist in the regeneration of native vegetation along the river bank	Construction contractor	Construction

## 6.1 Social

### 6.1.1 Existing environment

Sofala is a small historic village on the Turon River. The village has a rich gold mining history in a picturesque setting.

### 6.1.2 Impact assessment

The proposal would benefit the community by minimising the potential for flooding in the village of Sofala during high flow levels in the Turon River.

The proposal is not expected to impact on any Aboriginal or non-Aboriginal heritage items (refer Sections 6.8 and 6.9). However, it may result in minor short term amenity impacts on the local community due to the following:

- Potential increase in construction traffic due to the delivery of plant, materials and construction personnel.
- Increases in noise due the operation of plant and equipment and increased traffic.
- Visual impacts due to construction work.
- Potential dust disturbance due to exposed soils and stockpiles.

These issues have been outlined and assessed in other sections of this report, as follows:

- Traffic (refer Section 6.10).
- Noise and vibration (refer Section 6.6).
- Visual (refer Section 6.12)
- Air quality (refer Section 6.5).

Amenity in the broader area is unlikely to be impacted by construction as impacts would be localised and limited to areas immediately adjacent to the proposal site.

### 6.1.3 Mitigation measures

Impact	Environmental safeguards	Responsibility	Timing
Construction impacts on the community	Local residents will be notified before work starts and would be kept regularly informed of construction activities during the construction process.	Construction contractor	Pre-construction and Construction
Construction impacts on road users	Should any traffic disruptions occur, road users will be informed of any changed conditions.	Construction contractor	Construction

## 6.2 Cumulative impact

Potential cumulative impacts associated with the proposal would be short term and impacts would be localised. Council is unaware of any other projects that would be occurring concurrently with the proposal that have the potential to result in cumulative impacts.

The proposal would benefit the community by seeking to alleviate the flooding risk during high flow events of the Turon River.

## 6.3 Demand and resources

Construction work would not result in an excessive demand on any resources that are in short supply or at risk of becoming in short supply.

## 6.4 Ecological sustainable development

The proposal has been assessed against the following four principles of ecologically sustainable development listed in the *Protection of the Environment Administration Act 1991*:

- the precautionary principle.
- the principle of inter-generational equity.
- the principle of biological diversity and ecological integrity.
- the principle of improved valuation of environmental resources.

An assessment of compliance of the proposal with these principles is provided below.

### 6.4.1 Precautionary principle

The precautionary principle states that:

*‘if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

*In the application of the precautionary principle, public and private decisions should be guided by:*

- careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment, and
- an assessment of the risk-weighted consequences of various options’

A range of environmental issues have been considered in the preparation of this EIA. There are not considered to be any threats of serious or irreversible environmental damage.

The proposal has evolved to avoid environmental impact where practicable and mitigation measures would be implemented to reduce identified impacts. No mitigation measures have been deferred due to a lack of scientific certainty. The proposal is therefore considered to be consistent with the precautionary principle.

#### **6.4.2 Principle of inter-generational equity**

The principle of inter-generation equity states that:

*'the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.'*

The proposal aims to minimise the potential for flooding in the village of Sofala during high flow levels in the Turon River. The proposal would not result in any impacts that are likely to impact on the health, diversity or productivity of the environment for future generations. The proposal would benefit future generations of Sofala by aiming to reduce the potential for flooding which will make living in certain areas of Sofala safer and more attractive.

#### **6.4.3 Principle of biological diversity and ecological integrity**

The principle of biological diversity and ecological integrity states that:

*'conservation of biological diversity and ecological integrity should be a fundamental consideration.'*

Compared with other options considered, the proposal would reduce impacts on vegetation to the practical extent necessary while still meeting the objectives of the project. No area of native vegetation would be entirely removed. Impacts on flora and fauna have been considered in Section 6.1. The assessment found that the proposal is not likely to have a significant effect on any listed threatened species, population or ecological community and unlikely to pose a significant impact on any MNES.

#### **6.4.4 Improved valuation of environmental resources**

The principle of improved valuation of environmental resources states that:

*'environmental factors should be included in the valuation of assets and services, such as:*

- i. polluter pays – that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement,
- ii. the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste,
- iii. environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.'

The cost of environmental resources includes the costs incurred to protect the environment, including communities. The safeguards imposed to reduce the adverse impacts of this proposal would result in a cost to Council. This indicates the valuation of environmental resources has been considered and included in the proposal.

The proposal has been designed to reduce adverse impacts on the environment by confining work to a defined area and implementing appropriate mitigation measures when impacts are expected.

## **6.5 Justification of the proposal**

The proposal is considered justified as it will:

- Help reduce the potential for flooding hazard to the village of Sofala in the occurrence of a large scale flood event.
- Help mitigate flooding impacts whilst still maintaining a fully functioning native ecosystem.
- Lay the foundations to improve, through time, native vegetation cover throughout the riparian zone through bush regeneration works.
- Improve connectivity of native vegetation in the locality.
- Invest in improving the condition of retained vegetation.



# 7. Environmental management

Environmental management measures would be implemented during construction of the proposal in the form of an environmental management plan. An environmental management plan is a site or project specific plan developed to ensure that appropriate environmental practices are followed during the construction of a project (DIPNR, 2004). It is also an advisory document for regulatory authorities. According to the NSW Department of Planning and Infrastructure (DIPNR, 2004) an effective environmental management plan must ensure:

- the application of best practice environmental management to a project
- the implementation of a project environmental impact assessment including its conditions of approval
- compliance with environmental legislation
- that environmental risks associated with a project are properly managed.

This section details the provisions that would be included in a construction environmental management plan developed for the proposal and provides guidance for Bathurst Regional Council and the contractor when developing this plan.

## 7.1 Construction Environmental Management Plan

Prior to the commencement of construction, the contractor would prepare a CEMP for the construction of the proposal. The CEMP would cover the construction of the proposal and would be based upon, but not limited to, the contents of this section, and incorporate the mitigation measures outlined in this environmental assessment, thus maintaining the validity of this impact assessment.

The CEMP would be prepared once Council has determined to proceed with the proposal. The CEMP would include details such as:

- the statutory context of the proposal
- a brief description of the existing environment
- a brief description of the proposal
- details of the construction staging and timetable
- the construction activities and equipment to be used
- specific environmental issues and objectives and the location of sensitive sites shown on site plans
- details of the environmental management system
- the roles and responsibilities of key proposal team members
- the mitigation measures identified in Chapter 7.2 of this environmental assessment
- reporting requirements
- the consultation and communication as required
- the approvals and licences required
- the complaints handling and dispute resolution procedures
- emergency planning and response procedures

Environmental work method statements would also be prepared by the contractor that provides details of how the construction activities would comply with the CEMP. The work method statements would describe all the methods and safeguards to be adopted to mitigate potential environmental impacts during construction and would include maps showing sensitive areas and the location of environmental controls. Sub-contractors would be required to adhere to these environmental work method statements and the CEMP.

## 7.2 Summary of mitigation measures

The following provides a summary of the proposed mitigation measures for the proposal.

**Table 7.1 Summary of mitigation measures**

Impact	Environmental safeguards	Responsibility	Timing
Hydraulics and morphology			
Erosion and sedimentation	<ul style="list-style-type: none"> <li>Installation of erosion and sediment control measures prior to works</li> <li>Communication with personnel involved in works of the conservation value of surrounding vegetation and their responsibilities with regards to protecting vegetation and fauna habitats during works.</li> <li>All equipment must be refuelled at least 20 metres away from the river and all fuel and chemical storages should be bunded.</li> </ul>	Construction contractor	Construction
Vegetation disturbance and weeds	<ul style="list-style-type: none"> <li>Installation of temporary fencing to clearly delineate work zones and areas of vegetation to be retained</li> <li>Washing of vehicles and plant prior to work on site to prevent the spread of Phytophthora (<i>Phytophthora cinnamomi</i>) and Myrtle Rust (<i>Pucciniales fungi</i>) in line with the national best practice guidelines for Phytophthora (DEH 2006) and Myrtle Rust factsheet (DPI 2011) for hygiene control</li> <li>Herbaceous weeds to be controlled with the application of Roundup® Biactive herbicides applied using 'back packs' where revegetation activities are dominated by hand planting by suitably qualified and experienced contractors</li> <li>Weed disposal protocols such as the removal of large environmental woody weeds as part of a staged program</li> <li>Staged removal of willow and other woody weeds commencing in the upper reaches of the catchment and working down with the root ball of these species left in situ removal of saplings and emergent seedlings by hand with root systems left in situ.</li> </ul>	Construction contractor	Construction
Fauna	<ul style="list-style-type: none"> <li>Machinery is to be excluded from the river bed and from within 3 metres of the banks to protect Booroolong Frog habitat</li> <li>Avoid the removal of hollow-bearing trees and trees with flaking bark</li> <li>Avoid the removal of fallen timber</li> </ul>	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	<ul style="list-style-type: none"> <li>A fauna management protocol, including pre-clearing surveys for nests or sheltering terrestrial fauna and rescue and salvage of fauna where possible</li> <li>Protocols to prevent introduction or spread of chytrid fungus following OEH Hygiene protocol for the control of disease in frogs (DECCW, 2008) must be implemented.</li> </ul>		
Aquatic habitat	<ul style="list-style-type: none"> <li>Minimise and control sediment movement as a result of proposed works to limit sedimentation and maintain water quality as described above</li> <li>Maintain root balls for any trees close to the water line to ensure bank stability and provide consistent habitat for fish and macroinvertebrates.</li> </ul>	Construction contractor	Construction
<b>Air quality</b>			
Dust and particulates	Works are not to be carried out during strong winds or in weather conditions where high levels of dust or air borne particulates are likely.	Construction contractor	Construction
Odours and dust	Vehicles transporting waste or other materials that may produce odours or dust are to be covered during transportation.	Construction contractor	Construction
Emissions	Construction plant and equipment will be maintained in a good working condition in order to limit impacts on air quality.	Construction contractor	Construction
Emissions	Plant and machinery will be turned off when not in use and would not be left idling.	Construction contractor	Construction
Smoke	Vegetation or other materials will not be burnt on site.	Construction contractor	Construction
<b>Construction and vibration</b>			
Construction noise	Works will be carried out during normal work hours (i.e. 7 am to 6 pm Monday to Friday; 8 am to 1 pm Saturdays). Any work that is performed outside normal work hours or on Sundays or public holidays is to minimise noise impacts.	Construction contractor	Construction
Construction noise	Construction compounds will be laid-out in such a way that the primary noise sources are at a maximum distance from residences, with solid structures (sheds, containers, etc) placed between residences and noise sources (and as close to the noise sources as is practical).	Construction contractor	Construction
Plant and equipment noise	Compressors, generators, pumps and any other fixed plant will be located as far away from residences as possible and behind site structures.	Construction contractor	Construction
Truck noise	Material dumps, loading and unloading areas will be located as far as practical from the nearest residences.	Construction contractor	Construction
Truck noise	Work involving heavy articulated trucks and concrete trucks will be limited to the	Construction contractor	Construction

Impact	Environmental safeguards	Responsibility	Timing
	recommended construction hours where feasible and reasonable.		
Plant and equipment noise	Ensure plant is regularly maintained and operating efficiently.	Construction contractor	Construction
Construction noise	<p>All site workers will be briefed on the potential for noise and vibration impacts on local residents and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities. This will include:</p> <ul style="list-style-type: none"> <li>• Avoid the use of loud radios.</li> <li>• Avoid shouting and slamming doors.</li> <li>• Where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods.</li> <li>• Keep truck drivers informed of designated vehicle routes, parking locations and delivery hours.</li> <li>• Minimise reversing.</li> </ul> <p>All engine covers should be kept closed while equipment is operating.</p>	Construction contractor	Construction
<b>Waste management</b>			
Waste minimisation	<p>The following resource management hierarchy principles will be followed:</p> <ul style="list-style-type: none"> <li>• Avoid unnecessary resource consumption as a priority.</li> <li>• Avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling and energy recovery).</li> </ul> <p>Disposal is undertaken as a last resort (in accordance with the <i>Waste Avoidance and Resource Recovery Act 2001</i>).</p>	Construction contractor	Construction
Waste management	Waste bins will be provided and recycling of materials encouraged. Waste will be transported to an appropriate waste disposal facility.	Construction contractor	Construction
	All wastes will be managed in accordance with the POEO Act.	Construction contractor	Construction
	Noxious weeds removed during construction will be managed in accordance with the requirements of the <i>Noxious Weeds Act 1993</i> .	Construction contractor	Construction
	All site personnel will be inducted prior to commencing work. The induction will include waste management protocols. Records of induction would be maintained by the Site Supervisor.	Construction contractor	Construction
	There is to be no disposal or re-use of construction waste on to other land.	Construction contractor	Construction
	All waste material would be removed from the subject site.	Construction contractor	Construction
<b>Aboriginal heritage</b>			

Impact	Environmental safeguards	Responsibility	Timing
Aboriginal heritage	Construction machinery and personnel will be restricted to the subject site.	Construction contractor	Construction
Unexpected find	If an Aboriginal object (or suspected object) of heritage significance is discovered during the work, all work in that area would cease and the environmental representative for the Contractor would inform BCCs heritage advisor and the OEH in accordance with section 89A of the NPW Act.	Construction contractor	Construction
<b>Non-Aboriginal heritage</b>			
Non-Aboriginal heritage items	Works adjacent to the heritage items would be conducted in a manner that ensures there is no damage to the conservation area or Royal Hotel	Construction contractor	Construction
Unexpected find	Works will cease if an item (or suspected item) of non-Aboriginal heritage is discovered during the work, and informing the Contractor's environmental representative who would advise the Bathurst Regional Council Heritage Advisor as soon as possible to determine the subsequent course of action.	Construction contractor	Construction
<b>Traffic and access</b>			
Closure of cycle/ pedestrian paths	If cycle/pedestrian paths need to be closed due to activities for any period of time, barrier tape and detour signs would be erected.	Construction contractor	Construction
<b>Hazards and risk</b>			
General fire safety	Providing suitable fire suppression equipment (extinguishers, pumps, hoses etc) on site for the duration of work	Construction contractor	Construction
	Prohibit smoking on site and include in the induction	Construction contractor	Construction
	Incident management procedures to include evacuation procedures in the event of a bushfire or other contingency event	Construction contractor	Construction
Accidental spills	Spill kit on site	Construction contractor	Construction
Heavy vehicle interactions and collisions	Safe work method statements for vehicle use in vicinity of personnel Machine inductions/licensing Reversing alarms High visibility PPE	Construction contractor	Construction
Manual handling	Use of appropriate equipment for manual tasks Rotation of job roles where appropriate	Construction contractor	Construction
Slips, trips, falls	Safe work method statements for works on river bank and surrounding areas PPE including appropriate footwear and clothing	Construction contractor	Construction
Flash flooding	Incident management procedures to include procedures in the event of a flash flood event	Construction contractor	Construction
<b>Visual</b>			

Impact	Environmental safeguards	Responsibility	Timing
Clearing of vegetation	Native seed dispersal to assist in the regeneration of native vegetation along the river bank	Construction contractor	Construction
<b>Social</b>			
Construction impacts on the community	Local residents will be notified before work starts and would be kept regularly informed of construction activities during the construction process.	Construction contractor	Pre-construction and Construction
Construction impacts on road users	Should any traffic disruptions occur, road users will be informed of any changed conditions.	Construction contractor	Construction

## **8. Conclusion**

This environmental impact assessment has been prepared in accordance with Part 5 of the EP&A Act for the proposed flood mitigation works at Sofala. The assessment has identified that there is potential for some minor impacts associated with the proposal. Impacts associated with construction activities would be localised and short term in nature would be managed by implementing appropriate mitigation measures. A construction environmental management plan will be prepared which will be implemented during construction. Implementation of the mitigation measures documented will reduce harm to the local environment and any potential impacts arising from the proposal.



## 9. References

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# Appendices

# Appendix A – Consideration of Clause 228(2) factors and matters of national environmental significance

## Clause 228 matters for consideration

The below table summarises provisions listed under Clause 228 of the *Environmental Planning and Assessment Regulation 2000* which outlines the factors that must be taken into account when considering the impact of an activity on the environment.

Factor	Impacts
<p>(a) Any environmental impact on a community.</p> <p><i>Comments:</i></p> <p>It is not envisaged that there would be any significant adverse environmental impacts on the local community as a result of the project. There may be temporary impacts due to noise, air quality related to construction activities, and access to the rest and recreation area. These impacts would be short term and would be managed by implementing appropriate mitigation measures</p> <p>There would be no long term impacts on the community as the subject site would be returned to a similar state.</p> <p>The proposal would be beneficial for the Sofala community as it would aim to alleviate the risk of a large flow flood event, which would result in impacts to the village.</p>	
	<p>Short term – Negative</p> <p>Long term – Positive</p>
<p>(b) Any transformation of a locality.</p> <p><i>Comments:</i></p> <p>Surface work for the proposal is limited to the removal of woody weeds, leaving the root-ball intact.</p> <p>At the completion of project, ground levels would not have varied from their existing state and sites would be rehabilitated</p>	
	<p>Short term – Nil</p>
<p>(c) Any environmental impact on the ecosystems of the locality.</p> <p><i>Comments:</i></p> <p>The proposal would result in some minor impacts to flora and fauna during the construction phase, these impacts would be associated with direct impacts to vegetation due to thinning works. Assessments of significance were undertaken for potentially affected biota, these assessments concluded that impacts would not be significant.</p> <p>There would be no long term effects on ecosystems in the vicinity of the proposal.</p>	
	<p>Short term – Negative</p> <p>Long term - Nil</p>
<p>(d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality.</p> <p><i>Comments:</i></p> <p>There may be temporary impacts to noise and air quality related to construction activities, and access to the rest and recreation area. However these impacts would be minor and short term in nature and managed by implementing appropriate mitigation measures. Any possible risks to environmental quality as identified through the consultation process have been assessed in this EIA. Any reduction in the aesthetic, recreational, scientific or other environmental quality or value of the locality would be minimal.</p>	
	<p>Short term - Minor Negative</p>

Factor	Impacts
<p>(e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations.</p> <p><i>Comments:</i></p> <p>The proposal has been assessed as not resulting in any impacts to both Aboriginal and non-Aboriginal heritage. But aesthetic changes would be noticeable from air quality, noise and visual. These however would be temporary and minimal.</p>	<p>Nil</p>
<p>(f) Any impact on the habitat of protected fauna (within the meaning of the <i>National Parks and Wildlife Act 1974</i>).</p> <p><i>Comments:</i></p> <p>The proposal would remove some habitat for protected fauna, however the proposal is considered unlikely to have any substantial impact on habitat for protected fauna as only some trees will be removed and existing habitat resources will be largely retained.</p>	<p>Minor negative</p>
<p>(g) Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air.</p> <p><i>Comments:</i></p> <p>The potential impacts on threatened and vulnerable fauna species and their habitats have been assessed in this EIA. With the implementation of mitigation measures identified in the EIA impacts on fauna is considered to be minimal.</p>	<p>Minor Negative</p>
<p>(h) Any long-term effects on the environment.</p> <p><i>Comments:</i></p> <p>There would not be any significant long-term adverse effects on the environment caused by this proposal.</p>	<p>Nil</p>
<p>(i) Any degradation of the quality of the environment.</p> <p><i>Comments:</i></p> <p>The proposal has the potential to cause a short-term reduction in the quality of the environment resulting from construction activities due to noise, air quality (dust) and visual impacts. These impacts would be temporary and minor in nature.</p> <p>The proposal would not result in any long term quality impacts.</p>	<p>Short term - Minor Negative</p> <p>Nil</p>
<p>(j) Any risk to the safety of the environment.</p> <p><i>Comments:</i></p> <p>The proposal would result in some localised potential hydraulic and morphologic risks including an increased risk of erosion in the area upstream of Section 1179, a potential for channel bed aggregation and an increased flooding risk for buildings adjacent to the Turon River approximately 200 to 300 metres upstream of the Crossley Bridge. However a monitoring program would be implemented to assess the morphological responses and risks would be managed through the implementation of a number of mitigation measures.</p> <p>The proposal is unlikely to result in any significant risks to the safety of the environment. Mitigation measures would be implemented to manage potential impacts.</p>	<p>Minor Negative</p>

Factor	Impacts
<p>(k) Any reduction in the range of beneficial uses of the environment.</p> <p><i>Comments:</i></p> <p>Community access to the water front would be limited during the works. However, the restriction would be temporary only. The proposal would not significantly reduce the range of beneficial uses of the environment.</p>	<p>Short Term – Minor Negative</p>
<p>(l) Any pollution of the environment.</p> <p><i>Comments:</i></p> <p>During construction, the proposal has the potential to cause localised noise, air, and water pollution (erosion and sedimentation or accidental spills). These impacts would be minimised by implementing the mitigation measures outlined in Section 4.</p> <p>The proposal would not result in any long term pollution of the environment.</p>	<p>Short term - Minor Negative</p> <p>Long term - Nil</p>
<p>(m) Any environmental problems associated with the disposal of waste.</p> <p><i>Comments:</i></p> <p>Waste created during the vegetation thinning period would be removed from the subject site daily and disposed of at appropriately licensed facilities.</p>	<p>Nil</p>
<p>(n) Any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply.</p> <p><i>Comments:</i></p> <p>The proposal would not increase the demand on any resources that are or are likely to become in short supply.</p>	<p>Nil</p>
<p>(o) Any cumulative environmental effect with other existing or likely future activities.</p> <p><i>Comments:</i></p> <p>The proposal would not result in any significant cumulative environmental effects with any other existing activities.</p>	<p>Nil</p>
<p>(p) Any impact on coastal processes and coastal hazards, including those under projected climate change conditions.</p> <p><i>Comments:</i></p> <p>The proposal is not located within the coastal area and as such does not have the potential to impact upon coastal processes.</p>	<p>Nil</p>

## Matters of National Environmental Significance

Under the environmental assessment provisions of the EPBC Act, the following Matters of NES are required to be considered to assist in determining whether the proposal should be referred to the Department of the Environment and Energy.

Factor	Impact
a. Any impact on a World Heritage property? The proposal would not have any impact on a World Heritage property. There are no World Heritage properties within 10 kilometres of the proposal.	Nil
b. Any impact on a National Heritage place? The proposal would not have any impact on a National Heritage place. There are no National Heritage places located within 10 kilometres of the proposal.	Nil
c. Any impact on a wetland of international importance? The proposal would not have any impact on a wetland of international importance. There are no wetlands of international importance within 10 kilometres of the subject site.	Nil
d. Any impact on nationally threatened species or communities? A total of 26 threatened species were identified within 10 kilometres of the proposal. Impacts on threatened species listed under the EPBC Act are considered minimal. An assessment of significance was completed for the Booroolong Frog and this assessment concluded that no significant impacts would be experienced.	Minor negative
e. Any impacts on listed migratory species? A total of 11 migratory species were identified within 10 kilometres of the proposal. The proposal is considered unlikely to result in any impacts to migratory species.	Nil
f. Any impact on a Commonwealth marine area? The proposal would not have any impact on a Commonwealth marine area. No Commonwealth marine areas occur within 10 kilometres of the subject site.	Nil
i. Any impact on the Great Barrier Reef Marine Park? The proposal would not result in any impacts to the Great Barrier Reef Marine Park due to its distance from the park.	Nil
g. Does the proposal involve a nuclear action (including uranium mining)? The proposal does not involve a nuclear action.	Nil
h. Any impact on a water resource, in relation to coal seam gas development and large coal mining development? The proposal would not directly impact Commonwealth land, and is unlikely to indirectly impact Commonwealth land.	Nil

The proposal would not affect Commonwealth land and no Commonwealth agencies are proposing to take an action associated with the proposal.

# **Appendix B** – Ecological Impact Assessment

GHD 2016





## Bathurst Regional Council

### Sofala Flood Mitigation Project

### Ecological Impact Assessment

December 2015

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## Appendices

Appendix A – Likelihood of occurrence of threatened and migratory biota

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# 1. Introduction

## 1.1 Overview

GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council (“Council”) to prepare an ecological impact assessment to assess potential impacts arising from flood mitigation works to be undertaken along approximately 2,000 metres of riparian zone along the Turon River near the township of Sofala, NSW (see Figure 1 for the locality of the proposal).

This ecological impact assessment assesses the potential for impacts on ecological values at the site, with particular emphasis on threatened ecological communities, populations and species listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and *Fisheries Management Act 1994* (FM Act), and *Matters of National Environmental Significance* (MNES) listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Recommended mitigation measures to ameliorate potential impacts of the proposal are included in section 6 of this report.

## 1.2 Background and proposal description

Flood mitigation works were recommended in recent Floodplain Management Policy as the most efficient method to manage flood risks to the Sofala community. The Sofala Floodplain Risk Management Study recommended that the River Oaks (*Casuarina cunninghamia*) in the immediate upstream vicinity of the Crossley Bridge be removed, so as to help mitigate structural damage to the bridge during large flooding events (Cardno 2007). GHD has prepared a Vegetation Management Plan (VMP) to manage the thinning and rehabilitation of the vegetation along the Turon River at Sofala (GHD 2016). This plan recommends that the River Oaks be thinned to maintain a stems per hectare ratio that would be at the lower end of the benchmark for that vegetation type. This recommendation allows for positive outcomes by reducing the impact of flooding and maintaining a functioning ecosystem. The objective of the thinning program will be to maintain a stem density of less than 720 stems per hectare throughout the study area. Large areas of the study area have plant densities significantly higher than this, including the reach immediately to the north of the Sofala village and upstream of the bridge. Vegetation thinning would focus on the removal of smaller saplings and regenerating plants. Removal of large woody weeds (eg Willows) would also be carried out. Root balls would be retained to ensure bank stability (GHD 2016). Further detail of the vegetation thinning is provided in the VMP (GHD 2016).

The main focus of this ecological impact assessment is the selective thinning of the River Oaks. Additional matters relating to the recreation strategy are also included. The proposal comprises the following key aspects:

- Selective thinning of River Oaks to reduce the density of native riparian vegetation in the study area. Felling of trees will be carried out by hand to minimise ground disturbance, however a small mobile plant would be used to remove felled trees from the site. Access would be via an existing access track within the Sofala township on the southern side of the river and where possible, existing access tracks on the northern side of the river.
- Construction and maintenance of a foot path network to provide for passive movement along the southern edge of the riparian corridor and a loop walk on the northern side of the river (Figure 2).



- Revegetation with a more diverse and suitable species composition in the disturbed area near Crossley Bridge (Figure 2).

Works will be undertaken within 40 metres of the Turon River, which is defined as waterfront land under the *Water Management Act 2000* (WM Act). Under the WM Act, local councils are exempt from the need to obtain a controlled activity approval for any controlled activities they carry out on waterfront land. An impact assessment is required to assess the potential for impacts on threatened biota listed under the TSC Act, FM Act and EPBC Act..

### 1.3 Terms and definitions

The following terms are used in this report:

*The proposal:* proposed flood mitigation works at Sofala, including thinning of vegetation along the Turon River.

*Subject site:* the area in which vegetation thinning and revegetation will occur, which is the area extending approximately 500 metres upstream of Crossley Bridge at Sofala (see Figure 3).

*Study area:* the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. In this assessment it includes the proposed flood mitigation works, including the subject site defined above, as well as adjacent native vegetation and downstream areas of the Turon River that may be indirectly impacted by the proposal. The study area also extends well upstream of the subject site to allow for a control site for aquatic surveys and monitoring. The proposed walking trail is included in the study area as this will have minimal impact on the waterfront land (see Figure 3).

*Locality:* the area within a 10 kilometre radius of the subject site (see Figure 1).

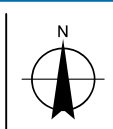
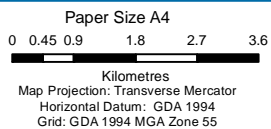
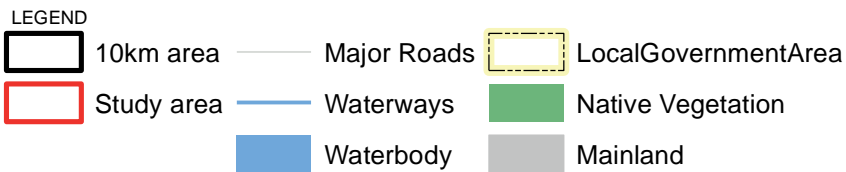
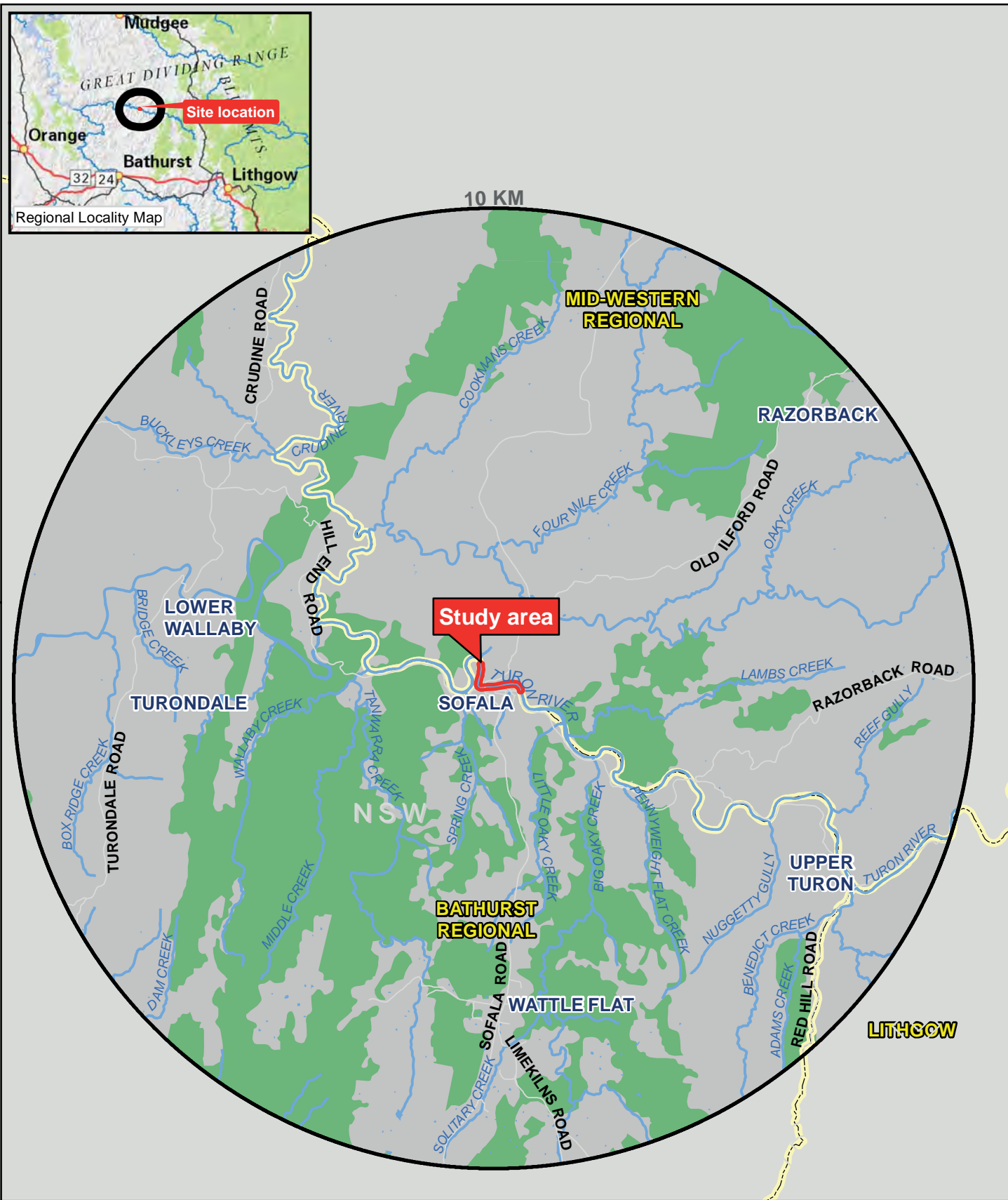
*Threatened and migratory biota:* Threatened species, populations and ecological communities that are listed under the TSC Act, FM Act and/or the EPBC Act and migratory species listed under the EPBC Act.

### 1.4 Scope of assessment

The scope of this Flora and Fauna Impact Assessment report is to:

- Conduct a desktop assessment to compile a list of threatened or migratory biota previously recorded, or predicted to occur in the locality.
- Describe the existing terrestrial environment of the study area, including flora species, vegetation communities, fauna species and habitats known or likely to occur.
- Describe the existing aquatic environment of the study area, including aquatic species and habitats known or likely to occur.
- Assess the value and conservation significance of native vegetation and habitats in the study area and the likelihood of occurrence of threatened biota based on the habitats present.
- Assess impacts of the proposal, addressing potential effects on native flora and fauna and particularly threatened biota and their habitats.
- Complete assessments of significance according to section 5A of the EP&A Act (the seven-part test) for threatened biota known or likely to occur in the study area and/or be affected by the proposal.
- Complete assessments of significance for EPBC Act MNES known or likely to occur in the study area and/or be affected by the proposal.

- Recommend mitigation measures to reduce impacts on biodiversity values.
- Provide concluding statements regarding the likely significance of impacts of the proposal on biodiversity values and on threatened biota or EPBC Act Matters of National Environmental Significance and the requirement or otherwise for further assessment or approvals at the State or Commonwealth level.



Sofala Flood Mitigation Project  
Bathurst Regional Council

Job Number | 21-23439  
Revision | A  
Date | 06 Feb 2015

Site location

Figure 1





- LEGEND**
- WALKING TRAIL
  - REVEGETATION AREA
  - PASSIVE RECREATION AREAS
  - HIGH WEED INFESTATION AREAS
  - LOW WEED INFESTATION AREAS



date: SEPT 2011  
job no: 22-15807  
drawing: SK001-RA

# BATHURST REGIONAL COUNCIL SOFALA VEGETATION MANAGEMENT PLAN

## 2. Legislative context

### 2.1 NSW legislation

#### 2.1.1 Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act forms the legal and policy platform for proposal assessment and approval in NSW and aims to, among other things, 'encourage the proper management, proposal and conservation of natural and artificial resources'. Under Section 111(1) of the Act, determining authorities must 'examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity'. This report addresses the ecological components of the environment to assist Council with addressing Section 111 of the Act.

In addition, Section 111(4) of the Act states that the determining authority must consider the effect of an activity on:

- 'Critical habitat' (as defined under the TSC Act and FM Act).
- Species, populations or ecological communities, or their habitats (as listed under the TSC Act and FM Act) and whether there is likely to be a 'significant effect' on those species, populations or ecological communities.
- Other protected fauna or protected native plants listed under the *National Parks and Wildlife Act 1974*.

Section 5A of the EPA Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of a proposed activity on threatened species, populations or ecological communities (or their habitats) listed under the TSC Act and the FM Act. The '7-part test' is used to assist in the determination of whether a proposal is 'likely' to impose a significant effect on threatened biota. Section 5A of the EPA Act has been addressed as part of this assessment and 7-part tests have been completed for relevant threatened species and ecological communities that are likely to be affected by the proposal and are presented in Appendix D.

If a significant impact on threatened biota is likely, a Species Impact Statement (SIS) must be completed and a licence obtained pursuant to Part 6 of the TSC Act. No significant impacts on threatened biota are anticipated from the proposal, and an SIS is therefore not required (refer to Section 5).

#### 2.1.2 Threatened Species Conservation Act 1995 (TSC Act)

The TSC Act provides legal status for biota of conservation significance in NSW. The Act aims to amongst other things, 'conserve biological diversity and promote ecologically sustainable proposals'. It provides for:

- The listing of 'threatened species, populations and ecological communities', with endangered species, populations and communities listed under Schedule 1, 'critically endangered' species and communities listed under Schedule 1A, vulnerable species and communities listed under Schedule 2.
- The listing of 'Key Threatening Processes' (KTPs) (under Schedule 3).
- The preparation and implementation of Recovery Plans and Threat Abatement Plans.
- Requirements or otherwise for the preparation of Species Impact Statement (SIS).



The TSC Act has been addressed in the current assessment through:

- Desktop review to determine the threatened species, populations or ecological communities that have been previously recorded within the locality of the site and hence could occur subject to the habitats present.
- Targeted field surveys for threatened species listed under the Act.
- Identification, assessment and mapping of threatened ecological communities (TECs) listed under the Act that have the potential to be affected by the proposal.
- Identification of KTPs operating in the study area and the potential for the proposal to increase the operation of these KTPs.
- Identification of suitable impact mitigation and environmental management measures for threatened species, where required.
- Assessment of potential impacts on threatened biota.

### 2.1.3 Fisheries Management Act 1994 (FM Act)

The objects of the FM Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. It provides for:

- The listing of threatened species, populations and ecological communities, with endangered species, populations and communities listed under Schedule 4, critically endangered species and communities listed under Schedule 4A, vulnerable species and communities listed under Schedule 5.
- The listing of 'Key Threatening Processes' (under Schedule 6).
- Diseases affecting fish and marine vegetation (under Schedule 6B).
- Noxious fish and noxious marine vegetation (under Schedule 6C).
- The preparation and implementation of Recovery Plans and Threat Abatement Plans.
- Requirements or otherwise for the preparation of a SIS.

As for biota listed under the TSC Act, potential impacts on any of these threatened biota must be addressed through 7 part tests in accordance with Section 5A of the EPA Act. If a significant impact is likely, an SIS must be completed and a licence obtained pursuant to Part 7a of the FM Act. The proposal is considered unlikely to impact on any threatened biota listed under the FM Act (see Section 4.3.2). The proposal does not involve any dredging or reclamation that would require specific consideration under the Act.

One of the objectives of the FM Act is to conserve key fish habitats which include aquatic habitats that are important to the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. Coxs River and the Macquarie River and many of their tributaries are defined as key fish habitat. To assist in the protection of key fish habitats, the Department of Primary Industries (DPI) has produced the *Policy and guidelines for fish habitat conservation and management* (DPI 2013 update). This policy applies to the following developments, works or activities, each of which can impact on fish habitat:

- Dredging or reclamation.
- Impeding fish passage.
- Damaging marine vegetation.
- Desnagging.

The proposal would not comprise dredging, would not temporarily or permanently block fish passage, and would not impact any marine vegetation listed under the FM Act.

The removal of snags is considered 'dredging under the FM Act and public authorities are required to notify the Minister of any proposal to remove or relocate snags, in particular fallen trees or rocks. In order of preference, DPI prefers lopping of snags, realignment of snags and finally relocation of snags. The proposal is unlikely to result in desnagging or disturbance of snags. Some fallen trees may be removed from within the riparian vegetation which may act as snags during high flow periods of during floods.

The FM Act has been addressed in this assessment through undertaking:

- A desktop review to determine the threatened species, populations or ecological communities that have been previously recorded within the locality of the site and hence could occur within the site, subject to the habitats present.
- Assessment of aquatic habitats during terrestrial field surveys.
- Assessment of impacts on threatened species, populations and ecological communities and their habitat listed under the FM Act.
- Assessment of impacts on key fish habitat.

#### 2.1.4 Water Management Act 2000 (WM Act)

The WM Act controls the carrying out of activities in or near water sources in NSW. 'Water sources' are defined very broadly and include any river, lake, estuary or place where water occurs naturally on or below the surface of the ground, and NSW coastal waters. Under the WM Act, 'waterfront land' is defined as land within 40 m of a river, lake, estuary or shoreline. A river includes 'any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved'. If a 'controlled activity' is proposed on 'waterfront land', an approval is required under the WM Act (Section 91E), however local councils are exempt from the need to obtain a controlled activity approval for any controlled activities that it carries out in, on or under waterfront land.

Notwithstanding the exemption from obtaining a controlled activity approval, this ecological impact assessment has taken into account the objectives and principles of the WM Act. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. The objectives of the WM Act (Section 3) are to 'provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations'. As discussed in this report, the proposal includes the revegetation of riparian areas to improve habitat values and water quality along the creeks in the study area. This will benefit both present and future generations. The water management principles as described in Section 5 of the WM Act have been considered in this report. The proposal would ensure that the quality of riparian vegetation is improved in the long term, which in turn would improve water quality. Mitigation measures provided in Section 6 would be implemented to ensure that potential impacts on the environment would be minimised.

#### 2.1.5 National Parks and Wildlife Act 1979

The National Parks and Wildlife Act 1974 (NPW Act) provides the basis for the legal protection of native animals and plants in NSW. A wildlife licence is required under the NPW Act to harm or pick protected fauna and flora. All surveys were carried out under a Section 132C scientific licence (SL100146).

### 2.1.6 Noxious Weeds Act 1993 (NW Act)

The NW Act provides for the declaration of noxious weeds by the Minister for Primary Industries. Noxious weeds may be considered noxious on a National, State, Regional or Local scale. All private landowners, occupiers, public authorities and Councils are required to control noxious weeds on their land under Part 3 Division 1 of the NW Act. As such, if present, noxious weeds on the site should be assessed and controlled.

There is one noxious weed species present in the study area which would require management during thinning and revegetation works, and may require ongoing control in the future (see section 4.2.2).

## 2.2 Commonwealth legislation

### 2.2.1 Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The purpose of the EPBC Act is to ensure that actions likely to cause a significant impact on 'matters of national environmental significance' undergo an assessment and approval process. Under the EPBC Act, an action includes a proposal, a development, an undertaking, an activity or a series of activities, or an alteration of any of these things (DotE, 2013). An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is deemed to be a 'controlled action' and may not be undertaken without prior approval from the Australian Government Environment Minister (the minister).

The EPBC Act identifies Matters of National Environmental Significance (MNES) as:

- World heritage properties.
- National heritage places.
- Wetlands of international importance (Ramsar wetlands).
- Threatened species and ecological communities.
- Migratory species.
- Commonwealth marine areas.
- The Great Barrier Reef Marine Park.
- Nuclear actions (including uranium mining).
- A water resource, in relation to coal seam gas development and large coal mining development.

The EPBC Act has been addressed in the current assessment through:

- Desktop review to determine the MNES, in particular threatened biota and migratory species, that are predicted to occur within the locality of the proposed scheme and hence could occur, subject to the habitats present.
- Targeted field surveys for threatened biota and migratory species listed under the Act.
- Identification of suitable impact mitigation and environmental management measures for threatened biota and migratory species, where required.
- Assessment of potential impacts on MNES.

Potential impacts on relevant MNES must be subject to assessments of significance pursuant to the EPBC Act Significant Impact Guidelines (DotE, 2013). If a significant impact on MNES is likely, a referral should be submitted to the Australian Government Department of the

Environment for a decision by the Minister on whether assessment and approval is required under the EPBC Act.

The factors listed in the EPBC Act significant impact guidelines (DotE 2013) were considered in conjunction with the assessments of significance included in Appendix D for threatened biota listed under the TSC Act. No significant impacts on MNES are anticipated as a result of the proposal, and a referral is not considered necessary (refer to Section 5).

## 2.3 Other policies

### 2.3.1 Groundwater Dependent Ecosystems

Principle 5 of the NSW Groundwater Dependent Ecosystem (GDE) Policy (DLWC 2002) states that planning, approval and management of developments and land use activities should aim to minimise adverse impacts on groundwater dependent ecosystems by:

- Maintaining, where practicable, natural patterns of groundwater flow and not disrupting groundwater levels that are critical for ecosystems.
- Not polluting or causing adverse changes in groundwater quality.
- Rehabilitating degraded groundwater systems where practical (DLWC 2002).

This policy has been addressed through the assessment of ecosystems in the study area with respect to their reliance on groundwater, and recommendations for mitigation measures to prevent or minimise impacts on any GDEs that may be present see section 0 for more detail).

## 2.4 Agency requirements

Consultation with the Office of Environment and Heritage (OEH), Department of Primary Industries (DPI) (Fisheries) and NSW Office of Water (NOW) was carried out in 2014. This ecological impact assessment has been prepared to address the requirements relating to the assessment of impacts on biodiversity, including aquatic and terrestrial habitats and groundwater dependent ecosystems.

## 2.5 Permits and licenses

Terrestrial flora and fauna surveys were carried out under a Section 132C scientific licence (SL100146) issued under the *National Parks and Wildlife Act 1979*. Aquatic surveys were carried out under a NSW Department of Primary Industries (DPI) Scientific Collection Permit (P07/0142-4.0 & OUT13/22250).

## 3. Methods

### 3.1 Review of previous reports

This ecological impact assessment is one of a number of technical reports that have been prepared for the proposal. The information presented in these reports has contributed to this assessment. Documents reviewed as part of this assessment included:

- Sofala Works Implementation Plan (GHD 2012).
- Sofala Vegetation Management Plan (GHD 2016).
- Sofala Floodplain Risk Management Study (Cardno 1997).

### 3.2 Database searches

A desktop database review was undertaken to confirm and update information on threatened flora and fauna species, populations and ecological communities (biota) listed under the TSC Act and FM Act, and MNES listed under the EPBC Act, that could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present.

Biodiversity databases and literature pertaining to the subject site and locality (i.e. within a 10 km radius of the site) that were reviewed prior to conducting field investigations included:

- The Commonwealth Department of the Environment (DotE) Protected Matters Search Tool (PMST), for all Matters of National Environmental Significance (MNES) online database selected for a 10 km radius of the proposal (DotE, 2014a).
- DotE online species profiles and threats database (DotE, 2014b).
- Office of Environment and Heritage (OEH) Wildlife Atlas database (licensed) for records of threatened species, populations and endangered ecological communities listed under the TSC Act that have been recorded within the locality of the proposal (OEH, 2014a).
- OEH threatened biota profiles for descriptions of the distribution and habitat requirements of threatened biota (OEH, 2014b). This resource was used to identify the suite of threatened ecological communities (TECs) that could potentially be affected by the proposal and to inform habitat assessments.
- The NSW vegetation types database (OEH, 2014c) to identify vegetation communities present in the study area.
- Department of Primary Industries (DPI) online protected species viewer for records of threatened aquatic species in the locality (DPI, 2014a).
- The NSW Department of Primary Industries (DPI) 'Threatened Fish and Marine Vegetation – Find a Species by Geographic Region' online search tool for Central West catchment area (DPI, 2014b).

The habitat resources present at the site (determined during the site inspection) were compared with the known habitat associations/requirements of the threatened and migratory biota highlighted by the desktop review. This was used to determine the likelihood of each threatened ecological community, endangered population and threatened or migratory species occurring within the study area. The results of this assessment are presented in Appendix A.



### 3.3 Previous survey effort

GHD conducted flora and vegetation surveys in the study area in 2011 to inform the Vegetation Management Plan (GHD 2016). The survey effort employed in the 2011 survey is described below.

A preliminary vegetation map was compiled from aerial photography interpretation using a GIS. Polygons delineating varying canopy colour, texture and density were mapped prior to field investigations. Preliminary vegetation types were assigned to these polygons for field verification.

The accuracy of the preliminary vegetation map was tested using four detailed quadrats (i.e. 20 X 20 m) measuring plant cover-abundance (i.e. Braun-Blanquet scale) and 10 rapid quadrats (i.e. 10 X 10 m) measuring plant species presence/ absence. Survey results were analysed and used to adjust polygon classification.

A larger 50 X 20 m plot measuring key vegetation and fauna habitat features was also completed at each of the detailed quadrat sampling locations. Data obtained from these larger plots was collected in a manner consistent with the methods specified by the BioBanking Assessment Methodology (DECCW, 2009). This data was used to evaluate vegetation condition against the reported benchmark values for the comparable BioMetric vegetation type (DECC, 2008a).

Intact native vegetation was classified into NSW Vegetation Types (OEH, 2014c). Vegetation within the study area was assessed against identification criteria for State and Commonwealth listed threatened ecological communities (TECs): critically endangered ecological communities (CEECs), endangered ecological communities (EECs) and vulnerable ecological communities (VECs). Vegetation and habitats was compared with descriptions provided in OEH (2014b) and DotE (2014b) profiles.

### 3.4 2015 survey methodology

Field surveys for the current study area were conducted by three ecologists between 14-16 January 2015. The survey methodology for terrestrial and aquatic flora and fauna surveys is described below. The survey methodology was designed to build on the previous surveys undertaken by GHD (2016) through undertaking additional field surveys targeting fauna and aquatic habitats, as this had not been part of the scope of the original survey.

#### 3.4.1 Flora and vegetation survey

##### ***Ground-truthing of vegetation mapping***

Previous vegetation mapping of the study area (GHD 2016) was ground-truthed in the field to verify the current location and extent of vegetation. Any necessary adjustments were made by hand on aerial photographs and by capturing waypoints on a hand-held GPS unit.

Vegetation within the study area was assessed against identification criteria for State and Commonwealth listed TECs. Vegetation and habitats were compared with descriptions provided in OEH (2014b) and DotE (2014b) TEC profiles.

##### ***Targeted threatened flora surveys***

The habitat requirements for threatened flora predicted to occur by the desktop assessment were identified prior to the field survey. Those requirements were then compared with the habitats present within the site during the field survey and an assessment of the likelihood of occurrence was completed based on consideration of known distributions, previous records in the locality and habitat requirements for each species. Searches for threatened plants in areas

of suitable habitat were conducted during all traverses across the study area, typically when walking between aquatic survey sites or similar.

The timing of field surveys (January 2015 (summer)) was not ideal for the detection/identification of some cryptic species e.g. those that flower in spring or which require specific climatic events to trigger flowering (if present).

The habitat assessment conducted for the study area allowed for identification of potential habitat for cryptic species, in order to make an assessment of their likelihood of occurring within the proposal footprint. As such, the survey was not designed to detect all species, rather to provide an overall assessment of the ecological values within the study area in order to predict potential impacts of the proposal, with particular emphasis on threatened biota and their habitats. The field survey aimed to identify areas of suitable habitat for cryptic species where possible.

#### 3.4.2 Terrestrial fauna survey

A variety of techniques were used for fauna surveys within the study area to compile a fauna species list, target threatened fauna species and assess habitat values. Detailed descriptions of survey techniques are outlined below. All observations of fauna habitat and direct fauna observations were recorded on proforma field data sheets. Survey locations are indicated on Figure 3.

##### ***Fauna habitat assessment***

Habitat assessments were undertaken throughout the study area, including active searches for potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as cobble areas, food trees, the density of understorey vegetation, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the study area following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in OEH and DotE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists. Fauna habitat assessments aimed to identify potential habitat for these species. Habitat assessment assists in the compilation of a comprehensive list of threatened fauna species that are predicted within the study area, rather than relying solely on single event surveys that are subject to seasonal limitations and may only represent a snapshot of assemblages present.

Habitat assessments included active searches for the following:

- Trees with bird nests or other potential fauna roosts.
- Burrows, dens and warrens.
- Hollow-bearing trees and logs which provide refuge, nest and den sites for a range of threatened fauna species.
- Specific food trees and evidence of foraging.
- Presence of potential habitat for frog species, in particular the threatened Booroolong Frog (*Litoria booroolongensis*).

The locations and quantitative descriptions of significant habitat features were captured with a handheld GPS unit and photographed where appropriate.

##### ***Spotlighting and call playback***

Spotlighting was carried out on two evenings in the study area by two ecologists. Surveys were conducted along the edges of the Turon River using Led Lenser torches and head lamps. Call

playback for the threatened Barking Owl (*Ninox connivens*) and Booroolong Frog (*Litoria booroolongensis*) was conducted in conjunction with spotlighting. Call playback for the Barking Owl was carried out at fixed positions, while call playback for the Booroolong Frog was undertaken along the entire spotlighting route (see Figure 3). These species had been recorded previously within 20 km of the study area (see Appendix A).

### **Anabat**

Microbat ultrasonic echolocation call recordings (Anabat surveys) were undertaken at two locations in the study area. Fixed recordings were undertaken from dusk until the following morning. Calls were identified using zero-crossing analysis and AnalookW software (version 3.8v, Chris Corben 2012) by visually comparing the time-frequency graph and call characteristics (e.g. characteristic frequency and call shape) with reference calls and/or species call descriptions from published guidelines. *The Bat calls of NSW: Region based guide to the echolocation calls of microchiropteran bats* (Pennay et al. 2004) was used to assist call analysis. Call identification was also assisted by consulting local bat records from the Atlas of NSW Wildlife (OEH 2014a).

### **Diurnal bird surveys**

Targeted surveys for diurnal birds were undertaken throughout the study area within two hours of dawn on two mornings. Surveys followed the area search method, where searches were conducted in a set area over an hour. Areas searched corresponded to the locations where spotlighting and frog call playback were also carried out (see Figure 3). Birds were identified by observation with binoculars and/or call identification. Opportunistic observations were also recorded throughout other surveys.

### **Opportunistic observations**

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys.

## 3.4.3 Aquatic survey methodology

### **Location of aquatic survey sites**

Four sites, each comprising a 100 metre reach, were surveyed following the aquatic survey methods described below. Locations of aquatic sites are detailed in Table 1 and mapped on Figure 3. The site coordinates provided in Table 2 are approximately the middle of each assessed reach. This study design provides an assessment of a control site located upstream of potential impacts, one site within the potential impact area, one site immediately downstream of the impact area and one site about 500 metres downstream of the impact area. This design establishes aquatic habitat conditions prior to the proposed works and provides a baseline for an ongoing monitoring program following implementation of the proposal, if required.

Table 1 Location of aquatic survey sites

Site	Site Code	Site Location Description	Latitude	Longitude
Site 1	SOF1	Downstream end of study area (downstream site)	-33.080555	149.689225
Site 2	SOF2	Adjacent to cleared camp site (downstream site)	-33.080555	149.689225
Site 3	SOF3	Adjacent to Sofala township (impact site)	-33.079778	149.692956
Site 4	SOF4	Upstream end of study area (upstream site)	-33.083335	149.696683

## Site Information and Habitat Assessment

Site information data was recorded during field surveys and included site location information and photographs; *in situ* water quality; geomorphology, instream and riparian vegetation, and aquatic habitat assessment; assessment of disturbances related to human activities (NSW AUSRIVAS; Turak *et al.*, 2004); modified riparian, channel and environmental (RCE ) inventory (Chessman *et al.*, 1997); Reference site condition selection criteria (DNRM, 2001); macroinvertebrate habitat and sample collection; and fish habitat and sampling data. Data was entered into an electronic database in the field. Habitat assessment reports generated by the database are included in Appendix C.

Descriptions of aquatic habitat were based on visual estimates of characteristics such as streambed composition (percentage of total composition for each substrate category), aquatic and riparian vegetation cover, amount of in stream organic material, and area of aquatic habitat and canopy cover. Estimates of channel morphology characteristics were made including stream width (wetted width in meters), bank full width (mean width between top of banks), and estimated depth. The condition and habitat suitability for threatened biota of the river reach in the study area was also noted. Photographs of each site were taken as a further record of physical conditions observed at the time of assessment.

Stream reach geomorphology and habitat descriptions were documented as per the NSW Australian River Assessment System (AUSRIVAS) Sampling and Processing Manual (Turak *et al.*, 2004), and included a whole of reach (at least 100 m section of the waterway) assessment, the presence of different instream habitat types, and the structure and condition of riparian vegetation. The information recorded was used to describe the nature of aquatic habitats present within the study area, and identify any areas of potential habitat for threatened aquatic fauna species.

The modified RCE inventory (Chessman *et al.* 1997) was used to assess aquatic and riparian habitats against thirteen categories providing a score ranging from 0 to 4 for each category. Each score, in each category, has a description of habitat condition which provides a consistent basis to descriptively assess and compare sites. Higher scores indicate better quality, less disturbed habitats and the total score provides an overall assessment of habitat conditions. This also allows for assessment against categories of recommended actions to address aquatic habitat condition as identified in Table 2.

Table 2 Modified RCE Total score, status, class and descriptions of recommended actions to address aquatic habitat condition

RCE Total Score	RCE Status	RCE Class	Recommended Action
0-11	Poor	V	Complete structural reorganization
12-21	Fair	IV	Major alterations required
22-31	Good	III	Minor alterations needed
32-41	Very Good	II	Selected alterations and monitoring for changes
42-52	Excellent	I	Biomonitoring and protection of the existing status

Assessment of habitat condition based on DNRM (2001) was used to rate the level of impact for ten possible impact categories on a scale from extreme impact (1) to no impact (5). These scores were added together and a total score for the site calculated with a possible maximum score of 50, in order to indicate the level of possible anthropogenic impacts at the site.

### *In situ* water quality

*In situ* physico-chemical water quality parameters were measured at each of the sites using a YSI 600QS multi-parameter water quality meter, calibrated in accordance with QS/QA (Quality

System/Quality Assurance) requirements and the manufacturer's specifications prior to its use in the field. Water quality measurements were taken between 10-30 cm depth within an edge and riffle habitat at the four sites. Parameters measured included temperature (°C), electrical conductivity (µS/cm), turbidity (NTU), dissolved oxygen (mg/L and % saturation) and pH.

## **Macroinvertebrate surveys**

### **Timing and validity of sample collection**

Following the AUSRIVAS macroinvertebrate sampling methodology for NSW (Turak *et al.*, 2004), macroinvertebrate sample collection should be conducted in autumn (March 15 to June 15) or spring (September 15 to December 15) as these are recognised as periods of peak macroinvertebrate activity and the optimal time to collect a diverse and representative sample. As this survey was conducted in summer (January 2015), the samples collected should not be considered comprehensive, rather they are a general indication of the macroinvertebrate community within the study area. If ongoing monitoring were required, macroinvertebrate sample collection should be conducted during the NSW AUSRIVAS autumn and/or spring sampling periods.

### **Sample collection methods**

Field sampling following Rapid Bioassessment (RBA) protocols was undertaken in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Turak *et al.*, 2004). At each site, one edge and one riffle sample was collected with the diversity of microhabitats within these habitats considered and sampled accordingly. Samples were preserved in 70% ethanol for lab analysis and clearly labelled with information including site, habitat, sampling method, date and sampler.

### **Laboratory identification**

Macroinvertebrates were examined using Wild Heerbrugg stereo-dissection microscope with a zoom capability between 6-50x. Freshwater macroinvertebrates were identified using published taxonomic keys, unpublished working keys and an extensive reference collection maintained by GHD following protocols identified in Hawking (2000). Most macroinvertebrates were identified to Family level with some exceptions following standard conventions of the NSW AUSRIVAS sampling and processing manual (Turak *et al.*, 2004). Chironomidae (Diptera) were identified to sub-family (e.g. Orthocladiinae, Chironominae, and Tanypodinae). Groups such as Nematoda, Oligochaeta and Acarina were identified to class or order level in accordance with accepted convention. Microcrustacea Ostracoda, Copepoda and Cladocera were also identified to the Order level. Macroinvertebrate data collected is stored on a specialised Zoological Database maintained by GHD.

Upon completion of identification all samples were returned to 100% ethanol for long-term archiving. This process allows samples to be re-examined at a later date if required. This may be important, particularly if the taxonomy changes significantly in the future or revision of species level taxonomic data is required. GHD will ensure that archived samples are retained for the life of the project or a minimum of five years.

### **Macroinvertebrate data analysis**

The data analysis adopted provides a list of the macroinvertebrate taxa (taxonomic levels as specified by NSW AUSRIVAS requirements) observed in the study area. It also provides indices allowing for a broad assessment of the condition or "health" of sites and allows a comparison between sites based upon community structure and defined habitat characteristics.

The statistical approach for data analyses in this project, discussed below, is designed to achieve the key objectives of developing an understanding of, and to gain a baseline condition of, the health of the macroinvertebrate communities prior to commencement of the proposed riparian vegetation thinning works.

The analysis techniques employed on macroinvertebrate data include:

- Taxa Richness Index (including EPT Taxa Index)
  - Richness refers to the number of different taxa contained in a sample. The EPT taxa index refers to the proportional representation of key macroinvertebrate taxa belonging to the Ephemeroptera, Plecoptera and Trichoptera groups. EPT taxa are known to be more sensitive to anthropogenic disturbances and thus are a good indicator of aquatic ecosystem condition.
  - Low EPT ratios (ie EPT taxa compared to total taxa) may suggest either habitat is unsuitable for these taxa or some anthropogenic disturbance is present. Site with higher EPT ratios may suggest more pristine environments, complex habitats, or larger natural variations in aquatic life.
- SIGNAL 2 Biotic Index (Chessman, 2003)
  - SIGNAL 2 (Stream Invertebrate Grade Number Average Level - Version 2) (Chessman, 2003) is a simple scoring system for macroinvertebrates of Australian rivers. SIGNAL 2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate families that have been derived from published and unpublished information on their tolerance to pollutants, such as sewage and nitrification (Chessman, 1995). Each taxon is assigned a grade from 1 (tolerant) to 10 (sensitive) based on eco-toxicity assessment data. The average of the grades for each site is used as the SIGNAL 2 score. Those families in a sample for which no grade can be assigned are excluded from the analysis. The calculation of the SIGNAL 2 score has not been weighted in regards to the abundance of organisms.
  - SIGNAL2 scores can be mapped on a biplot against taxa richness. High values of both SIGNAL2 scores and number of families indicates good habitat and chemically dilute water, low SIGNAL2 scores with high family diversity can indicate high salinity or nutrient levels, high SIGNAL2 and low diversity indicate toxic pollution or harsh physical conditions, and low SIGNAL2 scores and low taxa richness usually indicate urban, industrial or agricultural pollution.

### **Fish surveys**

Community based ecological assessments ideally require that the capture probability of each species is proportional to its absolute abundance at each site. The use of multiple sampling methods increases the probability of capturing all species in heterogeneous habitats. The pooled sample obtained from several methods more closely represents the entire fish assemblage at a site, reducing sampler bias that would be introduced in a single method (Gehrke *et al*, 1999). Several sampling techniques were employed for this study in an effort to capture as many different species as possible as described below.

All fish captured were identified to species level and the total length (TL) of the first 50 specimens captured at each site was measured. Native species were returned unharmed to the stream. Non-native species were euthanized and disposed of in accordance with ethics permit requirements. All by-catch fauna (e.g. yabbies) were noted and returned to the stream.



### Backpack electrofishing

Electrofishing was conducted in accordance with the Australian Code of Electrofishing Practice (1997). Electrofishing is a non-lethal active sampling technique, most effective in clear, shallow waters less than 1 m in depth. At each site the reach was surveyed using a Smith-Root backpack electrofisher (model LR24 with maximum output of 990 V and 40 amps peak, 4 amps continuous, with infinitely variable settings). This technique was not used where the depth, instream habitat or substrate was unsuitable for safe operation.

### Bait traps

Bait traps were used at all sites where water depth was suitable. Six collapsible baitfish traps (250 mm x 250 mm x 450 mm; 5 mm mesh) each baited with fish flavoured cat biscuits were set along the bank and adjacent to cover (vegetation, snags etc) where present. Bait traps were left overnight.

### Fyke nets

A single-winged fyke net (1.2 m x 0.8 m opening – 6 mm mesh, 10 m wing) was set with the mouth of the net facing downstream and the cod end tied above the water level to avoid mortality of non-target air breathing biota such as turtles. The net was set in a shallow, slow flowing section of the river and left overnight.

## 3.5 Weather conditions

Weather conditions were warm and sunny during surveys with no rain or wind. There had been about 30mm of rain in Bathurst and about 45 mm of rain in Lithgow over the week preceding the field survey. Observations for the Bathurst weather station (063005), located about 40km south of the study area are provided in Table 3. Note that weather conditions in the study area would likely be different due to the distance and higher elevation.

Table 3 Weather conditions during surveys

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
14/01/2015	18.0	23.5	9.4
15/01/2015	13.8	25.6	0.2
16/01/2015	10	25.0	0

## 3.6 Survey limitations

The field surveys built on previous work conducted in the study area by GHD (2016). The survey effort was determined based on the habitats present and landscape context of the study area, and took into consideration the previous surveys conducted in the study area. Fauna surveys (ie trapping) were not considered necessary given the limited impacts likely to result from the project on arboreal and terrestrial mammals.

Given the duration, extent and timing of the field surveys it is likely that some species that occur in the study area (permanently, seasonally or transiently) were not detected during the survey. These species are likely to include: flora species that flower at other times of year as well as annual, ephemeral or cryptic species; and frogs which call at other times of year or after heavy rainfall. Some fauna species are also mobile and transient in their use of resources and it is likely that not all species were recorded during the survey period.

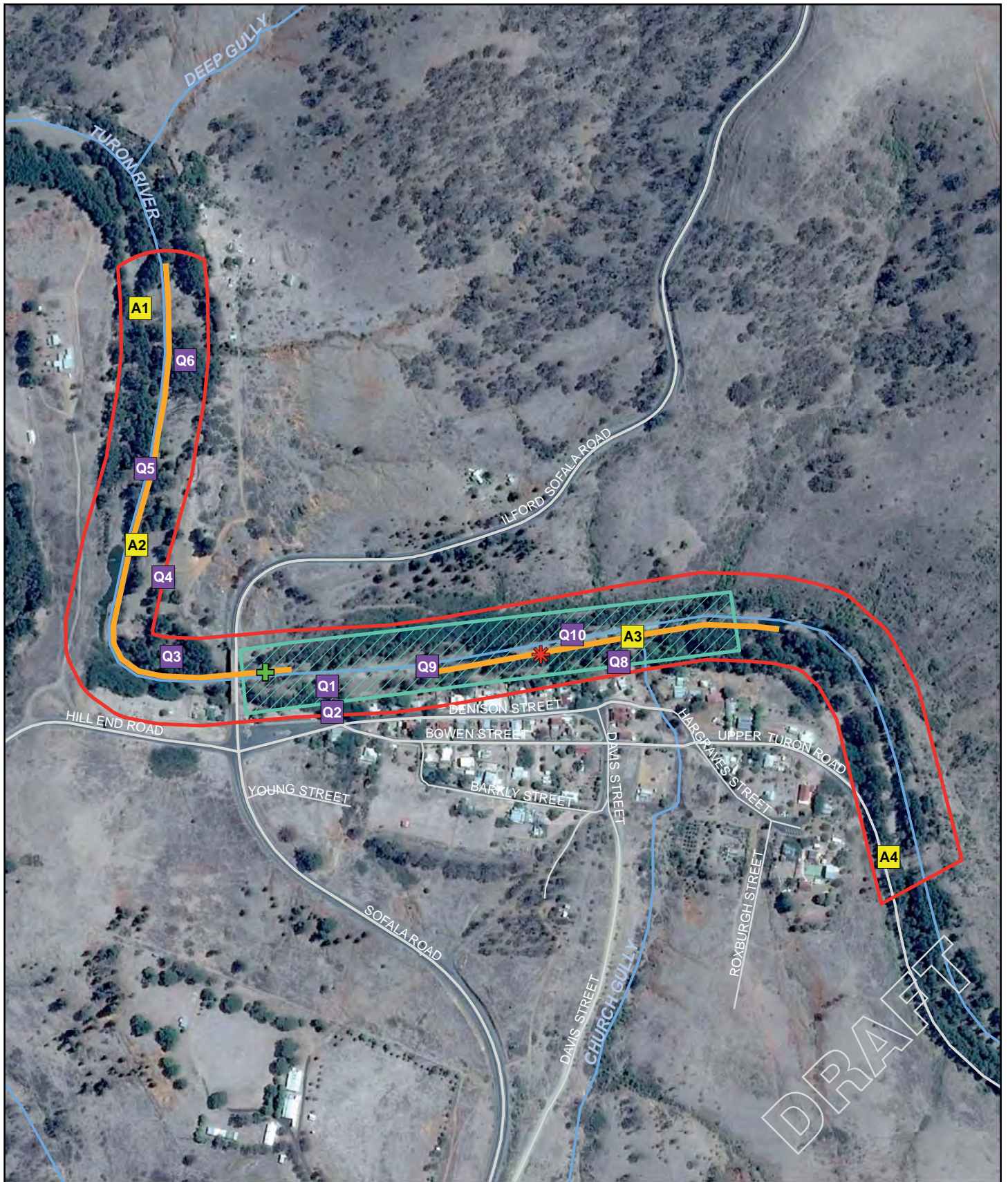
The habitat assessment conducted for the proposal allows for identification of habitat resources for such species, in order to make an assessment of their likelihood of occurring within the study area. As such, the survey was not designed to detect all species, rather to provide an overall

assessment of the ecological values within the study area in order to predict potential impacts of the proposal, with particular emphasis on TECs, threatened species and their habitats.








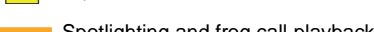


### 3.7 Likelihood of occurrence of threatened biota

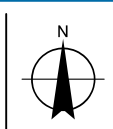
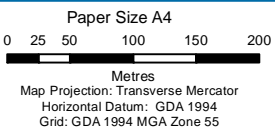
The likelihood of threatened and migratory biota occurring in the study area was assessed based on presence of records from the locality since 1990, species distribution and habitat preferences, and the potential suitability of habitat in the study area assessed during the field survey. The results of this assessment are provided Appendix A.





**LEGEND**

- |   |   |   |  |
|---|---|---|--|
|  Study area   | <b>Survey Effort</b>  | <b>Aquatic survey effort</b>  |  Major Roads |
|  Subject site |  Anabat            |  Aquatic sites                       |  Other Roads |
|   |  Owl call playback |  Spotlighting and frog call playback |  Waterways   |
|   |  Quadrats          |   |  |



Sofala Flood Mitigation Project  
Bathurst Regional Council

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Revision	A
Date	06 Feb 2015

**Survey locations**

**Figure 3**



## 4. Existing environment

### 4.1 Site context

#### 4.1.1 Location and land uses

The study area is located along the Turon River of the Central West catchment management area (CMA) in Sofala. Sofala is located approximately 42 kilometres north of Bathurst and is located within the Bathurst Regional Council LGA (Figure 1). The Turon River, a tributary of the Macquarie River, has a catchment area of 883 km<sup>2</sup> at Sofala.

Surrounding land uses include residential areas, agriculture (predominately sheep and cattle grazing), and areas of woodland.

#### 4.1.2 Hydrology

The Turon River flows through Sofala southwest into the Macquarie River. At Sofala, the Turon River has a gravel bed and is subject to erosion during flood events. A review of flood gauging data at Sofala since 1947 revealed the largest recorded flood at Sofala was the 1986 event. The 1986 event had an estimated peak flow that exceeded the 1% AEP flow that was derived from a flood frequency analysis.

#### 4.1.3 Geology and soils

The landform surrounding the site ranges from undulating hills to steep, rocky country often covered with dense native vegetation. The immediate channel of the Turon River is characterised by gravel shoals that are mobile in flooding events with the defined channel moving in a lateral manner after such events.

The dominant underlying geology of the Bathurst region is Bathurst Granite with basalt occurring at Mount Panorama and Mount Stewart. The Bathurst Granite is dominated by intermediate parent materials, which form such soils as the non-calcic brown soils and yellow soils in the less well drained locations (Terra Consulting 2003).

The *Non-Calcic Brown Soils* are the dominant soils of Bathurst and occur on slopes of undulating to rolling hills on the Bathurst Granite. Topsoils range from sandy loam to loam. They have a moderate water holding capacity, are pH neutral, have moderate chemical fertility and have a moderate erosion hazard.

### 4.2 Flora and vegetation

#### 4.2.1 Flora species

A total of 38 native plant species and 79 exotic species were observed within the native vegetation of the study area (refer to Appendix B). The Poaceae (grasses, 23 species, 11 native) and Asteraceae (daisies; flowering herbs and sub-shrubs, 16 species, three native) were the most diverse families recorded. No threatened flora species were recorded.

#### 4.2.2 Noxious weeds

Blackberry complex (*Rubus fruticosus* sp. agg.), a Class 4 declared noxious weed within the Upper Macquarie County Council control area, was abundant throughout much of the study area. The control requirements for this species are as follows:

*“The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed”.*

#### 4.2.3 Vegetation type

One native vegetation type is present in the study area: River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (DECCW, 2008a) (Photograph 1 and Photograph 2). This vegetation forms part of the 'Eastern Riverine Forests' vegetation class and 'Forested Wetlands' vegetation formation.

This vegetation typically forms on gravels, sands and loams on various substrates along major watercourses in the NSW South Western Slopes Bioregion and western edge of the Southern Highlands Bioregion, including the Macquarie River and its main tributaries. Estimated clearing of this vegetation type within the South Western Slopes Bioregion ranges between 45% to 85% of pre-European cover. Areas where clearing extents exceed 70% are classified as over-cleared landscapes. This vegetation type is not a threatened ecological community listed under the TSC or EPBC Acts. Figure 4 shows the extent of this vegetation within the subject site and broader study area.

The most common species present is the River Oak (*Casuarina cunninghamiana*), which forms a dominant tree canopy cover of varying height and density. This species is present along the banks of the river and the associated river flats. Other native tree canopy species observed included Blakely's Red Gum (*Eucalyptus blakelyi*), Yellow Box (*Eucalyptus melliodora*), Manna Gum (*Eucalyptus viminalis*). These eucalypts tend to occur upslope of the river banks. Occasional Willows (*Salix* sp.) are also present.

Occasional native shrub species were observed and included Native Blackthorn (*Bursaria spinosa*), Sticky Hop-bush (*Dodonaea viscosa*) and Tree Violet (*Melicytus dentatus*). Native understorey species included *Acaena* spp., *Aristida* spp., Windmill Grass (*Chloris truncata*), Common Couch (*Cynodon dactylon*), *Cyperus* spp., Kidney Weed (*Dichondra repens*), *Geranium* spp., Rush (*Juncus australis*), Spiny-headed Mat-rush (*Lomandra longifolia*), Weeping Grass (*Microlaena stipoides* var. *stipoides*), *Persicaria* spp., Tussock (*Poa labillardierei* var. *labillardierei*), *Rytidosperma* spp., *Senecio* spp. and Stinging Nettle (*Urtica incisa*). A high density of environmental weeds were also present, often dominating the understorey of the study area, particularly in the vicinity of Sofala township. Incidence of native understorey and groundcover increased with distance from Sofala.



Photograph 1 – River Oak forest and woodland adjacent to the Turon River



Photograph 2 – Willow and weeds adjacent to River Oak forest and woodland

#### 4.2.4 Groundwater dependent ecosystems

The NSW Groundwater Dependent Ecosystem (GDE) Policy defines GDEs as ecosystems, which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002). The Policy defines groundwater as the water beneath the earth's surface that has filtered down to the zone where the earth or rocks are fully saturated (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002). With the exception of the Great Artesian Basin's mound springs, the level of scientific understanding of the role that groundwater plays in maintaining ecosystems in Australia is generally low (DLWC 2002).

Hatton and Evans (1998) recognize four types of groundwater dependent ecosystems, based mainly on vegetation (DLWC 2002). Of these, two may be relevant to the investigation area: terrestrial vegetation and base flow in streams. These are discussed below.

##### **Terrestrial vegetation**

Shallow groundwater can support terrestrial vegetation, such as forests and woodlands, either permanently or seasonally (DLWC 2002). River Oak open forest within the investigation area may fall into this category. The Atlas of Groundwater Dependent Ecosystems maps this vegetation type elsewhere in the locality as having a moderate potential for groundwater interaction.

##### **Base flows in streams**

River flow is often maintained largely by groundwater, which provides base flows long after a rainfall event (DLWC 2002). The base flow typically emerges as springs or as diffuse flow from saturated sediments or rock underlying the stream and banks and may be crucial for in-stream and near-stream ecosystems (DLWC 2002). For example, Platypus feed upon invertebrates, such as dragonfly and mayfly larvae, which live in the riffle habitats. Reducing the base flow to groundwater-fed streams could dry out the riffles and reduce the invertebrate populations. This would have direct impacts on predators of invertebrates, such as the Platypus (DLWC 2002).

It is estimated that in NSW on average up to 40% of any river's flow duration is made up of groundwater-fed baseflow (DLWC 2002). Ecosystem dependence is not only related to the amount of base flow, but also to other flow factors such as seasonal variability (DLWC 2002).

The Atlas of Groundwater Dependent Ecosystems maps the Turon River at Sofala as having moderate potential for groundwater interaction. Smaller feeder streams in the locality have high potential for groundwater interaction.

### 4.3 Terrestrial fauna and habitats

#### 4.3.1 Terrestrial fauna species

A total of 61 terrestrial fauna species were positively recorded within the study area. This included five frog species, four reptile species, 42 bird species (two introduced species), and four terrestrial or aquatic mammal species and six microchiropteran bat species. An additional six microchiropteran bats were also potentially recorded using echolocation call analysis.

Two threatened species were positively identified in the study area:

- Booroolong Frog (*Litoria booroolongensis*), listed as an endangered species under the TSC Act and the EPBC Act.
- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), listed as a vulnerable species under the TSC Act.



One additional threatened bat species, the Eastern Cave Bat (*Vespadelus troughtoni*), listed as a vulnerable species under the TSC Act, was possibly recorded using echolocation call analysis. The quality of the call was not good enough to distinguish the calls from two common *Vespadelus* species that had also been recorded definitely in the study area.

The Gang-gang Cockatoo (*Callocephalon fimbriatum*), listed as a vulnerable species under the TSC Act, was recorded adjacent to the study area in Sofala township.

The full list of fauna species recorded is presented in Appendix B. Threatened fauna that were recorded or may occur are discussed below in section 4.3.2 in respect to the various habitat types and summarised in section 4.5.

#### 4.3.2 Terrestrial fauna habitats

##### **Riparian woodland**

Riparian woodland in the study area provides habitat for a range of native fauna species. A relatively diverse range of birds were recorded. Small birds included the Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*), Superb Fairy-wren (*Malurus cyaneus*) and Red-browed Finch (*Neochmia temporalis*), particularly among the shrubs and weeds. Larger birds observed in the canopy included the Nankeen Night Heron (*Nycticorax caledonicus*), Pied Currawong (*Strepera graculina*), Laughing Kookaburra (*Dacelo novaeguineae*) and White-winged Chough (*Corocrex melanoramphos*). Two small kingfisher species were observed, the Azure Kingfisher (*Ceyx azureus*) and the Forest Kingfisher (*Todiramphus macleayii*). These species would forage on the many small fish present in the river. A family of Brown Goshawks (*Accipiter fasciatus*) were also observed. This species feeds on a wide variety of fauna.

A number of microbat species were recorded using call echolocation analysis. These included the hollow-roosting Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Large Forest Bat (*Vespadelus darlingtoni*), Little Forest Bat (*Vespadelus vulturinus*) and Southern Forest Bat (*Vespadelus regulus*). One cave-roosting species, the threatened Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) was positively recorded, and one species, the Eastern Cave Bat (*Vespadelus troughtoni*) was possibly recorded. All bat species present would regularly forage for flying insects along the river.

Few hollow-bearing trees are present in the study area. Most hollows observed were small, providing potential roosting habitat for the hollow-roosting microbats noted above. Many trees within flaking bark were also present, which would also provide roosting habitat for these microbats. No large hollows suitable for birds such as the Gang-gang Cockatoo or Barking Owl were observed in the subject site. Cave roosting microbat species may roost temporarily under Crossley Bridge, or in cracks or crevices in rock outcrops or vertical alluvial banks. Old mine shafts and disused buildings in the locality are also likely to provide roosting habitat for these species.

Terrestrial mammals recorded included the Eastern Grey Kangaroo (*Macropus giganteus*) and Common Wombat (*Vombatus ursinus*). These species would forage along the river flats and river banks. A number of wombat burrows were observed. No arboreal mammals were recorded during spotlighting, possibly due to the lack of large hollows.

Reptiles typical of riparian environments were observed, including the Eastern Water Dragon (*Physignathus lesueurii*) and Eastern Water-skink (*Eulamprus quoyii*). Small skinks (*Lampropholis* spp.) were observed in leaf litter. The Red-bellied Black Snake (*Pseudechis porphyriacus*) is also likely to occur.

The Turon River riparian area is mostly vegetated, and is likely to comprise an important wildlife corridor, linking heavily vegetated areas to the east and west. The Sofala township and

immediately surrounding areas are mostly cleared. Many fauna species would use the riparian corridor for movement, and to travel between other areas of nearby vegetation.

### **Aquatic habitats**

The Turon River in the study area comprises a combination of pools and riffles. Recent rain had lead to good flow along the river, with depths ranging from about 10 cm to 2 m in a deep pool downstream of the bridge. Creek banks varied between cobbled and pebbled areas, vertical granite cliffs, high alluvial banks and low, vegetated banks.

Water birds observed along the river included the Pacific Black Duck (*Anas superciliosa*), Australian Wood Duck (*Chenonetta jubata*) and White-necked Heron (*Ardea pacifica*). Two kingfisher species, the Azure Kingfisher (*Alcedo azurea*) and an unidentified kingfisher (*Alcedo* sp.), were also recorded foraging along the river.

Mammal fauna that rely on aquatic environments include the Water Rat (*Hydromys chrysogaster*) and Platypus (*Ornithorhynchus anatinus*). Two Water Rats were observed during the 2015 survey (one upstream and one downstream of the bridge). Platypus were observed swimming in a large pool downstream of Crossley Bridge during the 2011 surveys (GHD 2016).

The riparian environments of the Turon River provide suitable habitat for frog species, such as the endangered Booroolong Frog (*Litoria booroolongensis*), which is regarded as an obligate stream species (i.e. exclusively lives within the stream environment). The Booroolong Frog has previously been recorded upstream of Sofala on the Turon River (OEH 2015a). One adult was observed in a small area of cobbles adjacent to a large pool downstream of the bridge on the first night of spotlighting (Figure 4). A possible juvenile was also observed nearby along a larger expanse of cobbles adjacent to the same pool (Photograph 3). A juvenile frog was observed about 300 m upstream of the bridge on the second night, on a cobble bar within the river (Photograph 4). Calls of two other individuals were heard from nearby cobbled areas. Other common riparian species observed included the closely related Lesueur's Frog (*Litoria lesueuri*) and also the Eastern Banjo Frog (*Limnodynastes dumerilii*). The Common Eastern Froglet (*Crinia signifera*) was heard calling from near the river, and the Spotted Grass Frog (*Limnodynastes tasmaniensis*) was heard calling from grassed areas away from the river.



Photograph 3 – Cobble habitat adjacent to a large pool



Photograph 4 – Cobble habitat adjacent to riffles

## 4.4 Aquatic species and habitats

### 4.4.1 Aquatic species

#### **Macroinvertebrates**

A total of 46 macroinvertebrate taxa were identified across the study area. A summary of the key orders recorded is provided in Table 4. A full list of taxa (Family/Sub-family taxonomic levels as required by NSW AUSRIVAS) recorded is provided in Appendix B.

Table 4 Macroinvertebrate Orders and SIGNAL 2 values for taxa observed in the study area

Class/Order	Common Name/s	SIGNAL 2 Grade (Order)	Average SIGNAL 2 Grade (Family)
Bivalvia	Bivalves	3	4.00
Coleoptera	Beetles	5	4.42
Decapoda	Shrimp, Prawns and Yabbies	4	3.50
Diptera	Flies (larvae)	3	3.65
Ephemeroptera	Mayflies	9	5.82
Gastropoda	Snails	1	1.67
Hemiptera	True Bugs	2	2.45
Lepidoptera	Aquatic Caterpillars	2	3.00
Megaloptera	Alderflies	8	7.00
Odonata	Dragonflies and Damselflies	3	4.70
Oligochaeta	Worms	2	N/A
Trichoptera	Caddisflies	8	5.20
Turbellaria	Flatworms	2	2.00
Average SIGNAL 2 Grade		4	3.95

These results indicate most groups present have a high to moderate tolerance of environmental conditions, however some less tolerant groups (eg Alderflies) are also present.

A summary of the macroinvertebrate indices for each of the survey sites is provided in Table 5. Taxa richness values were consistent across all sites and between habitats although variation in taxonomic composition between habitats was evident. Higher EPT taxa richness and SIGNAL 2 scores were recorded for riffle habitats. Riffle taxa generally utilise external gills to acquire oxygen from the higher concentrations commonly dissolved in well mixed flowing waters of riffle habitats. A dependence on dissolved oxygen generally makes these taxa highly sensitive to changes to flow and water quality, particularly increases in turbidity and suspended solids, often related to bank and riparian habitat disturbance.

Table 5 Summary of macroinvertebrate indices

Site Code	Habitat	Taxa Richness	EPT Taxa Richness	SIGNAL 2 Taxa Richness	SIGNAL 2 (Order)	SIGNAL 2 (Family)
Site 1	Edge	17	4	17	4.29	3.47
	Riffle	20	6	19	5.00	4.68
Site 2	Edge	21	5	20	4.19	3.25
	Riffle	18	6	17	5.28	5.12
Site 3	Edge	22	5	22	4.18	3.73
	Riffle	20	5	19	4.60	4.26

Site Code	Habitat	Taxa Richness	EPT Taxa Richness	SIGNAL 2 Taxa Richness	SIGNAL 2 (Order)	SIGNAL 2 (Family)
Site 4	Edge	19	5	19	4.26	3.47
	Riffle	21	6	20	4.95	4.80

Most sites fell in the quadrant that indicates some effect of salinity or nutrients (high taxa (>19) and low (<5) SIGNAL2 score). One site (Site 1 edge) potentially indicates some level of agricultural pollution, and one site (Site 2 riffle) potentially indicates harsh physical conditions or pollution. These results are not unexpected given the surrounding agricultural land use and nearby township.

The EPT taxa ratio ranged between 23% (Site 3 edge) and 33% (site 2 riffle). This indicates some anthropogenic disturbance is present, which corresponds to the SIGNAL2 results.

### Fish

A summary of fish species observed in the study area during the recent aquatic surveys is provided in Table 6. A total of five fish species were recorded in the study area, two of which, *Cyprinus carpio* (Carp) and *Gambusia holbrooki* (Eastern Gambusia) are exotic species. Of the native species observed *Maccullochella peelii* (Murray Cod) is listed as a vulnerable species under the EBPC Act. The presence of Murray Cod, individuals of which were juvenile specimens, is likely to be a result of recent fish stocking. Local residents and Bathurst City Council staff indicated that stocking of several native species, including Murray Cod, had occurred as little as one week prior to the field survey. One local resident reported that NSW DPI had recently provided locals with fingerlings of several native fish species for release into the Turon River. This is part of DPI's fish stocking program for NSW inland recreational fisheries (DPI 2015)

Table 6 Summary of fish survey results within the study area (\* NSW DPI Class 3 Noxious species; ^EBPC status vulnerable)

Species	Common Name	Number	Length (mm)			Native/Exotic
			Min	Avg	Max	
<i>Cyprinus carpio</i> *	Carp	9	75	99	138	Exotic
<i>Galaxias olidus</i>	Mountain Galaxias	47	33	50	75	Native
<i>Gambusia holbrooki</i> *	Eastern Gambusia	22	18	30	47	Exotic
<i>Hypseleotris galii</i>	Firetail Gudgeon	1	43	43	43	Native
<i>Maccullochella peelii</i> ^	Murray Cod	2	47	47	48	Native

*Galaxias olidus* (Mountain Galaxias) dominated the endemic native fish community and was observed at all sites in high abundance. This species is widely distributed throughout south-eastern Australia, from southern Queensland through to South Australia. The Mountain Galaxias is quite a variable small fish, and a recent revision of the species has proposed that this species complex represents 15 separate species, many of which have separate and defined ranges (Raadik, 2011).

#### 4.4.2 Aquatic habitats

Details of the aquatic habitat assessments for each of the aquatic survey sites can be found in Appendix C. A summary of the aquatic habitats present at the four sites is provided below. Descriptions of aquatic habitat follow the RCE assessment methodology (Chessman *et al.*, 1997) and commence with a broad scale assessment of riparian vegetation, down to instream and micro habitats.



The land use pattern beyond the immediate riparian zone consisted of mixed native vegetation, pasture and exotics and the width of the riparian strip of woody vegetation varied between 5 and 30 m. Tree cover was generally continuous, with some breaks present (usually at intervals of more than 50 m). Vegetation of the riparian zone within 10 m of the channel was dominated by native trees, with some shrubs and a high incidence of weeds. Stream bank structure was good and the bank was generally fully stabilised by riparian vegetation, including trees, shrubs, and understory grasses, sedges and herbs.

Bank undercutting generally only occurred on stream bends and at constrictions and the channel form varied from deep (width:depth ratio less than 8:1) to shallow (width:depth ratio greater than 15:1) although the shallow habitats were more prevalent. Riffle pool sequences (Photograph 5) were frequent and alternation of riffles and pools occurred through the study area with distances between riffles being fairly consistent across the study area. Logs were present and acted as retention structures but were considered to have limited damming effect, most commonly due to the width and depth where snags and logs were present (Photograph 6).

Channel sediment accumulation occurred throughout the study area predominantly as reasonably stable gravel and pebble bars but little sand or silt. The stream bottom was mainly cobbles and gravels with some cover of clay/silt although the variety of substrates across the study area provided for a fairly heterogeneous stream habitat. Stream detritus consisted of some wood, leaves, and coarse particulate organic matter (CPOM), with much fine detritus. Instream aquatic vegetation was limited to emergent macrophytes although some submerged macrophytes were present in riffle habitat in the upstream reaches of the study area.

The edge habitats where macroinvertebrate samples were collected contained a good mix of habitats, including overhanging vegetation, tree roots and undercut banks, snags, CPOM in the form of sticks, branches and other woody debris. Some emergent macrophytes occurred in the shallow silt/clay and pebble bars or in backwater areas and mainly consisted of sedges and *Juncus*. The riffle habitats contained a good mix of cobbles and gravels with some boulders in deeper sections (30-70 cm) and a variety of hydraulic habitats in riffles (Photograph 5) provided for heterogeneous riffles offering habitats for a diverse aquatic faunal assemblage. Light sedimentation was evident in shallow and slackwater areas where finer sediments were present.



Photograph 5 – Riffle habitats at aquatic site 1 containing a diverse hydraulic habitat



Photograph 6 – Instream snags and log jam in the pool upstream of site 1

As noted above, fingerlings (most likely from the recent stocking event) were recorded in the study area. Murray Cod are generally associated with deep holes in rivers and prefer habitats with instream cover such as rocks, stumps, fallen trees or undercut banks. The variety of habitats observed across the study could be considered reasonable habitat for the Murray Cod,

although the limited number of deep pools probably limits the population of this large bodied species within the Turon River.

Murray Cod make an upstream migration to spawn which can be up to 120 km and generally occurs in late winter/early spring when river levels are high. After spawning the fish move downstream again, returning to the same area they occupied before the migration, and often to exactly the same snag. Eggs are usually deposited onto a hard surface such as logs, rocks or clay banks (Lintermans, 2002). The Turon River within the study area could be considered a good nursery habitat for Murray Cod however mature adults are likely to move downstream to larger pools for the majority of their lifecycle. Habitat destruction through sedimentation is thought to be a potential threat to the species (Lintermans, 2002).

The dominant and endemic Mountain Galaxias population are likely to be a key food source for juvenile and sub-adult Murray Cod. Mountain Galaxias are often observed in schools in slower flowing or pool habitats. Individuals mature at the end of their first year or in their second year. Spawning occurs mainly in spring and early summer although a small proportion of fish may spawn in autumn. Between 50 and 400 eggs are laid on the underside of stones at the head of pools and in riffles (Lintermans, 2007). Similar to the Murray Cod, but to a greater degree, Mountain Galaxias are susceptible to sedimentation as spawning sites and habitat may be impacted by increased sedimentation rates. As the species is thought not to migrate, and to have a relatively small home range (Lintermans, 2007), any local scale impacts may affect the local population.

## 4.5 Conservation significance

### 4.5.1 Overview

Based on the desktop assessment the following threatened biota and MNES are known or predicted to occur in the locality:

- Five threatened ecological communities (TECs)
- 10 threatened flora species, comprising seven species listed under the TSC Act and nine species listed under the EPBC Act
- 30 threatened fauna species, including 24 species listed under the TSC Act, 17 species listed under the EPBC Act and six species listed under the FM Act
- 11 migratory species.

Appendix A includes a summary of the habitat requirements of the threatened biota and an assessment of whether they are known to occur or their likelihood of occurrence within the study area, based on the habitats present. The status of these threatened biota and MNES known or likely to occur within the subject site and study area is described in Section 4.5.2.

Apart from the above threatened biota and migratory species listed under the EPBC Act, no other MNES (World Heritage Areas, Wetlands of International Significance (Ramsar sites) or Commonwealth Marine Areas) occur within the locality or would be impacted by the proposal.

### 4.5.2 Threatened biota (TSC Act and FM Act)

#### ***Threatened ecological communities***

Vegetation in the study area is not commensurate with any threatened ecological community.

#### ***Threatened flora species***

No threatened flora species were recorded within the study area during the previous or recent field surveys.



Of the four threatened flora species previously recorded within 20 km of the study area (OEH, 2014a) and the additional six species predicted to occur (DotE, 2014a), none are considered likely to occur in the study area or be affected by the proposal. These species are associated with specific habitat types that are not present in the study area, as described in Appendix A.

### **Threatened terrestrial fauna species**

Two threatened fauna species have been positively recorded within the study area: the Booroolong Frog (*Litoria booroolongensis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*) (Figure 4). One additional threatened species has possibly been recorded from recorded echolocation calls: the Eastern Cave Bat (*Vespadelus troughtoni*). The Gang-gang Cockatoo (*Callocephalon fimbriatum*), was recorded outside the study area.

Adult or subadult Booroolong Frogs were observed at two locations in the study area. Two individuals were also heard calling. All individuals observed or heard were associated with cobbled and pebbled areas of the river. This is typical habitat of the species, which is usually associated with cobble banks or bedrock structures within stream margins, or near slow-flowing connected or isolated pools that contain suitable rock habitats (OEH 2012). The Turon River in the study area includes patches of appropriate cobble habitat interspersed with less suitable habitat where vegetation dominates the edges. Suitable cobble habitat is present in patches upstream and downstream of the study area. Other records of the species are present further upstream of Sofala (OEH 2014a).

A flock of about 15 gang-gang Cockatoos were observed one morning in a eucalypt tree located in a garden above the Turon River. The flock were roosting or resting in the tree, before flying away. This flock may roost within the study area. Only limited foraging habitat (mature eucalypts) is present. No breeding habitat (hollow-bearing eucalypts) for this species is present in the study area.

The Eastern Bentwing Bat was identified from echolocation call analysis. This species would forage above the Turon River and adjacent vegetation and cleared areas. This species breeds in caves and primarily roosts in caves or similar artificial structures but may also roost in tree-hollows. It could roost under the Crossley Bridge or in old mine shafts and buildings in the wider locality. The Eastern Cave Bat also breeds in caves and is known to roost in disused mine shafts (OEH 2015a). There is no breeding or primary roost habitat for these species in the study area. This species may temporarily roost under Crossley bridge, or possibly in tree hollows or flaking bark.

There is potential for a number of other threatened fauna species to occur within the subject site, given the presence of suitable habitat and previous records within the locality. There are no on-site records or specific habitat resources that suggest that permanent local populations of any of these threatened fauna are present in the study area. Individual threatened fauna may utilise habitat in the subject site and/or study area on a transitory or opportunistic basis. These include species such as the Barking Owl, hollow-dependent microbats and small woodland birds such as honeyeaters and robins (see Appendix A). These species have the potential to occur within the study area and subject site on a temporary or seasonal basis. Many of these species may use the study area and subject site in response to seasonal availability of food resources but are unlikely to reside within the study area on a permanent basis. The riparian habitat (1.35 hectares) to be removed and/or modified by the proposal is unlikely to comprise important habitat for these threatened species given its small size and homogenous nature.

### **Threatened aquatic fauna species**

As noted in section 4.4, the Murray Cod (*Maccullochella peelii*), is listed as a vulnerable species under the EPBC Act, was recorded in the study area. The presence of Murray Cod is likely to be a result of recent fish stocking (see Section 4.4.2).

No other threatened aquatic fauna were recorded in the study area however the range of aquatic habitats observed may be suitable for several species including the Freshwater Catfish (*Tandanus tandanus*), and Purple-spotted Gudgeon (*Mogurnda adspersa*). These species are known to occur in the central west catchment area (DPI 2015b). There are no on-site records that suggest permanent local populations of any of these threatened fauna are present in the study area. Individual threatened fauna may utilise habitat in study area on a transitory or opportunistic basis.

### **Migratory fauna**

A number of migratory species have the potential to occur within the site on an occasional or transient basis, given the presence of potentially suitable habitat. These include the Satin Flycatcher (*Myiagra cyanoleuca*), Rufous Fantail (*Rhipidura rufifrons*) and Rainbow Bee-eater (*Merops ornatus*).

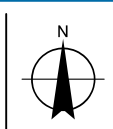
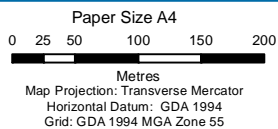
Vegetation within the study area is highly modified, fragmented and would have only limited value for migratory species listed under the EPBC Act. Habitat in the study area is not likely to support an ecologically significant proportion of the population of any of these species, be of critical importance to the species at particular life-cycle stages, be located at the limit of any of the species' range, and/or be located within an area where the species is declining. As such, potential habitat in the study area is unlikely to be 'important habitat' for any of these species, as defined by DotE (2013).





**LEGEND**

- |                               |                      |                    |             |
|-------------------------------|----------------------|--------------------|-------------|
| Study area                    | Booroolong Frog      | Eastern Cave Bat   | Major Roads |
| Subject site                  | Eastern Bentwing Bat | Gang-gang Cockatoo | Other Roads |
| River Oak forest and woodland | Waterways            |                    |             |



Sofala Flood Mitigation Project  
Bathurst Regional Council

Job Number 21-23439  
Revision A  
Date 12 Feb 2015

Vegetation and threatened biota **Figure 4**

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Data Source: NSW Department of Lands: Cadastre - Jan 2014; Geoscience Australia: 250k Data - Jan 2014; NSW Department of Primary Industry - Jan 2014; Google image Jan 2015. Created by: qjchung



## 5. Potential impacts

### 5.1 Direct impacts

#### 5.1.1 Vegetation clearing and habitat removal

As described in Section 1.2, the proposal would comprise the thinning of River Oaks (*Casuarina cunninghamiana*) to a density of less than 720 stems per hectare within the subject site as per the Vegetation Management Plan (see Figure 5). Thinning would focus on the removal of smaller saplings and regenerating plants. Vegetation stem densities have been mapped throughout the study area. Stem densities of greater than 1270 stems per hectare occur in a number of locations upstream of the bridge. Thinning would thus occur in the reach immediately to the north of the Sofala village upstream of the bridge. Note that stem densities between 720-1269 stems per hectare were mapped as part of the Vegetation Management Plan (GHD 2016) but these occur downstream of the bridge and would therefore not require thinning and are thus not discussed here. Further detail on the vegetation thinning and target stem densities is provided in the Vegetation Management Plan (GHD 2016).

No area of native vegetation would be entirely removed for the proposal. Removal of large woody weeds (eg Willows) would also be carried out within this area. Root balls would be retained to ensure bank stability (GHD 2016). Removal of weeds including Willows would also be undertaken. No hollow-bearing trees or trees with flaking bark should be removed as part of the thinning to minimise impacts on hollow-dependent fauna.

The proposal would also include the inclusion of walking tracks along the river as part of the recreation strategy. These would follow existing tracks or clearings where possible, however and removal of trees would be avoided where possible. It is recommended in section 6 that hollow-bearing trees and trees with flaking bark are avoided when constructing the walking trails to minimise impacts on important habitat for native fauna.

#### 5.1.2 Removal of fauna habitats

As noted above, the proposal would involve the thinning of River Oaks and removal of Willows and other weeds within the subject site. The loss of River Oaks and Willows would remove foraging and resting habitat for a range of bird and bat species. No foraging habitat for the Gang-gang Cockatoo would be removed. No hollow-bearing trees or trees with flaking bark would be removed. Retention of these trees (see section 6) would minimise impacts on nesting or denning fauna. These resources are scarce and limiting given the time it takes for hollows to develop.

There would be no removal of foraging or breeding habitat of the threatened Booroolong Frog. Removal of trees may disturb shelter habitat for the species through the movement of people or machinery. Retention of rootballs would protect shelter habitat in the long-term. The potential for indirect impacts on aquatic habitat for this species within the subject site and downstream are discussed in section 5.2.

The proposal is unlikely to have any substantial impact on habitat for fauna as involves removal of only some trees and existing habitat resources will be largely retained.

Removal of dense thickets of weeds for the walking trails would have the potential to impact on small birds that use these for refuge/nesting and foraging. Large areas of alternate habitat are present. Revegetation would restore this habitat in the long-term.

### 5.1.3 Fauna injury and mortality

As described above, the subject site provides habitat resources for native fauna species, including threatened fauna. More mobile native fauna such as adult birds (including the Gang-gang Cockatoo), and terrestrial and arboreal mammals are highly unlikely to be affected by thinning activities. Thinning may result in the injury or mortality of less mobile fauna that may be sheltering in trees to be removed. Common Ringtail Possums and nesting birds may be vulnerable to injury or mortality if present during clearing of trees and shrubs within the subject site.

Booroolong Frogs may shelter in cobbles and vegetation at the base of River Oaks and Willows that will be removed. The retention of root balls would minimise the impact on the shelter habitat of this species. There is a risk of accidental mortality of individuals resulting from the increased movement of people at the site during works, and movement of mobile plant during works. Hand removal of trees minimises the risk of mortality of these species. Similarly most thinning would occur away from the river banks, which would also reduce the risk of mortality.

Removal of weeds and small shrubs for the walking tracks has the potential to result in the injury or mortality of small birds, particularly species such as the Superb Fairy-wren which nests in these areas.

Hollow-bearing trees and trees with flaking bark would not be removed as part of the thinning or construction of walking trails. There is unlikely to be any injury or mortality therefore of hollow-nesting species.

Pre-clearing fauna surveys will be undertaken as part of the Construction Environmental Management Plan (CEMP) to reduce the risk of injury or mortality to native fauna and especially tree-dwelling fauna. These surveys will involve the inspection of trees for resident fauna as a precautionary measure prior to felling. The CEMP will also contain measures for the safe management of native fauna if detected in trees or on site generally during construction (see Section 6).

### 5.1.4 Aquatic habitats

The proposal would not directly impact aquatic habitats. There would be no blockage of fish passage as a result of the proposed thinning of vegetation. It is likely there would be little direct impacts on potential breeding habitat for any common or threatened fish. No snags would be removed and although thinning has potential to result in slightly fewer snags in future, it is unlikely that this would adversely influence native fish populations.

### 5.1.5 Groundwater dependent ecosystems

Direct impacts on vegetation and aquatic habitats are discussed above. These impacts would be relevant to any groundwater-dependent ecosystems that may be present. The proposal is unlikely to alter the flow system of groundwater within the subject site as it is limited to the hand removal of a relatively small number of trees. Native vegetation would be retained within the study area. No area of native vegetation would be entirely removed.

## 5.2 Indirect impacts

### 5.2.1 Erosion, sedimentation or contamination

The major potential impacts to aquatic habitats are associated with sedimentation through increased erosion risks and resulting changes to water quality. Sedimentation runoff to waterways from exposed soils due to riparian vegetation clearing can adversely affect aquatic

life by altering water quality and filling aquatic habitat with fine sediment. This reduces the habitat value of these areas for aquatic flora and fauna.

Current sediment levels and turbidity is relatively low, but would be high during flood events. Some sedimentation may occur as a result of the proposed works, although these are likely to be minimal given the method for thinning and the measures to control/manage erosion and sediment release into the river (see below). The geographical and temporal extent of potential impacts is likely to be negligible for threatened fish. Infilling of cobble banks with sediment could impact the shelter and breeding habitat of the threatened Booroolong Frog, however, as with threatened fish, the geographical and temporal extent of potential impacts is likely to be negligible for this species in the locality.

Thinning of trees would be undertaken by hand with use of mobile plant for removal of large tree trunks. Root balls would be retained which would reduce the risk of disturbance of sediments and maintain stability of the creek banks. The main risk of disturbance of sediments is from movement of mobile plant along the river banks, and clearing of large areas of herby weeds. Mitigation measures are recommended in Section 6 to minimise the risk of sedimentation, and include the broadcast of native seed or supplementary planting to stabilise exposed surfaces. Note that the Turon River riparian area is regularly subjected to flood events, which themselves cause erosion and sedimentation along the river. The retention of root balls would help maintain bank stability during these events.

Removal of weed thickets also has the potential for soil erosion and sediment movement. Soil would be stabilised after removal and staged removal is recommended would also help so time for stabilising cover crop to establish

Accidental spills of oils or other chemicals during the thinning process or revegetation activities could result in a decline in flora and fauna habitat and potential mortality to individuals. . Mitigation measures are recommended in Section 6 to minimise the risk of impact from contamination.

#### 5.2.2 Weed invasion and edge effects

'Edge effects' refers to changed environmental conditions at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. No area of vegetation would be entirely removed and no new edges would be created. Much of the existing vegetation is subject to edge effects already from the, road, town and other clearings.

Construction of walking trails and thinning of vegetation has the potential to increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of native vegetation via erosion (wind and water) and via workers shoes and clothing and through construction vehicles. Given the high levels of weeds present, this is unlikely. Removal of weeds and revegetation would reduce weeds in the long-term.

Vegetation management measures would be included in the CEMP for the proposal, to help avoid direct and indirect impacts on native vegetation in the subject site (see section 6.3.2). Retained and planted native vegetation would be managed under a VMP that would include measures for treatment of weed infestations and would aim to improve the condition of the retained vegetation (see section 6.3.1). Given these mitigation measures and the extent of existing weed infestation and disturbance in the study area the proposal would result in a minor increase in weed infestation and other edge effects.



### 5.2.3 Noise and vibration

The subject site is located near roads and the Sofala township. Habitats adjacent to the subject site therefore already experience some noise, light and vibration disturbance. There would be additional noise and vibration as a result of thinning activities. Works would occur during the day only, and would be short-term. Most of the species that are likely to nest or roost in the study area would be habituated to noise to a large extent, and would not be impacted substantially by the additional noise and vibration.

### 5.2.4 Pests and pathogens

Thinning activities within the subject site have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) in the study area through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora may result in the dieback or modification of native vegetation and damage to fauna habitats. Thinning activities within the subject site also have the potential to introduce or spread Chytrid fungus (*Batrachochytrium dendrobatidis*), which affects frog populations.

The potential for impacts associated with these pathogens is low, given the disturbed nature and high visitation rates to the subject site and study area. Mitigation measures are recommended to minimise the risk of the diseases being introduced to the study area (see Section 6).

### 5.2.5 Changes to flow regimes

The proposal would not alter the flow regime of the Turon River during usual or low flow periods. The thinning of trees is proposed to minimise flooding risk to Sofala township and reduce the risk of damage to the bridge.

### 5.2.6 Erosion and sedimentation

The Turon River is subject to regular flooding events, which cause erosion and sedimentation along the river. Locations and extent of cobble banks would change over time as a result of flooding events and water level. The removal of some trees is not likely to result in changes to erosion and sedimentation as a result of flooding, as root balls would be retained to maintain bank stability.

## 5.3 Key threatening processes

A key threatening process (KTP) is defined in the TSC Act as an action, activity or proposal that:

- Adversely affects two or more threatened species, populations or ecological communities.
- Could cause species, populations or ecological communities that are not currently threatened to become threatened.

KTPs are listed under the TSC Act, the FM Act and also under the EPBC Act. A number of KTPs are listed under more than one Act. Those potentially relevant to this proposal are discussed in Table 7 below. Mitigation measures to limit the impacts of these KTPs are discussed in Section 6.

Table 7 Key threatening processes

Key Threatening Process	Status	Comment
Clearing of native vegetation	TSC Act; EPBC Act	The proposal would comprise the thinning of River Oaks ( <i>Casuarina cunninghamiana</i> ) to a density of less than 720 stems per hectare throughout the study area, with root balls being left in situ. No area of native vegetation would be entirely removed. Clearing is defined as the destruction of a sufficient proportion of one or more strata (layers) within a stand or stands of native vegetation. As such, the proposal does not constitute clearing of native vegetation. Vegetation management measures as part of a CEMP are recommended to minimise impacts on native vegetation and to improve the condition of currently disturbed areas (see Section 6).
Loss of hollow-bearing trees	TSC Act	The proposal is unlikely to result in the removal of hollow-bearing trees. Management measures as part of a CEMP are recommended to minimise impacts on hollow-bearing trees and any resident fauna (see Section 6).
Removal of dead wood and dead trees	TSC Act	There are occasional dead trees and large quantities of fallen timber within the riparian zone that would provide habitat resources for native fauna. The proposal may result in the removal of some dead trees. Removal of fallen timber should be avoided if possible as this provides habitat for terrestrial fauna and contributes to snags in the river during and following flood events. Management measures as part of a CEMP are recommended to minimise impacts on hollow-bearing trees and fallen timber (see Section 6).
Invasion of plant communities by perennial exotic grasses	TSC Act	The study area features moderate to severe infestation with perennial exotic grasses. The proposal would include environmental management measures, including weed management (refer Section 6). These mitigation measures would limit the potential to increase the operation of this KTP.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	TSC Act	The study area features moderate to severe infestation of garden plants. The proposal would include environmental management measures, including weed management (refer Section 6). These mitigation measures would limit the potential to increase the operation of this KTP.
Infection of native plants by <i>Phytophthora cinnamomi</i>	TSC Act; EPBC Act	Thinning activities have the potential to introduce <i>Phytophthora</i> into the study area, through the transport and movement of plant, machinery and vehicles, as well as through any landscaping works following construction. The proposal would include environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6). The proposal is unlikely to increase the operation of this KTP.
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	TSC Act	Thinning activities have the potential to introduce Myrtle Rust to the study area. The proposal would include environmental management measures, including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6). The proposal is unlikely to increase the operation of this KTP.

Key Threatening Process	Status	Comment
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	TSC Act; EPBC Act	Thinning activities have the potential to introduce amphibian chytrid to the study area, which could lead to death of local frogs. The proposal would include environmental management measures including specific consideration of measures to reduce potential impacts on soil, water and native vegetation (refer Section 6). The proposal is unlikely to increase the operation of this KTP.
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	TSC Act; FM Act	There would be no activities within the Turon River. The proposal would thin trees within the riparian zone to minimise flood risk and damage to Sofala township. Flood intensity in the vicinity of Sofala may be reduced. The proposal would not result in an increase in the operation of this KTP.
The removal of large woody debris from NSW rivers and streams	FM Act	No large woody debris would be removed from within the Turon River. Some fallen timber may be removed from along the riparian zone, which could occur as snags during high flow periods. The proposal would result in a minor increase in the operation of this KTP. Management measures as part of a CEMP are recommended to minimise the removal or disturbance of snags and fallen timber (see Section 6).

## 5.4 Assessment of significance of impacts on threatened biota

### 5.4.1 Identification of affected threatened biota

The desktop assessment, field surveys and habitat assessments described above have been used to identify the suite of threatened biota that may be affected by the proposal, through either direct or indirect impacts. A number of threatened species may occur in the study area or have been recorded in the study area, but are unlikely to be impacted by the proposal, or the impact would be negligible. These are discussed in section 5.4.2. Threatened species that are likely to be impacted by the proposal (affected biota) are discussed in section 5.4.3.

### 5.4.2 Threatened biota unlikely to be impacted by the proposal

No threatened ecological communities are present, and no threatened flora species listed under the TSC Act, FM Act or EPBC Act are likely to occur in the study area.

The proposal would have a negligible impact on the Gang-gang Cockatoo, which was recorded near the study area. River Oaks are not a preferred forage tree, and no large eucalypts with hollows are present in the subject site. The removal of Willows, River Oaks and weeds would not impact habitat for this species. River Oaks with hollows would be preferentially retained to minimise impacts on hollow-roosting fauna.

The proposal would have a negligible impact on the Eastern Bent-wing Bat, which was recorded in the study area. This species breeds in caves. No breeding habitat would be impacted. It forages over a wide area, above cleared and forested land, and rivers and creeks. The thinning of vegetation within a small patch of riparian forest would have a negligible impact on the foraging habitat of this species. No temporary roosts would be removed. River Oaks with hollows would be preferentially retained to minimise impacts on hollow-roosting fauna.

Similarly the proposal would have a negligible impact on most threatened fauna species predicted to occur in the study area. These include the Barking Owl, a number of small woodland birds and additional microbats. These species are likely to forage in the subject site on occasion. The proposal would involve the removal of a very small area of foraging habitat for these wide-ranging species. Large expanses of foraging habitat are available for these species

in the locality. The subject site would make up only a small proportion of their home range. No large eucalypts with hollows (potential breeding habitat for the Barking Owl) would be removed. River Oaks with hollows would be preferentially retained to minimise impacts on other hollow-dependent fauna.

The proposal would be highly unlikely to have a significant impact on these species and no assessments of significance are considered necessary.

#### 5.4.3 Threatened biota likely to be impacted by the proposal

Assessments of significance have been prepared for fauna species that are known to occur in the subject site and are likely to be impacted by the proposal (Appendix D). These include the Booroolong Frog and threatened fish. The likely significance of impacts on affected threatened species and ecological communities has been assessed in accordance with Section 5A of the EP&A Act (the seven-part test) and with consideration of the Matters of National Environmental Significance – Assessment of significance guidelines (DotE, 2013), where relevant.

The Booroolong Frog, listed as endangered under the TSC Act and EPBC Act, was recorded in the study area. The thinning of trees may result in temporary sedimentation of breeding habitat and injury and mortality of adults. Sedimentation would be very limited given the measures to retain bank stability and stabilise disturbed soils. There is some potential for injury and mortality of individuals, however the retention of root balls would minimise this. The project is unlikely to have a significant impact on this species as:

- No area of breeding or shelter habitat would be removed.
- There would be only a temporary and minor risk of sedimentation of breeding habitat.
- There is only a small risk of injury and mortality of individuals that may be sheltering under Casuarinas.
- Large areas of cobble habitat for the species are present upstream and downstream of the subject site.

Aquatic habitats observed may be suitable for species known to occur in the central west catchment area (DPI 2015b), including the Freshwater Catfish (*Tandanus tandanus*) and Purple-spotted Gudgeon (*Mogurnda adspersa*). The thinning of trees may result in temporary sedimentation of aquatic habitats. Sedimentation would be very limited given the measures to retain bank stability and stabilise disturbed soils. The project is unlikely to have a significant impact on these species as:

- No area of breeding or shelter habitat would be removed.
- There would be no blockage of fish habitat.
- There would be only a temporary and minor risk of sedimentation of breeding habitat.
- Large areas of potential habitat for the species are present upstream and downstream of the subject site.

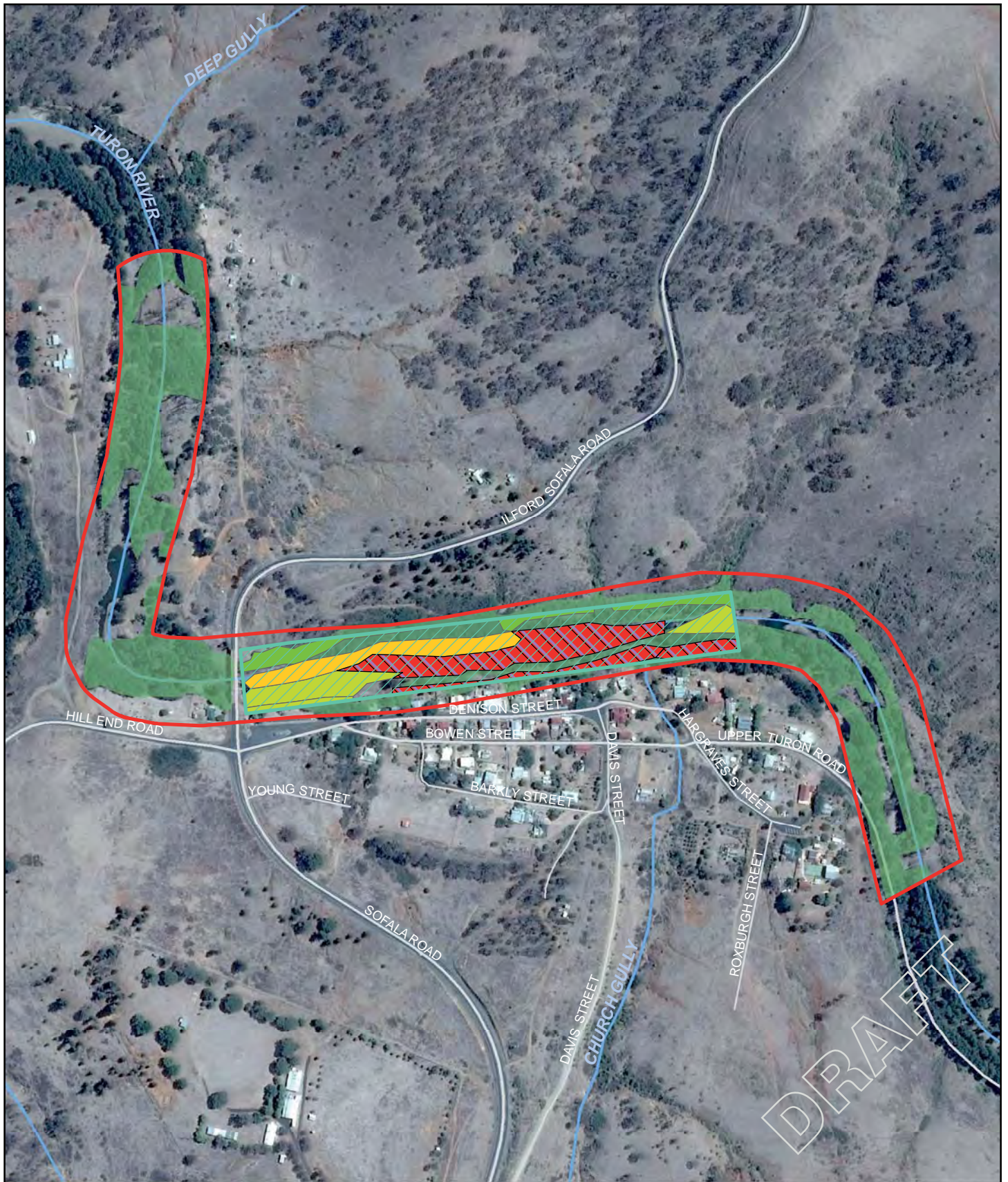
The Murray Cod, listed as vulnerable under the EPBC Act, was recorded in the study area. A number of fingerlings were caught during fish surveys, which are likely to have been released during a recent stocking event for recreational fishing. No assessment of significance pursuant to the EPBC Act is considered necessary as this species is stocked in the area. Considerations discussed in the assessment of significance for the threatened fish described above that may occur naturally also relate to this species. Based on the outcome of that assessment, the proposal is unlikely to have a significant impact on the Murray Cod.

Mitigation measures are detailed in section 6.3 to minimise the impact of the proposal on these and other threatened fauna.










## 5.5 Assessment of impacts on migratory fauna

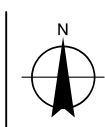
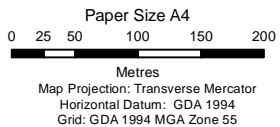
No migratory bird species listed under the EPBC Act have been recorded during the current or previous surveys, however potential habitat for the Satin Flycatcher, Rufous Fantail and Rainbow Bee-eater occurs within the study area. As discussed previously, the study area is highly modified and fragmented and would have limited value for these migratory species. Any species that may occur would occur on a transient basis only. The study area is not considered important habitat for any migratory species according to the significant impact criteria for migratory species (DotE, 2013), as it is very small in size and large expanses of potential habitat are present in the locality. No assessments of significance have been prepared for migratory species. Based on the above considerations the proposal is unlikely to impose “a significant effect” on any of the listed migratory fauna species predicted to occur within the locality.





**LEGEND**

- |   |   |   |   |
|---|---|---|---|
|  Study area   | <b>STEMS</b>  |  320 - 719   |  Thinning required             |
|  Subject site |  0 - 129   |  1270 - 5400 |  River Oak forest and woodland |
|  Waterways    |  130 - 319 |   |   |



Sofala Flood Mitigation Project  
Bathurst Regional Council

Job Number	21-23439
Revision	A
Date	06 Feb 2015

**Proposed vegetation thinning**

**Figure 5**



## 6. Mitigation measures

### 6.1 Overview

The proposal would result in direct impacts on native biota and their habitats within the subject site during the thinning activities. Construction of the walking track and removal of weeds also have the potential to impact native biota. Specific mitigation measures are recommended to minimise such impacts on the natural environment. The proposal would result in some positive impacts on biodiversity values through revegetation and management of weeds.

Mitigation has been assessed according to the hierarchy of avoid, mitigate and offset. The following sections detail the avoidance of impacts and mitigation measures recommended for the proposal.

### 6.2 Avoidance of impacts

The objective of this thinning program will be to maintain a stem density of less than 720 stems per hectare throughout the study area. No area of native vegetation would be entirely removed. Root balls would be retained to ensure bank stability (GHD 2016), and to minimise impacts on aquatic and riparian habitats. No hollow-bearing trees are to be removed for the walking tracks or thinning works.

### 6.3 Mitigation of impacts

#### 6.3.1 Vegetation management plan (VMP)

A Vegetation Management Plan (VMP) has been prepared for vegetation in the subject site (GHD 2016). The VMP specifies management actions to reduce flood risk, maintain and enhance the biodiversity value of native vegetation, roles and responsibilities, timing and costing of actions. The VMP includes:

- Local vegetation characteristics.
- Identification of suitable stem densities to minimise flood risk
- Management techniques necessary to progressively remove targeted native vegetation throughout the riparian zone of the Turon River, to minimise flood risk downstream.
- Strategies for the establishment of a functioning riparian ecosystem.
- Strategies for community participation in the implementation of the VMP.
- A maintenance program to ensure vegetation establishment.
- A monitoring program to assess the success (or otherwise) of the thinning with respect to flooding impacts.

Revegetation and habitat restoration is detailed in the VMP (GHD, 2016) and will include:

- Progressive landscaping of disturbed areas during construction to minimise soil erosion and weed establishment
- Seed collection from native plant material of local provenance and consistent with those of the River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions community, within a 5km radius of the site
- Hand broadcasting of native grass seed throughout the maintenance period of the restoration program. Broadcasting of native seed and supplementary planting where mature River Oaks or large areas of weeds have been removed

- Plant propagation, including the germination of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes and managed by a suitably qualified and experienced native plant production nursery
- Installation of plastic tree guards for planted shrub species comprising a plastic tree guard and three bamboo stakes
- Installation of native tubestock in autumn or spring as long as a suitable watering regime is implemented
- Maintenance of general activities, including repairing damaged tree guards, monitoring survival rates, installing replacement plants where required, weeding inside the tree guards and continued follow-up spot spraying
- Retention of large trees wherever possible within design constraints
- Installation of educational signage along proposed tracks to highlight the environmental importance of the riparian corridor.

### 6.3.2 Construction Environmental Management Plan

A Construction Environmental Management Plan (CEMP) would be required for the construction phase of the proposal. The CEMP would include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific measures including the procedures outlined below. The CEMP should be prepared and implemented by the contractor. The proposed measures would include environmental safeguards for protection of downstream properties and waterways in accordance with relevant policy documentation and Government guidelines.

The CEMP would be required to address the following as a minimum:

- Erosion and sediment control measures, which would require:
  - Installation of erosion and sediment control measures prior to works
  - Communication with personnel involved in works of the conservation value of surrounding vegetation and their responsibilities with regards to protecting vegetation and fauna habitats during works.
  - All equipment must be refuelled at least 20 metres away from the river and all fuel and chemical storages should be bunded.
- Vegetation management measures, including:
  - Installation of temporary fencing to clearly delineate work zones and areas of vegetation to be retained
  - Washing of vehicles and plant prior to work on site to prevent the spread of Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Pucciniales* fungi) in line with the national best practice guidelines for Phytophthora (DEH 2006) and Myrtle Rust factsheet (DPI 2011) for hygiene control
  - Herbaceous weeds to be controlled with the application of Roundup® Biactive herbicides applied using 'back packs' where revegetation activities are dominated by handplanting by suitably qualified and experienced contractors
  - Weed disposal protocols such as the removal of large environmental woody weeds as part of a staged program
  - staged removal of willow and other woody weeds commencing in the upper reaches of the catchment and working down with the root ball of these species left in situ
  - removal of saplings and emergent seedlings by hand with root systems left in situ.
- Fauna management measures, including (but not limited to) the following:

- Machinery is to be excluded from the river bed and from within 3 metres of the banks to protect Booroolong Frog habitat
- Avoid the removal of hollow-bearing trees and trees with flaking bark
- Avoid the removal of fallen timber
- A fauna management protocol, including pre-clearing surveys for nests or sheltering terrestrial fauna and rescue and salvage of fauna where possible (see below)
- Protocols to prevent introduction or spread of chytrid fungus following OEH Hygiene protocol for the control of disease in frogs (DECCW, 2008c) must be implemented.
- Aquatic habitat management, including:
  - Minimise and control sediment movement as a result of proposed works to limit sedimentation and maintain water quality as described above
  - Maintain root balls for any trees close to the water line to ensure bank stability and provide consistent habitat for fish and macroinvertebrates.

### 6.3.3 Fauna management protocol

#### *Pre-work surveys*

Pre-work surveys should be undertaken prior to thinning and track construction by a qualified ecologist and the required methodology and targeted species should be developed as part of the CEMP to manage impacts to fauna species and habitat. Surveys should include:

- Inspections of native vegetation for resident fauna, including ringtail dreys and bird nests, checking of bark for roosting microbats and searches for nests or other signs of fauna occupancy
- Inspection and identification/marketing of hollow-bearing trees and trees with flaking bark to assist with preferential retention of these trees.

#### *Thinning phase*

The following principals should be followed throughout the thinning phase:

- An ecologist or trained fauna handler should be present on site during thinning to ensure the safety of resident fauna.
- Machinery is to be excluded from the river bed and from within 3 metres of the banks to protect Booroolong Frog habitat
- Capture and relocation or captive rearing of less mobile fauna (such as roosting microbats, nestling birds or any injured fauna) by a trained fauna handler and with assistance from Wildlife Information Rescue and Education Service (WIRES) as required. Clearing methods and presence/fate of any resident fauna must be documented.
- Wildlife should not be handled wherever possible. Staff should only handle wildlife in an emergency situation. Uninjured wildlife should be gently encouraged to leave the site by the ecologist/ wildlife specialist. Injured wildlife would be taken to a local WIRES carer or veterinarian for treatment and care if necessary

## 6.4 Offsetting

Given the limited scale and magnitude of impacts arising from the proposal, no formal biodiversity offsets are proposed. The retention and replanting of native woodland vegetation would result in some positive impacts as described above. The improvements in biodiversity values within retained and planted vegetation is likely to exceed residual adverse impacts of the proposal and ensure no net loss of biodiversity values.

## 7. Conclusions

Flood mitigation works were recommended in recent Floodplain Management Policy (Cardno 1997) as the most efficient method to manage flood risks to the Sofala community. The Sofala Floodplain Risk Management Study recommended that the River Oaks (*Casuarina cunninghamia*) in the immediate upstream vicinity of the Crossley Bridge be removed, so as to help mitigate structural damage to the bridge during large flooding events (Cardno 2007). The proposal would comprise the thinning of River Oaks (*Casuarina cunninghamiana*) to a density of less than 720 stems per hectare throughout the nominated subject site, as well as the removal of Willows and other weeds. No area of native vegetation would be entirely removed for the proposal. The area where thinning would occur is located upstream of Crossley Bridge adjacent to Sofala township.

The inclusion of walking tracks along the river would have limited impacts on native biodiversity. These would follow existing gaps in the forest, and would mainly remove the weedy understory. Removal of trees would be minimised or avoided altogether. Trees with hollows would be retained.

No threatened ecological communities are present in the subject site or study area, and no threatened flora species listed under the TSC Act, FM Act or EPBC Act are likely to occur.

The Booroolong Frog, an endangered species listed under the TSC Act and EPBC Act, was recorded in the subject site. The thinning of trees may result in temporary sedimentation of aquatic habitats. Sedimentation would be very limited given the measures to retain bank stability and stabilise disturbed soils. There is also a low risk of injury and mortality of adults. The individuals present in the study area are likely to be part of a much larger population that resides in extensive cobble habitat present along the Turon River. Given the large expanses of potential habitat present along the Turon River in the locality, small area of impact, and low risk of sedimentation and injury or mortality, the proposal is not likely to have a significant impact on this species.

The Murray Cod, a vulnerable species listed under the EPBC Act, was recorded in the study area. A number of fingerlings were caught during fish surveys, which are likely to have been released during a recent stocking event. Aquatic habitats observed may also be suitable for the Freshwater Catfish (*Tandanus tandanus*) and Purple-spotted Gudgeon (*Mogurnda adspersa*). The key risk to all aquatic species in the study area would be increased sedimentation and associated changes to water quality. Sedimentation would be very limited given the measures to retain bank stability and stabilise disturbed soils. Mitigation measures are recommended to minimise the risk of sedimentation, and include retention of root balls to maintain bank stability, and the broadcast of native seed or supplementary planting to stabilise exposed surfaces.

Other threatened fauna species that are known or are likely to occur in the study area would occur on a transient basis only, and the study area would form only a very small part of the species' larger home range. Most species are unlikely to breed in the study area and the proposal is unlikely to impact breeding habitat. The proposal is likely to have a negligible impact on these species

Thinning of vegetation will include the retention of root balls to maintain bank stability and minimise sedimentation. Mitigation measures also include standard construction management, such as erosion and sediment control, protection of vegetation to be retained, and pre-clearing surveys and salvage of fauna. A Vegetation Management Plan has been prepared for the project, and would include monitoring of the thinning program to assess its effect on flood risk (GHD 2016). Additional mitigation measures recommended in this report would be incorporated into the CEMP for the project.



The proposal is not likely to have a significant effect on threatened species, populations or ecological communities listed under the TSC Act or FM Act, pursuant to s.5A of the EP&A Act see Appendix C). Consequently, a Species Impact Statement is not required for the proposal. On the basis of the assessments undertaken (Appendix C) and with respect to the EPBC Act significant impact guidelines (DotE 2013), the proposal is unlikely to impose a significant impact on any MNES and is therefore unlikely to be deemed a controlled action. Referral of the proposal to the Australian Government Minister for the Environment is not considered necessary.

## 8. Disclaimer

This report: has been prepared by GHD for Bathurst Regional Council and may only be used and relied on by Bathurst Regional Council for the purpose agreed between GHD and the Bathurst Regional Council as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Bathurst Regional Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

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## Appendices



## Appendix A – Likelihood of occurrence of threatened and migratory biota

### Key to Likelihood of Occurrence for Threatened Species

Likelihood	Definition
Likely	Species previously recorded within a 10 kilometre radius of the study area and suitable habitat occurs within the study area.
Possible	Species not previously recorded within a 10 kilometre radius of the study area, but the study area is within the species known distribution and suitable habitat occurs within the study area OR Plant species previously recorded within a 10 kilometre radius of the study area and suitable habitat occurs within the study area, however no individuals were observed despite appropriate surveys
Unlikely	Species previously recorded within a 10 kilometre radius of the study area but no suitable habitat recorded.
Nil	Species not previously recorded within a 10 kilometre radius of the study area, suitable habitat not recorded within subject, and/or study area outside species known distribution.
Absent	In the case of a threatened ecological community, not present within the study area.

**Threatened flora known or predicted from the locality, habitat association and likelihood of occurring at the subject site**

Scientific name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence
<i>Asterolasia elegans</i>	E	E	Occurs north of Sydney, in the Baulkham Hills, Hawkesbury and Hornsby LGAs, may also occur in the western part of Gosford LGA. 7 known populations. Occurs on Hawkesbury sandstone, commonly amongst rocky outcrops and boulders in sheltered forests on mid- to lower slopes and valleys.	Species or species' habitat may occur within 20km (DotE 2014a)	Nil. No suitable habitat present within study area.
<i>Eucalyptus cannonii</i> Capertee Stringybark	V		Mostly restricted to the central tablelands and slopes from Bathurst and Wallerawang to Mudgee, with isolated occurrences between Dunedoo and Merriwa. Broad altitudinal range (approx 450 - 1050m asl), and appears to tolerate most situations except valley floors. Occurs in dry sclerophyll forests and woodlands with grassy/shrubby understoreys, associated with a diverse suite of eucalypts.	3 records within 20km (OEH 2014a)	Unlikely. No suitable habitat present within study area.
<i>Eucalyptus pulverulenta</i> Silver-leafed Gum	V	V	The Silver-leafed Gum is a distinctively wattle-like, straggly mallee or small tree to about 10 m tall. This species grows in shallow soils as an understorey plant in open forest, typically dominated by Brittle Gum ( <i>Eucalyptus mannifera</i> ), Red Stringybark ( <i>E. macrorhynca</i> ), Broad-leafed Peppermint ( <i>E. dives</i> ), Silvertop Ash ( <i>E. sieberi</i> ) and Apple Box ( <i>E. bridgesiana</i> ). The Silver-leafed Gum is found in two quite separate areas, the Lithgow to Bathurst area and the Monaro (Bredbo, Bombala areas).	1 record within 20km (OEH 2014a)	Unlikely. No suitable habitat present within study area.
<i>Euphrasia arguta</i>	CE	CE	Recently rediscovered near Nundle on the north-western slopes and tablelands, once known from scattered locations between Sydney, Bathurst and Walcha. Known populations occur in eucalypt forest with a mixed grass/shrub understorey, while previous records are described as occurring in open forest, grassy country and river meadows. Annual and dies back over winter. Dense stands observed in cleared firebreak areas, suggesting it may respond well to disturbance.	Species or species' habitat may occur within 20km (DotE 2014a)	Unlikely. No suitable habitat present within study area.

Scientific name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence
<i>Lepidium hyssopifolium</i> Basalt Pepper-cress	E	E	Currently known near Bathurst and Bungendore, with historic records near Armidale. Grows on light to heavy, often friable clay loams, often in highly modified environments amongst exotic pasture grasses and weeds. Requires bare ground to establish (Tumino 2010)	Species or species' habitat may occur within 20km (DotE 2014a)	Unlikely. No suitable habitat present within study area.
<i>Leucochrysum albicans</i> var. <i>tricolor</i> Hoary Sunray		E	Occurs in grasslands, grassy areas in woodlands and dry open forests and modified habitats, on a variety of soils including clays, clay loams, stony and gravelly soils. Requires bare ground for germination and establishment and may occur in semi-urban areas including roadsides. Associated species commonly include Kangaroo and Wallaby grasses in the ground layer, often with <i>Eucalyptus melliodora</i> , <i>E. blakelyi</i> , <i>E. polyanthemus</i> , <i>E. mannifera</i> or <i>E. pauciflora</i> where a tree stratum is present (Sinclair 2010).	1 record within 20km (OEH 2014a)	Unlikely. No suitable habitat present within study area.
<i>Philotheca ericifolia</i>		V	This species occurs in drainage areas in dry sclerophyll open forest or woodland on sandstone and in heath on damp sandy flats and gullies. Specific microclimates include damp sandy flats, alluvial deposits of coarse gravel in dry creek beds and along a spur receiving soakage from high ground. Associated species include <i>Eucalyptus crebra</i> , <i>Beyeria viscosa</i> and <i>Phlitheca australis</i> .	Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. No suitable habitat present within study area.
<i>Prasophyllum petilum</i> Tarengo Leek Orchid	E	E	Occurs at 4 sites in NSW (Captains Flat Cemetery, Ilford Cemetery, Steves TSR at Delegate and Tarengo TSR near Boorowa). Also at Hall in ACT. Grows on relatively fertile soils in grassy woodland or natural grassland. Occurs in relatively moist, poorly drained areas (DECCW 2010).	1 record within 20km, last recorded 1993 (OEH 2014a); Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. No suitable habitat present within study area.
<i>Prasophyllum</i> sp. Wybong		CE	Endemic to NSW, known from seven populations within the Border Rivers, Central Rivers and Central West NRM regions. Known to occur in open eucalypt woodland and grassland (DotE 2014b).	Species or species' habitat likely occur within 20km (DotE 2014a)	Nil. No suitable habitat present within study area.

Scientific name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence
<i>Thesium australe</i> Austral Toadflax	V	V	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland, and is often found in association with Kangaroo Grass ( <i>Themeda australis</i> ).	Species or species' habitat likely occur within 20km (DotE 2014a)	Nil. No suitable habitat present within study area.



**Threatened fauna known or predicted from the locality, habitat association and likelihood of occurring at the subject site**

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E	E	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly Typha spp. and Eleocharis spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Species or species' habitat may occur within 20km (DotE 2014a)	Nil. No dense reed habitat present. Would not be impacted by the proposal.
<i>Rostratula australis</i>	Australian Painted Snipe	E	E	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Species or species' habitat may occur within 20km (DotE 2014a)	Nil. No suitable wetland habitat present. Would not be impacted by the proposal.
<i>Ninox connivens</i>	Barking Owl	V		Occurs from coast to inland slopes and plains, though is rare in dense, wet forests east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. Roosts along creek lines in dense, tall understorey foliage (e.g. in Acacia and Casuarina), or dense eucalypt canopy. Nests in hollows of large, old eucalypts. Territories range from 30 to 200 hectares.	1 record within 20km (OEH 2014a)	Likely. Could forage or roost in the study area. No suitable hollow-bearing trees present in the subject site.  Proposal would have a negligible impact on potential foraging habitat and no impact on potential breeding habitat.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Climacteris picumnus victoriana</i>	Brown Treecreeper (eastern subspecies)	V		Occurs from Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell to the east coast, in areas such as the Snowy River Valley, Cumberland Plain, Hunter Valley and parts of the Richmond and Clarence Valleys. Most common on the inland slopes and plains. Inhabits eucalypt woodlands and dry open forest, usually dominated by stringybarks or rough-barked species with open grassy understorey. Fallen timber is important foraging habitat. Nests in hollows in standing trees or stumps.	3 records within 20km (OEH 2014a)	Possible. May forage in the subject site. More likely to occur in adjacent eucalypt woodland. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat.
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V		Restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the Southwestern Slopes, south to and contiguous with the Victorian population. Inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. The Gang-gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. The Gang-gang Cockatoo feeds on seeds obtained in trees and shrubs, mostly from eucalypts and wattles.	1 record within 20km (OEH 2014a)	Recorded adjacent to the study area. Could forage in the study area. No suitable hollow-bearing trees present in the subject site. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat (large hollow-bearing trees).

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Melanodryas cucullata cucullata</i>	Hooded Robin (south-eastern form)	V		Considered a sedentary species, but local seasonal movements are possible. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Nests on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs.	3 records within 20km (OEH 2014a)	Possible. May forage in the study area. More likely to occur in adjacent eucalypt woodland. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat.
<i>Hieraaetus morphnoides</i>	Little Eagle	V		Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	1 record within 20km (OEH 2014a)	Likely. Would forage over the study area as part of a much larger home range. No large raptor nests observed. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Leipoa ocellata</i>	Malleefowl	E	V	Occurs in semi-arid to arid mallee country in the south-west of NSW. Its NSW stronghold is centred on Mallee Cliffs NP, extending east to Balranald and with scattered records north to Mungo NP. There are also populations in the Scotia mallee (W of the Darling River), central NSW (chiefly Yathong, Nombinnie and Round Hill NR), and Dubbo (Goonoo forest). Occasional records exist from the Pilliga, around Cobar and Goulburn River NP. Inhabits predominately mallee communities, apparently preferring areas of sandy soil, abundant leaf litter, dense canopy and an abundance of food shrubs and herbs (especially legumes). Less frequently found in other eucalypt woodlands such as Inland Grey Box, Ironbark and Bimble Box woodlands with thick understorey, and Mulga and native Cypress Pine communities.	Species or species' habitat likely occur within 20km (DotE 2014a)	Nil. No suitable habitat present, outside usual range. Would not be impacted by the proposal.
<i>Grantiella picta</i>	Painted Honeyeater	V		Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the <i>Amyema</i> genus. Nests in outer tree canopy.	1 record within 20km (OEH 2014a)	Unlikely. No suitable woodland habitat present. Unlikely to be impacted by the proposal.
<i>Anthochaera phrygia</i>	Regent Honeyeater	CE	E	In NSW confined to two known breeding areas: the Capertee Valley and Bundarra-Barraba region. Inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	3 records within 20km (OEH 2014a); Species or species' habitat known to occur within 20km (DotE 2014a)	Likely. May forage on occasion within the riparian woodland. Thinning of trees would have a negligible impact on available foraging resources in the locality. No impact on breeding habitat.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Petroica boodang</i>	Scarlet Robin	V		In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	1 record within 20km (OEH 2014a)	Unlikely. Limited suitable woodland habitat present. Unlikely to be impacted by the proposal.
<i>Polytelis swainsonii</i>	Superb Parrot	V	V	Occurs as a single population in the South-west Slopes and Riverina bioregions. Two core breeding areas: between Cowra and Yass – Grenfell, Cootamundra and Coolac in the SW Slopes, and along the Murray, Edward and Murrumbidgee Rivers in the Riverina. Birds breeding in the SW slopes migrate north to the Namoi/Gwydir Rivers for winter. Inhabits Box Gum, Box – Cypress Pine and Boree woodlands and River Red Gum Forest. Nest in hollow trees, in tall riparian River Red Gum communities (Riverina area) or open Box Gum woodland or isolated paddock trees (SW Slopes). Mainly forages in grassy box woodlands, up to 20km from breeding sites.	Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. No suitable woodland habitat present. No River Red Gums present. Unlikely to be impacted by the proposal. No large hollow-bearing trees to be removed.
<i>Lathamus discolor</i>	Swift Parrot	E	E	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains.	Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. No suitable woodland habitat present. Unlikely to be impacted by the proposal.
<b>Mammals</b>						



Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E	V	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	Species or species' habitat may occur within 20km (DotE 2014a)	Nil. No suitable habitat present. Would not be impacted by the proposal.
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing Bat	V		Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony.	No local records (OE 2014a)	Present. Would forage along the Turon River. No breeding habitat present. May temporarily roost under Crossley Bridge or in tree hollows in the study area. Proposal would have a limited impact on this species. No breeding habitat would be impacted. Hollow-bearing trees would be retained. No impact to foraging habitat.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V		Occurs in NE NSW south to Kempsey and west to the Warrumbungles. Inhabits rainforest margins, wet and dry sclerophyll forests through to drier forests and woodlands in semi-arid environments. All records are within close proximity to sandstone or volcanic escarpments. Roosts in overhangs and caves, mines, boulder piles, abandoned Fairy Martin nests and occasionally in buildings, and regularly switches between alternate roost colonies. Forages over a small area, but are capable of flying 500 m over clear paddocks	No local records (OEH 2014a)	Possibly recorded in the study area. Would forage along the Turon River (if present). No breeding habitat present. May temporarily roost under Crossley Bridge or in tree hollows in the study area. Proposal would have a limited impact on this species. No breeding habitat would be impacted. Hollow-bearing trees would be retained. No impact to foraging habitat.
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V		Occurs on southeast coast and ranges. Prefers tall (>20m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12km foraging movements recorded) (Churchill 2008, Law et al 2008).	1 record within 20km (OEH 2014a)	Unlikely. Preferred habitat not present. Proposal would have a limited impact on this species. Hollow-bearing trees would be retained. No impact to foraging habitat.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Phascolarctos cinereus</i>	Koala	V	V	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred hectares.	14 records within 20km (OEH 2014a); Species or species' habitat known to occur within 20km (DotE 2014a)	Possible. Occasional feed trees present along the riparian corridor. Would not be impacted by the proposal. No eucalypts to be removed.
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V	V	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Species or species' habitat known to occur within 20km (DotE 2014a)	Possible. May forage over the Turon River on occasion. No breeding habitat present.
<i>Pseudomys novaehollandiae</i>	New Holland Mouse		V	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke 1999). Populations may recolonise/increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson 1999).	Species or species' habitat may occur within 20km (DotE 2014a)	Nil. No suitable habitat present. Would not be impacted by the proposal.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat	V	V	Little known about the biology or social structure of these bats - rarely recorded and scattered distribution (DotE 2014b). Limited distribution that is restricted to the Murray-Darling Basin and western slopes in south-eastern Australia. Occur in a wide range of habitats including River Red Gum, Black Box, Allocasuarina, Belah, Mallee, open woodlands and savannahs, but are most common in box, ironbark and cypress open forests and buloke woodlands of inland northern NSW (Churchill 2008). In SA known to roost in tree hollows less than 3m above the ground with multiple small entrances, elsewhere they roost in fissures in branches and under exfoliating bark. Tree hollows used as maternity sites (Churchill 2008).	Species or species' habitat may occur within 20km (DotE 2014a)	Possible. May forage and roost in the study area. Proposal would have a limited impact on this species. Hollow-bearing trees would be retained. No impact to foraging habitat.
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V	E	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	2 records within 20km (OEH 2014a); Species or species' habitat known to occur within 20km (DotE 2014a)	Likely. May forage in the study area. Known to use riparian corridors for movement. Breeding unlikely given the narrow riparian corridor and presence of dogs. Proposal would have a limited impact on this species.
<b>Reptiles</b>						
<i>Hoplocephalus bungaroides</i>	Broad-headed Snake	E	V	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small	Species or species' habitat likely occur within 20km (DotE 2014a)	Nil. No suitable habitat present. Would not be impacted by the proposal.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
				mammals.		
<i>Aprasia parapulchella</i>	Pink-tailed Worm-lizard	V	V	Populations occur in the Queanbeyan/Canberra district, Cooma, Yass, Bathurst, Albury and West Wyalong areas. Inhabits grassland and open woodland with substantial embedded rock cover in sunny situations. Recorded in both native and non-native grasslands. Usually recorded under small rocks (150 - 600 mm basal area) shallowly embedded in the soil (2 - 5 cm, and use ant burrows under these rocks.	Species or species' habitat known to occur within 20km (DotE 2014a)	Nil. No suitable habitat present. Would not be impacted by the proposal.
<b>Frogs</b>						
<i>Litoria booroolongensis</i>	Booroolong Frog	E	E	Restricted to western slopes and tablelands, mainly in western-flowing streams and their headwaters on the Great Dividing Range. Has disappeared from the Northern Tablelands and rare throughout the rest of its range. Occurs along permanent streams with some fringing vegetation cover, ranging from slow-flowing creeks to large rivers, in both forested/ open pasture areas. Found on or near cobble banks and other rock structures within stream margins and shelter under rocks or amongst vegetation near the ground on the stream edge.	4 records within 20km (OEH 2014a); Species or species' habitat likely occur within 20km (DotE 2014a)	Present. Two adults observed and two individuals heard calling within the subject site. Foraging and breeding habitat present. Proposal may impact foraging and shelter habitat and indirectly impact breeding habitat through sedimentation.



Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<b>Fish</b>						
<i>Tandanus tandanus</i>	Freshwater Catfish in the Murray/Darling Basin	EP		Once widespread and abundant throughout the Murray-darling system, has declined rapidly and in NSW is currently only regularly observed 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. Present in a range of riverine and lake habitats, preferring sluggish or still waters. Found in both clear and turbid waters, in areas ranging from mud to gravel to rock substrates. Now rare in riverine habitats in inland NSW and Queensland but can be found in farm dams (DPI 2011b).	Species known to occur within the Central West catchment management authority (DPIa)	Possible. Rare in natural riverine habitats and prefers sluggish or still waters. Proposal could potentially impact species (if present) through loss of habitat and spawning sites through siltation, if appropriate mitigation measures are not implemented.
<i>Maccullochella peelii</i>	Murray Cod		V	Occurs throughout the Murray-Darling Basin. Can 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 presence of wood debris has been shown to be the primary factor determining Murray cod presence (Kearney and Kildea 2001).	Species or species' habitat may occur within 20km (DotE 2014a); Species known to occur within the Central West catchment management authority (DPIa)	Present. Fingerlings caught during electrofishing surveys are likely to be from a recent stocking event in the area. Proposal may impact breeding habitat (if breeding in the subject site) through sedimentation of spawning sites, if appropriate mitigation measures are not implemented.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Mogurnda adspersa</i>	Purple-spotted Gudgeon	E (listed under the FM Act)		Occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. Now extremely rare in inland NSW, having been recorded from this area only once since 1983. Found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large woody debris (snags) (DPI 2014c).	Species known to occur within the Central West catchment management authority (DPIa); Species known to occur within the Central West catchment management authority (DPIb)	Possible. Study area outside current known distribution. Rare in inland NSW. Proposal may impact breeding habitat (if present) through sedimentation of spawning sites, if appropriate mitigation measures are not implemented.
<i>Bidyanus bidyanus</i>	Silver Perch	V (listed under the FM act)		In NSW now absent from much of their former range across the Murray-Darling. Most abundant remaining natural population occurs in the central Murray River downstream of Yarrowonga Weir as well as several of its anabranches and tributaries including the Edward River - an anabranch of the Murray River that flows through Deniliquin, and the Murrumbidgee River. 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. Information on habitat preferences is scarce for this species (NSW DPI 2006a).	Species known to occur within the Central West catchment management authority (DPIa); Species known to occur within the Central West catchment management authority (DPIb)	Unlikely. Study area outside current known distribution. Unlikely to be impacted by the proposal.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Maccullochella macquariensis</i>	Trout Cod	E (listed under the FM Act)		There are 3 known breeding populations in NSW: a naturally occurring population below Yarrowonga Weir in the Murray River, a stocked population in the Murrumbidgee River at Narrandera and a translocated population in Cataract Dam in coastal NSW. There are stocked (breeding unconfirmed) populations within the Murray, Murrumbidgee and Macquarie Rivers, and in Talbingo Dam in Kosciusko NP (NSW DPI 2006b). The species occurs in a range of habitats, but is strongly associated with the presence of woody debris and snags (NSW DPI 2006b).	Species known to occur within the Central West catchment management authority (DPIa); Species known to occur within the Central West catchment management authority (DPIb)	Unlikely. Study area outside current known distribution. Unlikely to be impacted by the proposal.
<i>Ambassis agassizii</i>	Western NSW population of the Olive Perchlet	EP		Occur in the Murray-Darling drainages. Inhabit 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 (DPI 2014c).	Species known to occur within the Central West catchment management authority (DPIa); Species known to occur within the Central West catchment management authority (DPIb)	Unlikely. Study area outside current known distribution. Unlikely to be impacted by the proposal.
<b>Invertebrates</b>						
<i>Notopala sublineata</i>	River Snail	E (listed under the FM act)		Endemic to the Murray/Darling Basin. The species is now restricted to a few populations in irrigation pipes near Mildura but were once common and widely distributed throughout the basin where it was found along the river banks attached to logs and rocks or crawling in the mud (DPI 2014c)	Species known to occur within the Central West catchment management authority (DPIb)	Unlikely. Study area outside current known distribution. Unlikely to be impacted by the proposal.

Scientific name	Common name	TSC Status	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
<i>Paralucia spinifera</i>	Bathurst Copper Butterfly	E	V	Occurs on the Central Tablelands of NSW in an area approximately bounded by Oberon, Hartley and Bathurst. The butterfly is found at 35 locations, all with a west to north-west aspect, usually where direct sunlight reaches the habitat, and with extremes of cold such as regular winter snowfalls or heavy frosts. Geology, soils and dominant vegetation canopy species vary between habitat locations. However vegetation structure is consistent, commonly open woodland or open forest with a sparse understorey that is dominated by the shrub, Blackthorn <i>Bursaria spinosa</i> subsp. <i>lasiophylla</i> . Its lifecycle relies on a mutualistic relationship with the ant, <i>Anonychomyra itinerans</i> , and on the presence of Blackthorn which is used as the larval food plant. The butterflies emerge between August (later at higher altitude sites) and November, with a two-week peak of activity in September.	Species or species' habitat likely occur within 20km (DotE 2014a)	Nil. No suitable habitat present. Would not be impacted by the proposal.

All information in these tables is taken from NSW OEH and Commonwealth DotE Threatened Species profiles (OEH, 2014a; DotE 2014b).

Key: CE – Critically Endangered; E – Endangered; V – Vulnerable; EP – Endangered Population.

***Migratory fauna known or predicted from locality, habitat association, likelihood of occurring in the subject site, and potential impact***

Common name	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
Black-faced Monarch	Migratory, marine	Found along the coast of eastern Australia, becoming less common further south. 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. It may also migrate to Papua New Guinea in autumn and winter.	Species or species' habitat known to occur within 20km (DotE 2014a)	Unlikely. Preferred habitat not present in the study area. Unlikely to be impacted by the proposal.
Rainbow Bee-eater	Migratory terrestrial	Distributed across much of mainland Australia, and several near-shore islands. Occurs in a range of habitats, including open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia. Nests are made in sandy banks.	Species or species' habitat may occur within 20km (DotE 2014a)	Likely. Species may forage or breed in the study area. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat, as thinning would occur on river flats and root balls would be left in situ..
Rufous Fantail	Migratory, marine	Found along NSW coast and ranges. Inhabits rainforest, dense wet forests, swamp woodlands and mangroves. During migration, it may be found in more open habitats or urban areas (Birds Australia 2008).	Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. Preferred habitat not present in the study area. Unlikely to be impacted by the proposal.



Common name	EPBC Status	Habitat description	Source	Likelihood of occurrence and potential impact
Satin Flycatcher	Migratory, marine	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Species or species' habitat known to occur within 20km (DotE 2014a)	Possible. May occur in the study area on occasion. Proposal would have a negligible impact on potential foraging habitat and is unlikely to impact breeding habitat.
White-bellied Sea-Eagle	Migratory terrestrial	Primarily coastal but may extend inland over major river systems. Breeds close to water, mainly in tall open forest/woodland but also in dense forest, rainforest, closed scrub or remnant trees. Usually forages over large expanses of open water, but also over open terrestrial habitats (e.g. grasslands).	Species or species' habitat likely occur within 20km (DotE 2014a)	Unlikely. Preferred habitat not present in the study area. Unlikely to be impacted by the proposal.
White-throated Needletail	Migratory, marine	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types, but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Species or species' habitat likely occur within 20km (DotE 2014a)	Likely. Species may forage high above the study area. Does not breed in Australia. Unlikely to be impacted by the proposal.

## Appendix B - Field survey data

## Flora species recorded

Family	Exotic	Scientific Name	Common Name
Rosaceae		<i>Acaena novae-zelandiae</i>	Bidgee-widgee
Rosaceae		<i>Acaena ovina</i>	Acaena
Simaroubaceae	*	<i>Ailanthus altissima</i>	Tree of Heaven
Amaranthaceae	*	<i>Amaranthus albus</i>	Tumbleweed
Myrsinaceae	*	<i>Anagallis arvensis</i>	Scarlet Pimpernel
Papaveraceae	*	<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>	Mexican Poppy
Poaceae		<i>Aristida ramosa</i>	Purple Wiregrass
Poaceae		<i>Aristida vagans</i>	Threeawn Speargrass
Rubiaceae		<i>Asperula conferta</i>	Common Woodruff
Poaceae		<i>Austrostipa scabra</i>	Speargrass
Poaceae	*	<i>Avena fatua</i>	Wild Oats
Poaceae	*	<i>Bambusa</i> sp.	Unidentified bamboo
Asteraceae	*	<i>Bidens pilosa</i>	Cobbler's Pegs
Brassicaceae	*	<i>Brassica</i> sp.	Brassica
Poaceae	*	<i>Briza maxima</i>	Quaking Grass
Poaceae	*	<i>Bromus catharticus</i>	Praire Grass
Pittosporaceae		<i>Bursaria spinosa</i>	Native Blackthorn
Casuarinaceae		<i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i>	River Oak
Gentianaceae	*	<i>Centaurium erythraea</i>	Common Centaury
Caryophyllaceae	*	<i>Cerastium glomeratum</i>	Mouse-ear Chickweed
Solanaceae	*	<i>Cestrum parqui</i>	Green Cestrum
Poaceae		<i>Chloris truncata</i>	Windmill Grass
Lauraceae	*	<i>Cinnamomum camphora</i>	Camphor Laurel
Asteraceae	*	<i>Cirsium vulgare</i>	Spear Thistle
Apiaceae	*	<i>Conium maculatum</i>	Hemlock
Convolvulaceae		<i>Convolvulus erubescens</i>	Pink Bindweed
Asteraceae	*	<i>Conyza bonariensis</i>	Flaxleaf Fleabane
Crassulaceae	*	<i>Crassula</i> sp.	Stoncrop
Apiaceae	*	<i>Cyclospermum leptophyllum</i>	Slender Celery
Poaceae		<i>Cynodon dactylon</i>	Common Couch
Cyperaceae	*	<i>Cyperus eragrostis</i>	Umbrella Sedge
Cyperaceae		<i>Cyperus lucidus</i>	Leafy Flat Sedge
Cyperaceae		<i>Cyperus</i> sp.	
Solanaceae	*	<i>Datura ferox</i>	Fierce Thornapple
Solanaceae	*	<i>Datura stramonium</i>	Common Thornapple
Convolvulaceae		<i>Dichondra repens</i>	Kidney Weed
Sapindaceae		<i>Dodonaea viscosa</i>	Sticky Hop-bush
Poaceae		<i>Echinopogon ovatus</i>	Forest Hedgehog Grass
Boraginaceae	*	<i>Echium plantagineum</i>	Patterson's Curse
Poaceae	*	<i>Ehrharta erecta</i>	Panic Veldtgrass
Myrtaceae		<i>Eucalyptus blakelyi</i>	Blakely's Red Gum
Myrtaceae		<i>Eucalyptus melliodora</i>	Yellow Box
Myrtaceae		<i>Eucalyptus viminalis</i>	Manna Gum
Asteraceae		<i>Euchiton sphaericus</i>	Star Cudweed
Euphorbiaceae	*	<i>Euphorbia peplus</i>	Petty Spurge

Family	Exotic	Scientific Name	Common Name
Apiaceae	*	<i>Foeniculum vulgare</i>	Fennel
Fumariaceae	*	<i>Fumaria capreolata</i> subsp. <i>capreolata</i>	Climbing Fumitory
Rubiaceae	*	<i>Galium aparine</i>	Goosegrass
Rubiaceae		<i>Galium gaudichaudii</i>	Rough Bedstraw
Geraniaceae		<i>Geranium antrorsum</i>	
Geraniaceae		<i>Geranium solanderi</i>	Native Geranium
Poaceae	*	<i>Holcus lanatus</i>	Yorkshire Fog
Clusiaceae	*	<i>Hypericum perforatum</i>	St. Johns Wort
Asteraceae	*	<i>Hypochaeris glabra</i>	Smooth Catsear
Asteraceae	*	<i>Hypochaeris radicata</i>	Catsear
Juncaceae		<i>Juncus australis</i>	Rush
Asteraceae	*	<i>Lactuca saligna</i>	Willow-leaved Lettuce
Asteraceae	*	<i>Lactuca serriola</i>	Prickly Lettuce
Oleaceae	*	<i>Ligustrum lucidum</i>	Large-leaved Privet
Lomandraceae		<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
Solanaceae	*	<i>Lycium ferocissimum</i>	African Boxthorn
Malvaceae	*	<i>Malva parviflora</i>	Small-flowered Mallow
Violaceae		<i>Melicytus dentatus</i>	Tree Violet
Poaceae		<i>Microlaena stipoides</i> var. <i>stipoides</i>	Weeping Grass
Malvaceae	*	<i>Modiola caroliniana</i>	Red-flowered Mallow
Poaceae	*	<i>Nassella trichotoma</i>	Serrated Tussock
Oleaceae	*	<i>Olea europaea</i> subsp. <i>cuspidata</i>	African Olive
Oxalidaceae	*	<i>Oxalis latifolia</i>	
Oxalidaceae		<i>Oxalis perennans</i>	
Poaceae	*	<i>Paspalum dilatatum</i>	Paspalum
Malvaceae	*	<i>Pavonia hastata</i>	
Poaceae	*	<i>Pennisetum clandestinum</i>	Kikuyu Grass
Polygonaceae		<i>Persicaria decipiens</i>	Slender Knotweed
Polygonaceae		<i>Persicaria hydropiper</i>	Water Pepper
Poaceae	*	<i>Phalaris aquatica</i>	Phalaris
Phytolaccaceae	*	<i>Phytolacca octandra</i>	Inkweed
Plantaginaceae	*	<i>Plantago lanceolata</i>	Lamb's Tongues
Poaceae		<i>Poa labillardierei</i> var. <i>labillardierei</i>	Tussock
Lamiaceae	*	<i>Prunella vulgaris</i>	Self-heal
Amygdalaceae	*	<i>Prunus</i> sp.	
Fagaceae	*	<i>Quercus</i> sp.	
Ranunculaceae	*	<i>Ranunculus muricatus</i>	Sharp Buttercup
Ranunculaceae	*	<i>Ranunculus repens</i>	Creeping Buttercup
Rosaceae	*	<i>Rosa rubiginosa</i>	Sweet Briar
Rosaceae	*	<i>Rubus fruticosus</i> sp. agg.	Blackberry complex
Polygonaceae		<i>Rumex brownii</i>	Swamp Dock
Polygonaceae	*	<i>Rumex conglomeratus</i>	Clustered Dock
Polygonaceae	*	<i>Rumex crispus</i>	Curled Dock
Poaceae		<i>Rytidosperma caespitosum</i>	Ringed Wallaby Grass
Poaceae		<i>Rytidosperma racemosum</i>	Wallaby Grass
Salicaceae	*	<i>Salix</i> sp.	
Cyperaceae		<i>Schoenus apogon</i>	Fluke Bogrush

Family	Exotic	Scientific Name	Common Name
Asteraceae		<i>Senecio linearifolius</i>	Fireweed Groundsel
Asteraceae	*	<i>Senecio madagascariensis</i>	Fireweed
Asteraceae		<i>Senecio quadridentatus</i>	Cotton Fireweed
Fabaceae (Caesalpinioideae)	*	<i>Senna pendula</i> var. <i>glabrata</i>	
Poaceae	*	<i>Setaria parviflora</i>	
Rubiaceae	*	<i>Sherardia arvensis</i>	Field Madder
Malvaceae	*	<i>Sida rhombifolia</i>	Paddy's Lucerne
Asteraceae	*	<i>Silybum marianum</i>	Variiegated Thistle
Brassicaceae	*	<i>Sisymbrium officinale</i>	Hedge Mustard
Brassicaceae	*	<i>Sisymbrium</i> sp.	
Solanaceae		<i>Solanum americanum</i>	Glossy Nightshade
Solanaceae	*	<i>Solanum nigrum</i>	Black-berry Nightshade
Asteraceae	*	<i>Sonchus asper</i> subsp. <i>asper</i>	Prickly Sowthistle
Asteraceae	*	<i>Sonchus oleraceus</i>	Common Sowthistle
Poaceae	*	<i>Sporobolus africanus</i>	Parramatta Grass
Poaceae		<i>Sporobolus creber</i>	Slender Rat's Tail Grass
Asteraceae	*	<i>Tagetes minuta</i>	Stinking Roger
Asteraceae	*	<i>Taraxacum officinale</i>	Dandelion
Fabaceae (Faboideae)	*	<i>Trifolium arvense</i>	Haresfoot Clover
Fabaceae (Faboideae)	*	<i>Trifolium repens</i>	White Clover
Urticaceae		<i>Urtica incisa</i>	Stinging Nettle
Verbenaceae	*	<i>Verbena bonariensis</i>	Purpletop
Verbenaceae	*	<i>Verbena rigida</i> var. <i>rigida</i>	Veined Verbena
Fabaceae (Faboideae)	*	<i>Vicia sativa</i>	Common vetch
Apocynaceae	*	<i>Vinca major</i>	Periwinkle
Violaceae	*	<i>Viola odorata</i>	Sweet Violet
Vitaceae	*	<i>Vitis</i> sp.	



*Vertebrate fauna species recorded in the study area*

Scientific Name	Common Name	Exotic	NSW Status	EPBC Status	Observation Type
<b>Birds</b>					
<i>Alisterus scapularis</i>	Australian King-parrot				O
<i>Cracticus tibicen</i>	Australian Magpie				O
<i>Corvus coronoides</i>	Australian Raven				O
<i>Chenonetta jubata</i>	Australian Wood Duck				O
<i>Ceyx azureus</i>	Azure Kingfisher				O
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike				O
<i>Accipiter fasciatus</i>	Brown Goshawk				O
<i>Acanthiza pusilla</i>	Brown Thornbill				O
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill				
<i>Scythrops novaehollandiae</i>	Channel-billed Cuckoo				O
<i>Platycercus elegans</i>	Crimson Rosella				W
<i>Gallinula tenebrosa</i>	Dusky Moorhen				O
<i>Acanthorhynchus tenuirostris</i>	Eastern Spinebill				W
<i>Eopsaltria australis</i>	Eastern Yellow Robin				O
<i>Turdus merula</i>	Eurasian Blackbird	*			O
<i>Petrochelidon ariel</i>	Fairy Martin				O
<i>Cacomantis flabelliformis</i>	Fan-tailed Cuckoo				W
<i>Todiramphus macleayii</i>	Forest Kingfisher				O
<i>Eolophus roseicapillus</i>	Galah				O
<i>^Callocephalon fimbriatum</i>	Gang-gang Cockatoo		V		O
<i>Rhipidura albiscapa</i>	Grey Fantail				O
<i>Colluricincla harmonica</i>	Grey Shrike-thrush				W
<i>Passer domesticus</i>	House Sparrow	*			O
<i>Dacelo novaeguineae</i>	Laughing Kookaburra				O
<i>Dicaeum hirundinaceum</i>	Mistletoebird				O
<i>Nycticorax caledonicus</i>	Nankeen Night Heron				O
<i>Philemon corniculatus</i>	Noisy Friarbird				O
<i>Anas superciliosa</i>	Pacific Black Duck				O
<i>Strepera graculina</i>	Pied Currawong				O
<i>Neochmia temporalis</i>	Red-browed Finch				O
<i>Psephotus haematonotus</i>	Red-rumped Parrot				O
<i>Zosterops lateralis</i>	Silvereye				O
<i>Pardalotus striatus</i>	Striated Pardalote				W
<i>Malurus cyaneus</i>	Superb Fairy-wren				O
<i>Sericornis frontalis</i>	White-browed Scrubwren				O
<i>Egretta novaehollandiae</i>	White-faced Heron				O

Scientific Name	Common Name	Exotic	NSW Status	EPBC Status	Observation Type
<i>Cormobates leucophaea</i>	White-throated Treecreeper				O
<i>Corcorax melanorhamphos</i>	White-winged Chough				O
<i>Rhipidura leucophrys</i>	Willie Wagtail				O
<i>Lichenostomus chrysops</i>	Yellow-faced Honeyeater				O
<i>Acanthiza chrysorrhoa</i>	Yellow-rumped Thornbill				O
<b>Mammals</b>					
<i>Vombatus ursinus</i>	Common Wombat				F
<i>Macropus giganteus</i>	Eastern Grey Kangaroo				O
<i>Ornithorhynchus anatinus</i>	Platypus				O
<i>Hydromys chrysogaster</i>	Water-rat				O
<i>Tadarida australis</i>	White-striped Freetail-bat				D, W
<i>Chalinolobus morio</i>	Chocolate Wattled Bat				D
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat				D
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing Bat		V		D
<i>Vespadelus darlingtoni</i>	Large Forest Bat				D
<i>Vespadelus vulturnus</i>	Little Forest Bat				D
<i>Vespadelus troughtoni</i>	Eastern Cave Bat		V		Po
<i>Nyctophilus gouldi</i>	Gould's Long-eared Bat				Pr
<i>Scotorepens balstoni</i>	Inland Broad-nosed Bat				Pr
<i>Nyctophilus geoffroyi</i>	Lesser Long-eared Bat				Pr
<i>Mormopterus "Species 2"</i>	Eastern Freetail Bat				Pr
<i>Mormopterus "Species 4"</i>	Southern Freetail Bat				Pr
<b>Reptiles</b>					
<i>Chelodina (Chelodina) longicollis</i>	Eastern Snake-necked Turtle				O
<i>Intellagama lesueurii</i>	Eastern Water Dragon				O
<i>Eulamprus quoyii</i>	Eastern Water-skink				O
<i>Lampropholis sp.</i>	Skink				O
<b>Frogs</b>					
<i>Litoria booroolongensis</i>	Booroolong Frog		E	E	OW
<i>Crinia signifera</i>	Common Eastern Froglet				W
<i>Limnodynastes dumerilii</i>	Eastern Banjo Frog				O
<i>Litoria lesueurii</i>	Lesueur's Frog				O
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog				W
<b>Fish</b>					
<i>Cyprinus carpio</i>	Carp	*			O
<i>Gambusia holbrooki</i>	Eastern Gambusia	*			O
<i>Hypseleotris galii</i>	Firetail Gudgeon				O

Scientific Name	Common Name	Exotic	NSW Status	EPBC Status	Observation Type
<i>Galaxias olidus</i>	Mountain Galaxias				O
<i>Maccullochella peelii</i>	Murray Cod			V	O

\* = exotic, V – vulnerable; D – anabat definite; O – observed, Po – anabat possible; Pr – anabat probable; W – heard, F – Tracks or scratchings,

*Aquatic invertebrate fauna taxa recorded in the study area*

Common Name	Class/Order	Family/Sub-family	Exotic	NSW Status	EPBC Status	Observation Type
Flat Worm	Turbellaria	Dugesiidae				O
Freshwater Snails	Gastropoda	Lymnaeidae				O
	Gastropoda	Ancylidae				O
	Gastropoda	Physidae	*			O
Bivalve	Bivalvia	Corbiculidae				O
Worm	Oligochaeta	Oligochaeta				O
Freshwater Shrimp	Decapoda	Atyidae				O
Freshwater Prawn	Decapoda	Palaemonidae				O
Yabbie	Decapoda	Parastacidae				O
Aquatic Beetles	Coleoptera	Dytiscidae				O
	Coleoptera	Gyrinidae				O
	Coleoptera	Hydrophilidae				O
	Coleoptera	Scirtidae				O
	Coleoptera	Elmidae				O
	Coleoptera	Psephenidae				O
	Coleoptera	Hydrochidae				O
Flies (Larvae)	Diptera	Tipulidae				O
	Diptera	Ceratopogonidae				O
	Diptera	Simuliidae				O
	Diptera	Tabanidae				O
	Diptera	Stratiomyidae				O
	Diptera	Dolichopodidae				O
	Diptera	Tanypodinae				O
	Diptera	Orthoclaadiinae				O
	Diptera	Chironominae				O
Mayflies	Ephemeroptera	Baetidae				O
	Ephemeroptera	Leptophlebiidae				O
	Ephemeroptera	Caenidae				O
Water Bugs	Hemiptera	Mesoveliidae				O
	Hemiptera	Hydrometridae				O
	Hemiptera	Veliidae				O
Water Strider	Hemiptera	Gerridae				O
	Hemiptera	Corixidae				O
Back Swimmer	Hemiptera	Notonectidae				O
Moth (Larvae)	Lepidoptera	Crambidae				O
Alderflies	Megaloptera	Corydalidae				O
Damselflies	Odonata	Coenagrionidae				O

Common Name	Class/Order	Family/Sub-family	Exotic	NSW Status	EPBC Status	Observation Type
	Odonata	Diphlebiidae				O
Dragonflies	Odonata	Gomphidae				O
	Odonata	Telephlebiidae				O
Caddisflies	Trichoptera	Hydrobiosidae				O
	Trichoptera	Hydroptilidae				O
	Trichoptera	Philopotamidae				O
	Trichoptera	Hydropsychidae				O
	Trichoptera	Ecnomidae				O
	Trichoptera	Leptoceridae				O

\* = exotic; O = observed



## Appendix C – Aquatic habitat assessment reports

# Appendix D - TSC Act Assessments of Significance

## *Legislative requirement*

Section 5A of the EP&A Act lists seven factors that must be taken into account in the determination of the significance of potential impacts of an activity on 'threatened species, populations or ecological communities (or their habitats)' listed under the TSC Act. The '7 part test' is used to determine whether an activity is 'likely' to impose 'a significant effect' on threatened biota and thus whether a species impact statement (SIS) is required. Should the 7 part test conclude that a significant effect is likely, an SIS must be prepared.

Seven part tests have been provided for threatened biota recorded in the study area. The following threatened biota are included in these assessments:

- Booroolong Frog.
- Threatened fish.

### **Booroolong Frog**

The Booroolong Frog requires extensive rocky structures along a stream, with some fringing vegetation. Adults occur on or near cobble banks and other rock structures within stream margins, or near slow-flowing connected or isolated pools that contain suitable rock habitats. Females deposit eggs in the crevices of the rock structures within the shallow slow, to medium flowing sections of a stream or in adjacent slow flowing connected or isolated rock pools (Hunter, 2007; Antsis 2002; DotE 2015b). Studies by Hunter (2007) have found a negative relationship between the proportion of canopy cover and the species occurrence, likely relating to thermoregulatory requirements (e.g. attaining warmer body temperatures enhance growth and development).

The dispersal capabilities and non-breeding habitats of the species are unknown, but the species is relatively sedentary (DotE 2015b). Hunter (2001) found that the majority of recaptured individuals moved less than 50 metres within a season, with maximum movements of up to 300 metres being recorded across seasons (DotE 2015b).

The Booroolong Frog has been found to persist in sections of streams that have been highly modified, denuded of native vegetation and open to stock access, as well as within artificial structures such as weirs, but such high levels of disturbance are unlikely to be conducive to long term persistence (Hunter 2007; Antsis et al 1998; DotE 2015b).

The Booroolong Frog was recorded in the study area. Two adults and one juvenile frog were observed in cobble areas immediately adjacent to the water (one within the subject site) and two frogs were heard calling within the subject site. The species has previously been recorded about 20 km upstream of Sofala (OEH 2015a).

#### **Booroolong Frog (endangered)**

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Booroolong Frogs present in the study area are likely to be part of a much larger population associated with the Turon River. Based on inspection of habitat in the study area and visual inspection of aerial photographs, and surveys undertaken for other assessments, cobble habitat occurs in many locations along the Turon River up and downstream of the subject site.

All cobble banks and bars along the Turon River in the study area and surrounds represent breeding habitat for this species. These are located alongside both stream margins and pools. Cobble areas range in size from small (1m x 1m) to large expanses over 50 m in length and 10 m in width. Frogs in the study area were recorded in both small and larger areas of cobbles. Surrounding vegetation ranged from herbaceous weeds to stands of River Oaks. No cobble areas would be removed as a result of the vegetation thinning works. Thinning of trees would be undertaken along a 500 m section of the Turon River by hand with use of mobile plant for removal of large trees trunks. Thinning works would cause a temporary disruption to cobble habitat as a result of movement of people and small plant during thinning activities. This could potentially disturb adult frogs if present. There would be no direct impact on pool and stream habitat where eggs and

## Booroolong Frog (endangered)

tadpoles occur.

The main risk of disturbance of sediments is from movement of mobile plant along the river banks, and clearing of large areas of herby weeds. Root balls of trees would be retained which would maintain bank stability and minimise the potential for slips or sediment movement. Surfaces disturbed through weed removal would be stabilised through supplementary planting.

Sedimentation resulting from disturbance during thinning works may adversely affect breeding habitat of the Booroolong Frog by altering water quality and filling aquatic habitat with fine sediment. The Turon River is subject to regular flooding events, which cause erosion and sedimentation along the river. Locations and extent of cobble banks would change over time as a result of flooding events and water level. The additional sedimentation risk is likely to be temporary and low compared to the normal conditions of the river.

Booroolong Frogs may shelter in cobbles and vegetation at the base of River Oaks and Willows that will be removed. There is a risk of accidental mortality of individuals resulting from the movement of people and plant at the site during works. The retention of root balls would minimise disturbance of shelter sites and the potential for mortality of individuals is likely to be low.

The proposal would have no impact on connectivity for the species. No areas of habitat would become isolated or fragmented. Thinning of trees may improve habitat in some areas as the species prefers areas with little canopy cover.

Given that the proposal would not remove foraging or breeding habitat, would not fragment or isolate any areas of habitat, the risk of injury and mortality of individuals is low, the river is regularly subject to changes in water levels that change the location and distribution of breeding areas, and sedimentation is not likely to be greater than is already experienced during flood events, the proposal is not likely to have an adverse effect on the life cycle of the species such that the local population of the species is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action

## Booroolong Frog (endangered)

proposed, and

No area of breeding or foraging habitat would be removed. Thinning of trees along a 500 m section of the Turon River would be undertaken by hand with use of mobile plant for removal of large trees trunks. Root balls of trees would be retained which would maintain bank stability and minimise the potential for slips or sediment movement. Surfaces disturbed through weed removal would be stabilised through supplementary planting. Sedimentation resulting from disturbance during thinning works may adversely affect breeding habitat of the Booroolong Frog by altering water quality and filling aquatic habitat with fine sediment. This is not likely to be above that which is experienced by the species during flood events.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The proposal would have no impact on connectivity for the species. No areas of habitat would become isolated or fragmented.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

Habitat present in the subject site is important to the species' survival in the subject site. The proposal involves the thinning of River Oaks along a 500 m section of the Turon River, as well as weed removal and revegetation works. No area of important habitat would be isolated. There would be a temporary risk of sedimentation of breeding habitat resulting from the works. Any sedimentation that may occur is unlikely to be greater than that experienced during flood events. Booroolong Frogs present in the study area are likely to be part of a much larger population associated with the Turon River. Based on inspection of habitat in the study area and visual inspection of aerial photographs, cobble habitat occurs in many locations along the Turon River, and the habitat to be impacted makes up a very small proportion of important habitat in the locality.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

There is no critical habitat listed for the Booroolong Frog. Cobble banks are critical to the survival of the species as it uses these habitat areas for breeding, foraging and shelter. As discussed above, no areas of cobble banks would be removed. There may be possible disturbance through movement of people and plant during thinning to gain access to the vegetation. The proposal may result in temporary sedimentation of these areas within the subject site. Each flood event in the Turon River would alter sediment load and location and extent of exposed cobble areas, and the temporary sedimentation that may occur as a result of the proposal would not substantially alter breeding habitat for the species. Large reaches of potential breeding habitat are present upstream and downstream of the study area. Given these points, the proposal is not likely to have an adverse effect on critical habitat.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

## Booroolong Frog (endangered)

The overall objective of the Booroolong Frog recovery plan (OEH 2012) is to minimise the probability of extinction of the Booroolong Frog in the wild, and to increase the probability of populations becoming self-sustaining and viable in the longer term. One particular action is to reduce the impact of known or perceived threats contributing to the ongoing decline of the Booroolong Frog. No area of habitat would be removed as a result of the proposal. The proposal could result in temporary sedimentation of breeding habitat, and possible injury or mortality of adult frogs, however the risk of this is low and not likely to be greater than that experienced during flood events. Given the large areas of available habitat present along the Turon River, and the temporary nature and limited extent of potential impacts, the proposal is not likely to interfere with the recovery of the species.

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed action would contribute to the operation of two KTPs as follows:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands. The proposal would not alter the natural flow regime of the Turon River during low or normal flow periods.
- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis. The proposal could potentially introduce chytrid fungus to the study area. Mitigation measures are recommended to reduce the likelihood of this occurring.

### Conclusion of Assessment of Significance

The proposal is unlikely to significantly affect the Booroolong Frog as:

- No area of breeding or shelter habitat would be removed.
- The risk of sedimentation of breeding habitat is low given the thinning method (hand thinning and retention of root balls) and the mitigation measures (standard sediment and erosion control measures).
- The risk of injury and mortality of individuals during the proposed is low.
- Large reaches of suitable habitat for the species are present upstream and downstream of the subject site.
- The proposal would not alter the natural flow regime of the Turon River during low or normal flow periods.



### Threatened fish

Aquatic habitats observed may be suitable for species known to occur in the central west catchment area (DPI 2015b), including the Freshwater Catfish (*Tandanus tandanus*) and Purple-spotted Gudgeon (*Mogurnda adspersa*).

The Freshwater Catfish occurs in a range of riverine and lake habitats, preferring sluggish or still waters. Found in both clear and turbid waters, in areas ranging from mud to gravel to rock substrates. The Purple-spotted Gudgeon is found in slow-moving or still waters of rivers, creeks and billabongs, often amongst weeds, rocks or large woody debris (snags) (DPI 2014c).

The thinning of trees may result in temporary sedimentation of aquatic habitats. Sedimentation would be very limited given the measures to retain bank stability and stabilise disturbed soils.

#### Murray Cod (Vulnerable)

a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

A short term increased sedimentation during and following the implementation proposed works may occur. This may have an impact on the breeding sites and habitats for these fish species at the local reach scale (if present). Root balls of trees would be retained which would maintain bank stability and minimise the potential for slips or sediment movement. Surfaces disturbed through weed removal would be stabilised through supplementary planting. The lateral and temporal extent of any increases in sedimentation rates is likely to be minimal.

There would be no removal of snags, no instream structures, and no blockage of fish passage.

Given that the proposal would not remove foraging or breeding habitat, would not fragment or isolate any areas of habitat, would not block fish passage, and sedimentation is not likely to be greater than is already experienced during flood events, the proposal is not likely to have an adverse effect on the life cycle of these species such that the local population of the species (if present) is likely to be placed at risk of extinction.

b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Murray Cod (Vulnerable)

Not applicable.

d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The proposal will not remove any habitat within the Turon River. The proposal will not include instream structures that may block fish passage.

A short term increased sedimentation during and following the implementation proposed works may occur. This may have an impact on the breeding sites and habitats for these species at the local reach scale. Root balls of trees would be retained which would maintain bank stability and minimise the potential for slips or sediment movement. Surfaces disturbed through weed removal would be stabilised through supplementary planting. The lateral and temporal extent of any increases in sedimentation rates is likely to be minimal.

No removal of instream snags will occur although council have proposed the removal of some fallen trees on the banks with the aim of reducing the risk of damage to assets during high flow events. If this occurs it may temporarily reduce the prevalence of snags as future habitat of the native fish species.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The proposal will not include instream structures that may block fish passage. As such no area of habitat would become fragmented or isolated as a result of the proposal.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

There is no evidence of these species in the study area. These species are rare in the central west catchment area. The subject site is unlikely to be important to these species. Increase sedimentation, a possible result of the proposed works, may temporarily reduce quality of potential habitat for these species.

e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

There is no critical habitat listed for these species.

f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

There is no recovery plan for these species. As noted above, the subject site is unlikely to be important to these species given the lack of evidence in the subject site and rarity of these species in the central west catchment area. The potential temporary increase in sedimentation is unlikely to interfere with the recovery of these species.

## Murray Cod (Vulnerable)

g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed action would contribute to the operation of KTPs as follows:

- Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands. The proposal would not alter the natural flow regime of the Turon River during low or normal flow periods.

### Conclusion of Assessment of Significance

- No area of breeding or shelter habitat would be removed.
- There would be no blockage of fish passage.
- The risk of sedimentation of breeding habitat is low given the thinning method (hand thinning and retention of root balls) and the mitigation measures (standard sediment and erosion control measures).
- Large reaches of suitable habitat for the species are present upstream and downstream of the subject site.
- The proposal would not alter the natural flow regime of the Turon River during low or normal flow periods.

GHD

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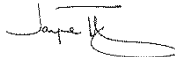
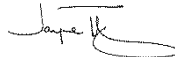
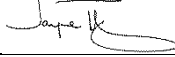
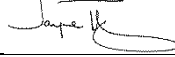
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## Appendix C – Aboriginal Assessment



### **Bathurst Local Aboriginal Land Council**

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### *Aboriginal Assessment- Sofala Flood Mitigation Project*

A survey was conducted on Monday 18 August 2014 for the Sofala Flood Mitigation Project proposed by Bathurst Regional Council. The purpose of this project is to remove Casuarina's from the area to prevent blockages causing flooding in the local area. Two person's were present to preform the assessment Amy Armstrong from the Bathurst Local Aboriginal Land Council and James Locke present from GHD.

With the area being surveyed the results showing ground cover is at 20% visibility. River rock showing its domain over the area, also main tree life in the area consists of Casuarina's. The area shows no signs of Aboriginal occupation. As the terrain is quite rough and inaccessible The Bathurst Local Aboriginal Land Council is consistent with the decision that Aboriginal activities were not undertaken in this certain area. Therefore The Bathurst Local Aboriginal Land Council has no objections to Bathurst Regional Council proceeding with the Mitigation Project.

Amy Armstrong  
Sites Officer  
Bathurst Local Aboriginal Land Council  
18/08/2014



# **Appendix D** – Works Implementation Plan

GHD 2012



CLIENTS | PEOPLE | PERFORMANCE

**Bathurst Regional  
Council**

Sofala  
Works Implementation Plan  
June 2012



# 1. Introduction

## 1.1 Overview

GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council (BRC) to prepare a detailed implementation plan for riparian vegetation rehabilitation and management works for a section of the Turon River, at Sofala. The implementation plan was a key recommendation from the Vegetation Management Plan (VMP), which was recently prepared by GHD. The aim of the works plan is to provide the successful contractor with the necessary details to adequately undertake the works and to satisfy the requirements of the VMP.

## 1.2 Background

A VMP was prepared by GHD (November, 2011) on behalf of BRC as a response to a recommendation from the Sofala Floodplain Risk Management Study (Cardno Willing, 2007). This study identified opportunities to reduce flooding impacts in the township of Sofala through the implementation of improved vegetation management in the locality.

That study concluded that 'thinning' of vegetation within the riparian corridor (native and introduced) would reduce flooding impacts in large events. This implementation plan sets out the methods and targets for the rehabilitation and management of riparian vegetation in the locality to help achieve this outcome.

## 1.3 Location

The study area is located in the Macquarie River Valley of the Central West Catchment Management Authority (CMA). The township of Sofala is located approximately 42 kilometres north of Bathurst and is located within the Bathurst Regional Council LGA. The subject site is defined as the riparian zone of the Turon River from Golden Point, 1,500 metres upstream of Crossley Bridge at Sofala to 500 metres downstream of the bridge. The Turon River, a tributary of the Macquarie River has a catchment area of 883 km<sup>2</sup> at Sofala. The location of the site and details of the area of concern in this works plan are shown in Appendix A, Figure 1.



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## Appendices

- A Vegetation Management and Rehabilitation Plan
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## 2. Legislation

### 2.1 Relevant Legislation and Policies

The Works Implementation Plan for Sofala has been prepared in accordance with the provisions contained in relevant legislation and policy guidelines, including but not limited to the following:

#### 2.1.1 Water Management Act 2000

Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. This Works Implementation Plan has considered the implications of the Water Management Act 2000 (WMA Act). A controlled activity approval under the WMA is required for certain types of developments and activities that are carried out in or near a river, lake or estuary. This includes the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise. Office of Environment and Heritage (OEH) is required to assess the impact of a controlled activity to ensure that minimal harm will be done to any waterfront land, i.e. the bed and a distance inland of 40 metres from a river, lake or estuary.

#### 2.1.2 Threatened Species Conservation Act 1995

The Threatened Species Conservation Act (TSC Act) 1995 includes schedules that list threatened species, populations and ecological communities and key threatening processes. The objectives of the TSC Act are to:

- Conserve biological diversity and promote ecologically sustainable development, to prevent the extinction and promote the recovery of threatened species, populations and ecological communities.
- To protect the critical habitat of those threatened species, populations and ecological communities that are endangered.
- To eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities.
- To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed.
- To encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.

The Implementation Plan for the Sofala VMP is not expected to impose a significant negative effect on any local populations of native biota, including threatened species, Endangered Ecological Communities (EEC's) and their habitats listed on the TSC Act, which occur on the study site or in adjoining habitats.

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list "Clearing of native vegetation" as a KEY THREATENING



PROCESS on Schedule 3 of the Act. Listing of Key Threatening Processes is provided for by Part 2 of the Act.

### 2.1.3 NSW Native Vegetation Act 2003

The NSW Native Vegetation Act 2003 was established to regulate the clearing of native vegetation in NSW apart from the Sydney Basin. The main objectives of the NV Act are:

- a) to provide for, encourage and promote the management of native vegetation on a regional basis in the social, economic and environmental interests of the State,
- b) to prevent broad scale clearing unless it improves or maintains environmental outcomes,
- c) to protect native vegetation of high conservation value having regard to its contribution to such matters as water quality, biodiversity, or the prevention of salinity or land degradation,
- d) to improve the condition of existing native vegetation, particularly where it has high conservation value,
- e) to encourage the revegetation of land, and the rehabilitation of land, with appropriate native vegetation, in accordance with the principles of ecologically sustainable development.

Proposals for the clearing (including ecological thinning) of remnant native vegetation and protected regrowth generally fall into one of three categories. The thinning of native vegetation falls into the following:

- 'green light' category - actions that improve or maintain environmental outcomes in their own right and can be undertaken without offsets (thinning native *BioMetric* 3.1 Operational Manual 8 vegetation to benchmark stem densities for the vegetation type falls within this category).

### 2.1.4 Noxious Weeds Act 1993 (NSW)

This Implementation Plan also considers the landowner's obligations to control weeds listed as noxious and/or environmental in the LGA. During the revegetation activities, site owners are legally obliged to 'fully and continuously suppress and destroy' any noxious weed colonisation.

A total of six (6) listed noxious weeds were found during the flora assessment. Weed control methodologies outlined in this plan should be implemented upon initiation of clearing works to decrease the chances of site infestation by invasive noxious weed species.

### 2.1.5 Other Legislation and Policies

Other legislation and policies that may be relevant to the Implementation Plan for the Sofala VMP include:

- Bathurst Interim Local Environmental Plan 2005.
- Central West Catchment Management Authority Guidelines.





## 3. Work Plan Methodology

### 3.1 Aims and Objectives

The works plan aims to provide a clear, concise and practical framework for the establishment, management and rehabilitation of vegetation in the riparian area situated along a section of the Turon River at Sofala.

### 3.2 Work Plan Methodology

This detailed work plan includes the following:

- An outline of the scope of proposed works, including references to GHD reports.
- An outline of techniques necessary to progressively remove targeted native vegetation throughout the riparian zone of the Turon River, to minimise flood risk downstream.
- Revegetation work details, including number of plants, locations and plant protection measures incorporated.
- Bush regeneration work details, including number of sessions and types of activities.
- Site protection and erosion control work detail – location of fencing and erosion protection measures.
- Maintenance work detail, including number of sessions and types of activities.
- Updated cost estimate for the described works.

### 3.3 Summary Actions

This implementation plan describes the rehabilitation and management actions required to implement the necessary works, as outlined in the Vegetation Management Plan, Sofala (GHD, November, 2011). The implementation plan includes three components, these being:

- Native vegetation thinning, concentrating on the selective removal of River Oak (*Casuarina cunninghamiana*). Strategies for the removal of River Oak have been based on the recommendations of the Sofala Floodplain Risk Management Study (2007) and the field assessments carried out by GHD (July, 2011). A targeted weed removal and bush regeneration program to improve the condition of retained remnant vegetation. It is recommended that the targeted weed removal program concentrate on noxious weeds found on site, including the selective removal of Willows, and follow up weed control be included in the bush regeneration program. Revegetation will be limited to a small area immediately east of the bridge (near the existing park) and 'infill' plantings, to help stabilise areas which do not have existing riparian vegetation and erosion is occurring. Plantings will be limited to middle and lower storey species as the overall program includes a reduction in canopy species to assist with flooding implications.

A monitoring and reporting program will also be established to monitor the success of the *Casuarina* thinning program, weed control and bush regeneration activities and the survival rates of the revegetation program.



All of the above actions are described in more detail in Table 2 below.

### 3.4 Description of Key Terms

The following key terms are used throughout the description of the proposed rehabilitation program.

- **Regeneration** - Refers to natural regeneration of the vegetation community.
- **Revegetation** - Refers to the planting of tube stock or similar grown from local provenance seed to re-establish vegetation.
- **Restoration**- Refers to a combination of restoration activities and management techniques to restore native vegetation.
- **Practical completion**-Refers to the completion of installation of revegetation activities.
- **Establishment**- Refers to the minimum 24 month maintenance program applied to revegetation work to ensure plant establishment.
- **Final Completion**- Refers to the successful completion of the entire restoration program in accordance with the VMP.





## 4. Proposed Works

### 4.1 Outline of the Scope of Works

The following information provides a detailed description of all activities required to implement the actions outlined in the GHD report 'Sofala Vegetation Management Plan' (November, 2011). Detailed techniques used for revegetation and regeneration are included in Figure 1 of the VMP.

### 4.2 Rehabilitation Works

#### 4.2.1 Vegetation Removal Strategy

Though vegetation removal is desirable to help reduce flooding impacts, in New South Wales it is necessary to obtain approval from the NSW Office of Water (NOW) before removing any vegetation from within 20 metres of a river or watercourse. Council does not necessarily need to go through the formal approval process but advising NOW of the works proposed is recommended. It may be necessary to submit a plan for replacement vegetation in order to prevent erosion of the bank.

#### Native Vegetation Removal

The Sofala Floodplain Risk Management Study recommended that the casuarinas in the immediate upstream vicinity of the Crossley Bridge be 'thinned', so as to help mitigate structural damage to the bridge during large flooding events.

Based on the conclusions drawn from an analysis of the Sofala Floodplain Risk Management Study by GHD (Section Figure 1 in the VMP, November, 2011), it is recommended that the River Oaks (*Casuarina cunninghamiana*) be thinned to maintain a stems per hectare ratio that would be at the lower end of benchmark for that vegetation community (see section 4.3 in the VMP for explanation of Benchmark for this vegetation type). This recommendation allows for positive outcomes for reducing the impact of flooding and maintaining a functioning ecosystem.

The objective of this thinning program will be to maintain a stem density of less than 720 stems per hectare throughout the study area. Highest priority for the thinning of *Casuarina cunninghamiana* would be in the 1,500 metres riparian zone upstream of the Crossley Bridge, in areas depicted as having a stem count above 720 per hectare (See Figure 2, Appendix B). Working towards the Crossley Bridge to approximately 500 metres past it in areas where stem counts exceed 720 per hectare is desirable.

The thinning of casuarinas should be limited to saplings and emergent seedlings in the riparian zone where stem density is above the recommended 720 stems per hectare, as detailed in Figure 2, Appendix B. It is recommended that species to be removed should have a diameter at breast height (dbh) of less than 20 centimetres. Refer to the following website examples of thinning of invasive native species,

[http:// www.environment.nsw.gov.au/projects/biometrictool.htm](http://www.environment.nsw.gov.au/projects/biometrictool.htm).



Another good point of reference for all matters relating to native vegetation is the OEH website, in particular the Native Vegetation Act, 2003, which can be found through the following website:

<http://www.environment.nsw.gov.au/vegetation/nvmanagement.htm>.

#### **Removal of Willows and other Woody Weeds**

Various species of Willows (*Salix spp.*) have been identified along the bed and banks of the Turon River, with a concentration of mature Willows either side of the Crossley Bridge at Sofala.

Staged removal, commencing in the upper reaches of the study area and working down stream, is desirable. Clearing large areas of willow removal in any one place along the riparian zone should be avoided so as to protect the banks from destabilisation. Instead selective removal of large willows, leaving the root ball in-situ is recommended. Follow up weed control can be conducted as part of the structured bush regeneration program. In addition removal of willows from areas where thinning of *Casuarina cunninghamiana* has taken place should be completed over a number of years, so as to reduce erosion potential. Even then it should proceed with caution so as to not disturb any additional plantings or natural regeneration.

A large amount of information exists concerning the control of Willows in Australia. Several recommended sources for accessing such information includes the following websites:

- Weeds Australia – Weeds of National Significance  
<http://www.weeds.org.au/WoNS/willows/resources.htm>
- The Florabank website has information on Weed Control techniques  
<http://www.florabank.org.au>
- Weeds in Australia - <http://www.weeds.gov.au/index.html>
- <http://www.dpi.nsw.gov.au/agriculture>

#### **4.2.2 Erosion Control**

To mitigate the potential for erosion on the river bank it is recommended that the removal of larger environmental woody weeds be conducted as part of a staged program. It is also recommended that the root balls of these species be left in-situ (as described above) to reduce the potential for soil erosion. See Table 3 below for detailed actions.

#### **4.2.3 Revegetation Program**

There will be limited revegetation works within the site. Works will be confined to areas where weed removal has taken place and soil is exposed to reduce the potential for erosion and river bank instability. It is envisaged that small pockets of hand planting will be conducted in these areas with plantings consisting of shrubs and ground covers only, Table 1, below, provides a list of appropriate species. Table 3 outlines detailed actions for these works.

Seed collection for the revegetation program should commence as soon as approvals for licence requirements have been granted. Collection of seed should be carried out by qualified professionals who are familiar with guidelines relating to seed collection, storage and propagation techniques. Guidelines using best practice techniques can be found at the Florabank website <http://www.florabank.org.au>.





Species to be collected should be consistent with those of the River Oak Forest and Woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions community (as per recommended in the Sofala Vegetation Management Plan, GHD, 2011). Species to be collected should be limited to shrubs and groundcovers as listed in Table 1 below.

**Table 1 Planting List**

Botanical Name	Common Name	Density	Revegetation Activity
<b>Middle Storey:</b>			
<i>Acacia implexa</i>	Hickory Wattle	1 per m2	Planting
<i>Bursaria spinosa</i>	Black thorn	1 per m2	Planting
<i>Callistemon sieberi</i>	River bottlebrush	1 per m2	Planting
<i>Leptospermum myrtifolium</i>	Myrtle tea-tree	1 per m2	Planting
<b>Groundcovers:</b>			
<i>Commelina cyanea</i>	Scurvy weed	4 per m2	Broadcasting (cuttings)
<i>Cymbopogon refractus</i>	Barbed wire grass	4 per m2	Planting/broadcasting
<i>Dichondra repens</i>	Kidney Weed	4 per m2	Broadcasting (cuttings)
<i>Geraniumsolanderi</i>	Native Geranium	4 per m2	Planting
<i>Lomandra longifolia</i>	Mat rush	4 per m2	Planting
<i>Microlaena stipoides</i>	Weeping meadow grass	4 per m2	Planting
<i>Oplismenus aemulus</i>	Basket Grass	4 per m2	Broadcasting (cuttings)
<i>Pratia purperescens</i>	Whiteroot	4 per m2	Broadcasting (cuttings)
<i>Poa labillardieri</i>	Large tussock grass	2 per m2	Planting/broadcasting

#### 4.2.4 Bush Regeneration Program

A structured bush regeneration program will be implemented along sections of the creek, concentrating on follow-up treatment of willows, noxious weeds as listed in the VMP and areas of environmental weeds. The majority of the program will focus on the control of perennial and annual weeds. The site has only scattered specimens of woody weeds, with greatest densities being west of the Crossley Bridge and these will be treated as part of the target weed control activities. Weeds to be targeted include large woody weeds such as Large-leaved Privet and Blackberry and a variety of other herbaceous weeds, including Cobblers Peg, Hemlock, Bridal Creeper and Fleabane. See Table 3 below for detailed actions.

Several publications have been produced regarding best practice guidelines for bush regeneration, generally focusing on vegetation of the Sydney Basin. These publications are also relevant to other locations within NSW as they can be adapted to other vegetation communities. Best Practice Guidelines for Bush Regeneration - Sydney Turpentine-Ironbark Forest, DECCW, 2008 being recommended and can be located at the following website:





[http://www.sydney.cma.nsw.gov.au/component/option.com\\_repository/Itemid.24/func.fileinfo/id.348/](http://www.sydney.cma.nsw.gov.au/component/option.com_repository/Itemid.24/func.fileinfo/id.348/)

#### 4.2.5 Monitoring and Reporting

In order to accurately evaluate the success of the restoration works, GHD recommends an initial report be prepared at 'Practical Completion' of the works and then summary reports be prepared annually throughout the maintenance period. See Table 3 below for detailed actions.

### 4.3 Key Tasks and Timing of Activities

An overview of the key tasks and the timing of activities as they relate to the management actions are tabled below.

**Table 2 Key Tasks and Timing of Activities**

Task Number	Task	Timing
1.	<p><b>Seed Collection</b></p> <ul style="list-style-type: none"> <li>Apply for seed collection licence as soon as contractors have been appointed to the project.</li> <li>Seed collection of target species to follow Florabank guidelines.</li> </ul>	Prior to vegetation removal.
2.	<p><b>Casuarina cunninghamiana thinning</b></p> <p>Selective thinning of <i>Casuarina cunninghamiana</i> in riparian zone, concentrating on areas upstream of the Crossley Bridge where stem ratios are above 720 stems per hectare.</p> <p>Contractors to refer to Figure 1, Appendix A as to where they will stage their works. Staging of works as follows;</p> <ul style="list-style-type: none"> <li>Start in the upper most limit of the study area, upstream of the Crossley Bridge.</li> <li>Delineate area (cell) to be worked over the allocated time. A suggested time frame would be in the spring, when growth of new seedlings and saplings is high and when chance of rain is lower. This allows for natural regeneration to occur over spring.</li> <li>Cell areas will have to be calculated to maintain benchmark stem count for the Casuarinas. It may be desirable to divide areas into manageable zones i.e. 0.5 ha = 360 stems.</li> <li>Select trees, those with dbh of less than 20cm within the work cell by flagging these with high</li> </ul>	<p>As soon as consultation with NSW Office of Water has been conducted.</p> <p>Springtime</p> <p>2 days per week for 10 weeks (team of 2)</p>





Task Number	Task	Timing
	<p>visibility tape.</p> <ul style="list-style-type: none"> <li>Set out cells to be worked in a matrix such that no two cells are side by side or are opposite each other on opposite sides of the bank. This mitigates the potential for erosion.</li> <li>Do not stage works if it is raining or if periods of heavy rain have been experienced prior to works being carried out.</li> </ul>	
3.	<p><b>Erection of temporary fencing</b></p> <ul style="list-style-type: none"> <li>Erect fencing around recently worked areas to prevent stock access and to delineate areas where traffic should be limited to prevent further erosion.</li> </ul>	Post Casuarina thinning.
4.	<p><b>Native Seed Dispersal</b></p> <ul style="list-style-type: none"> <li>Native seed dispersal can be carried out as soon as a cell has been thinned of Casuarinas. Dispersal is a simple process and involves casting out native seed by hand in areas where there is bare soil.</li> <li>Ideal conditions are post rain events of at least two days to ensure adequate soil moisture.</li> <li>Hand broadcasting larger seeds or those with awns that bury into the soil (ie. <i>Microlaena stipoides</i>) and in areas where there is a layer of surface mulch will offer greater success rates.</li> <li>It is recommended that soil depth be no less than 5mm. Most species can be sown at a depth of between 5-10mm and larger seeds 10-25mm.</li> <li>Broadcast seed can be lightly buried by raking or harrowing to improve the connectivity between the soil and the seed.</li> </ul>	<p>Post Casuarina thinning.</p> <p>As soon as a cell has been worked on.</p>
5.	<p><b>Removal of Willows</b></p> <ul style="list-style-type: none"> <li>Consultation with NSW OoW to discuss possible removal of large willows along the riparian zone.</li> <li>Selective removal of willows in upper sections of the study area and downstream for approximately 500m.</li> <li>Plan to start removal of willows on the inside bends of the river, as these areas are more stable.</li> <li>Apply a similar method of selective removal that</li> </ul>	<p>Summer/early Autumn.</p> <p>3 days per week for 4 weeks - team of 4 (As part of the target weed control program)</p>





Task Number	Task	Timing
	<p>has been applied to the Casuarina thinning, so as not to destabilise the banks.</p> <ul style="list-style-type: none"> <li>• Identify 'seed' producing trees and tag these with conspicuous plastic ribbon that can withstand flooding and grazing animals. Most seed producing trees flower between September and November, so plan to do the survey during this time.</li> <li>• Control methods include:               <ul style="list-style-type: none"> <li>– Hand pulling of seedlings less than 0.5cm tall.</li> <li>– Chainsaw saplings off at the base and apply selective herbicide to cut.</li> <li>– Stem injection of large trees. Make cuts into sapwood approximately 20-30 mm deep and inject with selective herbicide.</li> <li>– Leave Willow trees in situ for approximately 12 months to ensure successful kill and allow for other naturally regenerating/hand planted/hand broadcast native species to establish.</li> </ul> </li> </ul> <p><b>Note: All seedlings, branches and twigs must be bagged and taken off-site to be disposed of so that sprouting does not occur.</b></p>	<p>Springtime</p> <p>Apply herbicide early summer to autumn.</p>
6.	<p><b>Target Weed Control</b></p> <ul style="list-style-type: none"> <li>• Control of listed noxious weeds through several methods. Best method of approach is an integrated weed control program which includes physical and chemical control.</li> <li>• Techniques are too numerous to go into detail in this document. Refer to treatment techniques in the Sofala VMP (Section 7.9.1) and the web sites in Table 3 Action Plan for control techniques.</li> <li>• Target weed control will be concentrated in areas of high weed infestation, with the focus east of the Crossley Bridge.</li> </ul>	<p>Post Casuarina thinning.</p> <p>Late Summer/Early Autumn</p> <p>3 days per week for 4 weeks – team of 4</p>
7.	<p><b>Bush Regeneration</b></p> <p>The main components of the bush regeneration program are as follows:</p> <ul style="list-style-type: none"> <li>• <i>Hand Weeding</i> <ul style="list-style-type: none"> <li>– Minimal soil disturbance is crucial as other weeds will quickly redistribute themselves when</li> </ul> </li> </ul>	<p>Post Casuarina thinning and target weed control.</p> <p>Early Summer when weed growth is most active and when weeds more effectively absorb</p>







- Low
- Performance target: goal, objective or desired outcome for addressing issues, consistent with VMP (GHD, 2011).





Table 3 Action Plan

Objective	Means to Achieve	Industry Standards and/or regulations	Estimated Costs	Priority	Performance Targets
Native Vegetation Removal	<p><b>Vegetation Removal</b></p> <ul style="list-style-type: none"> <li>Consult with the NSW Office of Water to remove vegetation from within 20 metres of a waterway.</li> <li>Selective thinning of <i>Casuarina cunninghamiana</i> in riparian zone, concentrating on areas upstream of the Crossley Bridge where stem ratios are above 720 stems per hectare.</li> <li>Thinning should be carried out on saplings and emergent seedlings, leaving the roots in tact so as to reduce erosion. Saplings can be sawn off at ground level and seedlings snipped with hand held secateurs and then 'painted' with a selective herbicide such as Grazon™ DS (consideration must be given to the most appropriate herbicide and application technique for given weather conditions and the fact we are working within a waterway).</li> <li>It is advisable to stage thinning works, so as not to work on large areas of the riparian zone at one time, as this will leave the area vulnerable to erosion if large rainfall events were to occur.</li> <li>All material is to be removed off site to reduce</li> </ul>	<p>NSW Office of Water  <a href="http://www.water.nsw.gov.au">http://www.water.nsw.gov.au</a>            Central West Catchment Management Authority  <a href="http://cw.cma.nsw.gov.au">http://cw.cma.nsw.gov.au</a>            Native Vegetation Regulation 2005: Environmental Outcomes Assessment Methodology  <a href="http://www.environment.nsw.gov.au/project/sbiometrictool.htm">www.environment.nsw.gov.au/project/sbiometrictool.htm</a>  <a href="http://www.environment.nsw.gov.au/vegetation/nvmanagement.htm">http://www.environment.nsw.gov.au/vegetation/nvmanagement.htm</a></p>	\$27,000 (Team of two for 20 days)	High	<ul style="list-style-type: none"> <li>Reduce stem count of <i>Casuarina cunninghamiana</i> to the lower end of benchmark for that species and maintain this at less than 720 stems per hectare.</li> <li>Leaving mature <i>Casuarinas</i> to grow and retain benchmark status.</li> <li>Reduce the potential for flooding and maintain a functioning ecosystem.</li> </ul>





	<p>the debris lying on the ground that could potentially pose a blockage hazard, particularly up stream of the bridge, which could increase potential flooding impacts on Sofala township in large rainfall events.</p>			
<p>Soil Management</p>	<ul style="list-style-type: none"> <li>• Staged removal of vegetation to reduce exposing large areas of 'bare' soil.</li> <li>• Where larger areas of vegetation have been removed native seed dispersal is recommended as a technique to stabilise these areas.</li> <li>• Fencing off these areas to reduce the access stock has to recently worked sections.</li> </ul>	<p>\$1,360 (based on 2 days) \$900 Installation of temporary fencing)</p>	<p>High</p>	<ul style="list-style-type: none"> <li>• Stabilise banks throughout the riparian zone, so as to minimise erosion potential in periods of flooding.</li> <li>• Monitor success rates of native seed dispersal through monitoring and reporting program.</li> </ul>
<p>Removal of Willows</p>	<ul style="list-style-type: none"> <li>• Consult with the NSW Office of Water to remove vegetation from within 20 metres of a waterway.</li> <li>• Staged removal commencing in upper reaches of study area working towards the Crossley Bridge and downstream of it for approximately 500 metres.</li> <li>• Selectively remove willows so as to not destabilise the banks and leave root ball in-situ to maintain stability of the banks.</li> <li>• Saplings can be chainsawed off at ground level and painted with a selective herbicide that is safe to be used near and/or within a waterway.</li> <li>• All material to be moved off site to reduce</li> </ul>	<p>See weed control below.</p> <p><a href="http://www.dpi.nsw.gov.au/agriculture">http://www.dpi.nsw.gov.au/agriculture</a> <a href="http://www.weeds.org.au/WoNS/willows/resources.htm">http://www.weeds.org.au/WoNS/willows/resources.htm</a> <a href="http://www.weeds.gov.au/index.html">http://www.weeds.gov.au/index.html</a></p>	<p>Medium</p>	<ul style="list-style-type: none"> <li>• Improve water quality, by reducing the amount and type of leaf debris in the river system, which has been known to have adverse effects on the natural ecosystem.</li> <li>• Improve habitat for native species.</li> <li>• Reduce the potential load for flooding and promote a healthy functioning ecosystem.</li> </ul>





	potential for blockage and increasing flooding impacts.								
<b>Revegetation</b>									
Seed Collection	<ul style="list-style-type: none"> <li>Apply for seed collection licence S91 prior to vegetation removal works begin, so as to allow for enough lead in time to pick endemic native species to be used in native seed dispersal and for growing on of native plants for revegetation works.</li> <li>Seed collection carried out by qualified collectors and will focus on 5km radius of the site so as to collect endemic species of River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions community.</li> <li>Collection, handling, cleaning, storage and database entry of seeds to comply with appropriate Florabank guidelines, recognised as best practise.</li> </ul>	<p>Guidelines and code of practice for seed collection, handling, storage and database entry found at Florabank website:  <a href="http://www.florabank.org.au">http://www.florabank.org.au</a></p>	\$1,200	High	<ul style="list-style-type: none"> <li>To collect enough endemic seed for use in hand broadcasting and for propagation.</li> </ul>				
Propagation	<ul style="list-style-type: none"> <li>Plant propagation refers to the germinating of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes.</li> <li>All plants will be produced from local provenance seed.</li> <li>This activity should be managed by a suitably qualified and experienced native plant production nursery.</li> </ul>	<p>Guidelines for plant propagation and benefits of local provenance seed found at Florabank website:  <a href="http://www.florabank.org.au">http://www.florabank.org.au</a></p>	\$2,400 (Based on hand planting of 500 plants)	Medium	<ul style="list-style-type: none"> <li>Have sufficient, healthy endemic plant species to be used in small areas of revegetation throughout the riparian zone</li> <li>The propagation of endemic species should produce plants which are better adapted to local conditions.</li> </ul>				





Target weed control and Bush Regeneration					
Target Weed Control	<ul style="list-style-type: none"> <li>This component of the restoration program refers to the control of listed noxious weeds such as Blackberry Complex, Bridal Creeper, Hemlock, Large-leaved Privet, Tree of Heaven and Willows.</li> <li>This program requires specialised equipment and chemicals and will be managed by appropriately trained and experienced staff.</li> <li>A summary of the most appropriate weed treatments is provided in the Sofala VMP.</li> <li>Control of these plants usually requires several treatments and is most effective during summer and early autumn.</li> <li>Target weed control will be concentrated in areas of high weed infestation, with the focus west of the Crossley Bridge.</li> </ul>	<p><a href="http://www.weeds.gov.au/index.html">http://www.weeds.gov.au/index.html</a></p> <p><a href="http://www.dpi.nsw.gov.au/agriculture">http://www.dpi.nsw.gov.au/agriculture</a></p>	\$16,200 (team of 4 for 12 days)	High	<ul style="list-style-type: none"> <li>Effective treatment of environmental (woody weeds and vines) and noxious weeds.</li> <li>85% survival rates from plantings.</li> <li>A reduction of environmental and noxious weeds, with minimal disturbance to native regenerating species, particularly ground covers.</li> <li>Further reduction will be achieved over time as native vegetation cover increases.</li> </ul>
Bush Regeneration	<ul style="list-style-type: none"> <li>GHD recommends that all remaining weeds (mostly annual and perennial) be included in the bush regeneration program.</li> <li>The site has only scattered specimens of woody weeds, treatment of which will be included as part of the targeted weed control.</li> <li>Bush regeneration will occur across the full length of the riparian zone, covered in the VMP.</li> <li>All weed control and bush regeneration activities</li> </ul>	<p><a href="http://www.sydneycma.nsw.gov.au/component/option,com_remositor/v/Itemid,24/func,fileinfo/id,348/">http://www.sydneycma.nsw.gov.au/component/option,com_remositor/v/Itemid,24/func,fileinfo/id,348/</a></p>	<p>\$19,200 (For primary bush regeneration)</p> <p>\$12,000 (For follow-up bush regeneration sessions)</p>	High	<ul style="list-style-type: none"> <li>Effective treatment of annual and perennial weeds, and continued suppression of these weeds through effective follow-up bush regeneration sessions</li> <li>Reduction in cover and abundance of introduced plant species through the maintenance activities.</li> <li>This approach will improve the condition of remnant vegetation in this</li> </ul>





	<p>are to be completed by a suitably qualified contractor.</p> <ul style="list-style-type: none"> <li>The bush regeneration program will run over the entire length of the overall restoration program.</li> <li>6 primary bush regeneration sessions are recommended per year in the first two years and then a further 4 follow-up sessions per year occurring in the remaining period.</li> <li>The 5 year maintenance program will run concurrently with the bush regeneration program.</li> </ul>				<p>location, thereby improving habitat conditions</p>
<b>Maintenance</b>					
<p>General maintenance</p>	<ul style="list-style-type: none"> <li>It is recommended that 11 visits be conducted over the 5 year maintenance period.</li> <li>General maintenance activities will include repairing damaged tree guards, monitoring survival rates, installing replacement plants where required, weeding inside the tree guards and continued follow-up spot spraying.</li> <li>11 general maintenance visits have been scheduled throughout the maintenance period. Four per year in the first three years and two per year during the final two years.</li> </ul>	<p>The Florabank website has included a whole section on Native Revegetation Techniques. These guidelines are designed to specify the processes, techniques and standards required for effective restoration of landscapes for biodiversity conservation.</p>	<p>\$9,570</p>	<p>Medium</p>	<ul style="list-style-type: none"> <li>To ensure the success of the revegetation activities it is essential to control weed infestation. Weeds compete with the newly installed plants for nutrients and water thereby limiting their survival and growth rates.</li> </ul>





Monitoring and Reporting					
Monitoring	<ul style="list-style-type: none"> <li>The monitoring and evaluation program should address the points set out in the VMP.</li> <li>GHD recommends that the points addressed in the VMP be monitored and evaluated through the set-up of one representative quadrat in each of the major vegetation communities at each restoration zone (i.e. revegetation zone and bush regeneration zone) upon 'Practical Completion'.</li> <li>Photos should be taken by digital camera and recorded in the project file by date and discrete photo-point number. Photo-point locations should be clearly marked on site and mapped by a surveyor or by GPS.</li> <li>An initial report will be prepared at 'Practical Completion' and then summary reports will be prepared at six monthly intervals throughout the five year maintenance period.</li> <li>These reports should be brief, approximately one page, and include a field monitoring sheet (or similar). (See Appendix B).</li> <li>The summary monitoring reports should also contain recommendations by the restoration contractor to the client in regard to issues affecting the ongoing success, or otherwise, of the restoration works, and the possible need for</li> </ul>	<a href="http://www.florabank.org.au">http://www.florabank.org.au</a>	\$8,500	Medium	<ul style="list-style-type: none"> <li>Performance targets throughout the monitoring and reporting program will focus on the following:               <ul style="list-style-type: none"> <li>Plant growth, percentage cover and survival rates.</li> <li>Plant losses through herbivory, disease, vandalism, storm damage or other factors.</li> <li>Weed regrowth and control measures.</li> <li>Percentage plant replacement.</li> <li>Degree of guard repair and weeding inside guards required.</li> <li>Monitoring of Casuarina regrowth (through emergent stem counts).</li> <li>Monitoring of growth of existing Casuarinas to provide development of mature tree canopy to maintain benchmark conditions for this vegetation classification.</li> </ul> </li> </ul>
Reporting					





	additional activities that may be required outside the normal maintenance program to meet the targets for revegetation activities and weed control.					
<b>Signage and Community Involvement</b>						
Signage	<ul style="list-style-type: none"> <li>Design and install clear contemporary signage along the proposed walking tracks throughout the riparian zone that were proposed in the recreation strategy (Figure 2, Appendix A in the VMP).</li> </ul>		TBA (not included in costs associated with the VMP)	Medium		<ul style="list-style-type: none"> <li>Provision of suitable signage along proposed pathways throughout the riparian zone to assist in the community awareness of environmental management activities associated with flooding and educate about the areas rich history.</li> </ul>
Community Organisations	<ul style="list-style-type: none"> <li>Investigate the potential to work with local Landcare groups or similar to undertake the works within the riparian zone.</li> </ul>		TBA (not included in costs associated with the VMP)	Medium		<ul style="list-style-type: none"> <li>Community environment organisations such as local Landcare groups to be encouraged to undertake regeneration and restoration works throughout the riparian zone.</li> </ul>



## 5. Conclusion

This Work Plan provides guidance on the native vegetation removal, willow removal, target weed control and bush regeneration methods as well as maintenance requirements for the site. Implementation of the Work Plan will aim to achieve the objectives of the associated VMP, as follows:

- Help mitigate potential for flooding hazard to the Crossley Bridge and the Sofala township in the occurrence of a large scale flood event.
- Help mitigate flooding impacts whilst still maintaining a fully functioning native ecosystem.
- Lay the foundations to improve, through time, native vegetation cover throughout the riparian zone through bush regeneration works.
- Improve connectivity of native vegetation in the locality.
- Invest in improving the condition of retained vegetation.
- Provide the base rehabilitation/revegetation structure that will be implemented as part of this framework.



## 6. Disclaimer

This Work Plan for the Sofala Vegetation Management Plan ("Report"):

1. has been prepared by GHD Pty Ltd ("GHD") for Bathurst Regional Council;
2. may only be used and relied on by Bathurst Regional Council;
3. must not be copied to, used by, or relied on by any person other than Bathurst Regional Council without the prior written consent of GHD;
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- were limited to those specifically detailed in section 3 of this Report.

The Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on for a period of 6 months, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.





Appendix A

# Vegetation Management and Rehabilitation Plan







Appendix B  
**Field Monitoring Sheet**



# Monitoring Field Sheet

22/15807/2306

Project: \_\_\_\_\_ Date: \_\_\_\_\_  
 Quadrat: \_\_\_\_\_ Recorder: \_\_\_\_\_

Measure	Observation			Comments/Actions Required	Responsibility	Completion Date
<b>Plant Growth (cm):</b>						
Trees	0-5	5-20	20-50	50+		
Understorey	0-5	5-10	10-30	30+		
Ground cover	0-5	5-10	10-20	20+		
<b>Percentage Cover (%):</b>						
Trees	0-10	10-50	50-85	85+		
Understorey	0-10	10-50	50-85	85+		
Ground cover	0-10	10-50	50-85	85+		
<b>Survival Rates (%):</b>						
Trees	0-10	10-50	50-85	85+		
Understorey	0-10	10-50	50-85	85+		
Ground cover	0-10	10-50	50-85	85+		
<b>Plant replacement required/Ha</b>						
Trees	0-5	5-20	20-50	50+		
Understorey	0-5	5-20	20-50	50+		
Ground cover	0-5	5-50	50-100	100+		
<b>Weed regrowth (% cover)</b>	0-10	10-50	50-85	85+		
<b>Condition of Tree Guards</b>	Poor	Ok	Good			
<b>Watering required</b>	Yes	Some	No			
<b>Stream bank erosion</b>	Stable	Slight	Mod.	Severe		
<b>Photographs:</b>						
Number						
Location						
Direction						



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**Document Status**

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1.	L. Gallagher	D. Williams	<i>D Williams</i>		Client review	15/3/12
2.	L Gallagher	D Williams	<i>D Williams</i>	Paul Parker	<i>Paul Parker</i>	4/6/12

# **Appendix E** – Vegetation Management Plan

GHD 2016



CLIENTS | PEOPLE | PERFORMANCE

# Bathurst Regional Council

Sofala

Vegetation Management Plan

September 2016





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### **List of Abbreviations**

The following summarises the various abbreviations used throughout the VMP.

APZ	Asset Protection Zone (firebreak)
BRC	Bathurst Regional Council
DP	Department of Planning
EEC	Endangered Ecological Communities
EPBC Act	Environmental Protection and Biodiversity Conservation Act
LEP	Local Environment Plan
LGA	Local Government Area (Bathurst Regional Council)
OoW	Office of Water
OEH	Office of Environment and Heritage
RFS	Rural Fire Service
TSC Act	Threatened Species Conservation Act
VMP	Vegetation Management Plan
WMA	Water Management Act 2000



## Executive Summary

GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council (“Council”) to prepare a Vegetation Management Plan (VMP) for a study area covering approximately 2,000 metres of riparian zone along the Turon River near the township of Sofala, NSW.

The VMP is required to provide a clear, concise and practical framework to guide proposed riparian zone works which include reducing the existing density of an undesirable native plant followed by revegetation works with a more diverse and suitable species composition. The proposed works were recommended in recent Floodplain Management Policy as the most efficient method to manage downstream flood risks to the Sofala community.

The objectives of the VMP are to map the vegetation in the designated study area, determine local vegetation characteristics and flora values and describe the management activities necessary to balance the desire for a valuable, healthy riparian corridor with the need to reduce flood impacts and comply with relevant legislation.

This VMP covers an area located in the Macquarie River Valley of the Central West Catchment Management Authority (CMA), 46 kilometres north of Bathurst. The subject site is defined as the riparian zone of the Turon River from Golden Point, 1,500 metres upstream of Crossley Bridge at Sofala to 500 metres downstream of the bridge.

The proposed flood mitigation works requires selective clearing to reduce the density of native riparian vegetation in the of the study area. As works will be undertaken within 40 metres of the Turon River, the proposal is a controlled action under the *Water Management Act 2000*.

This VMP has been prepared giving consideration to the NSW Office of Environment and Heritage guidelines and addresses the following issues: legislative requirements and VMP methodology, existing site conditions, flooding assessment, riparian zone vegetation removal, weed control, program of works, costing, and monitoring and evaluation.

Vegetation dominated by River Oak within the Macquarie River catchment is described as the “River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)” (DECCW, 2008). This vegetation forms part of the ‘Eastern Riverine Forests’ vegetation class and ‘Forested Wetlands’ vegetation formation and is not currently recognised as a vulnerable or endangered ecological community.

The tree canopy of vegetation cover occurring within the Turon River is almost exclusively dominated by River Oak (*Casuarina cunninghamiana*). Other native tree canopy species commonly observed within this vegetation type across its natural extent include Blakely’s Red Gum (*Eucalyptus blakelyi*), Yellow Box (*Eucalyptus melliodora*), Manna Gum (*Eucalyptus viminalis*) although occurrences of these trees within the site were upslope of the riparian environment.

The shrub midstory of River Oak dominated vegetation within the Central West CMA is characterised by a few species including *Callistemon sieberi*, Silver Wattle (*Acacia dealbata*), *Hymenanthera dentata*. Of these only *Hymenanthera dentata* was detected within the midstory of the sites natural vegetation.

The groundcover stratum is generally grassy herbaceous.

This VMP was prepared as a response to a recommendation from the Sofala Floodplain Risk Management Study (Cardno Willing 2007). This study identified opportunities to reduce flooding impacts in the township of Sofala through the implementation of improved vegetation





management in the locality.

This study concluded that 'thinning' of vegetation within the riparian corridor (native and introduced) would reduce flooding impacts in large events.

This VMP sets out the methods and targets for the rehabilitation and management of riparian vegetation in the locality to help achieve this outcome. The VMP describes an appropriate monitoring and evaluation program to assess the success of the program and the achievement (or otherwise) of clear performance targets.



# 1. Introduction

## 1.1 Overview

This Vegetation Management Plan (VMP) has been prepared in response to the brief issued by Bathurst Regional Council (Quotation Number 37.00333). The aim of the VMP is to determine a management framework to improve the ecological values of the riparian corridor and reduce flooding impacts associated with a reach of the Turon River, at Sofala.

## 1.2 Aims and Objectives

The VMP aims to provide a clear, concise and practical framework for the establishment, management and rehabilitation of vegetation in the riparian area situated along a section of the Turon River at Sofala.

The objectives of the VMP are:

- ▶ To determine local vegetation characteristics.
- ▶ To describe the management techniques necessary to progressively remove targeted native vegetation throughout the riparian zone of the Turon River, to minimise flood risk downstream.
- ▶ To describe a strategy for the establishment of a functioning riparian ecosystem.
- ▶ To identify strategies for community participation in the implementation of the VMP.
- ▶ Describe the maintenance program to ensure vegetation establishment.

## 1.3 Background

This VMP was prepared by GHD on behalf of Bathurst Regional Council (BRC) as a response to a recommendation from the Sofala Floodplain Risk Management Study (Cardno Willing 2007). This study identified opportunities to reduce flooding impacts in the township of Sofala through the implementation of improved vegetation management in the locality.

That study concluded that 'thinning' of vegetation within the riparian corridor (native and introduced) would reduce flooding impacts in large events. This VMP sets out the methods and targets for the rehabilitation and management of riparian vegetation in the locality to help achieve this outcome.

GHD's review of the Cardno report indicates there are opportunities as described, though the results, in terms of reducing flooding impacts, may not be as great as predicted.

GHD considered the following when determining an appropriate vegetation management program:

- ▶ Vegetation condition and ecological values.
- ▶ The stability of the river in this locality in terms of erosion control and bed protection.
- ▶ The objectives of the Water Management Act 2000.
- ▶ The objectives of the Sofala Floodplain Risk Management Plan.

The completion of this VMP included detailed reviews of the following:

- ▶ Cardno Willing 2007, *Sofala Floodplain Risk Management Study*, completed for Bathurst Regional Council.



- ▶ SMEC 2003, Georges and Sofala Flood Scoping Study – Final Report: Sofala, completed for Evans Shire Council.
- ▶ NSW Office of Water (2008) Guidelines for Controlled Activities: Vegetation Management Plans.
- ▶ Bathurst Vegetation Management Plan (2003).
- ▶ Department of Environment and Climate Change and Water (DECCW) (2008a) *Vegetation Types Database*. <http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm>
- ▶ Department of Environment and Climate Change and Water (DECCW) (2008b) *Threatened Species Profile Database*. [http://www.environment.nsw.gov.au/biobanking/VegType Database.htm](http://www.environment.nsw.gov.au/biobanking/VegTypeDatabase.htm)

## 1.4 Relevant Legislation and Policies

The VMP has been prepared in accordance with the provisions contained in relevant legislation and policy guidelines, including but not limited to the following:

### 1.4.1 Water Management Act 2000

Riparian corridors form a transition zone between terrestrial and aquatic environments and perform a range of important environmental functions. The protection or restoration of vegetated riparian areas is important to maintain or improve the geomorphic form and ecological functions of watercourses through a range of hydrologic conditions in normal seasons and also in extreme events. This VMP, and the subsequent implementation of recommended restoration works, has considered the implications of the Water Management Act 2000 (WMA Act). A controlled activity approval under the WMA is required for certain types of developments and activities that are carried out in or near a river, lake or estuary. This includes the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise. Office of Environment and Heritage (OEH) is required to assess the impact of a controlled activity to ensure that minimal harm will be done to any waterfront land, i.e. the bed and a distance inland of 40 metres from a river, lake or estuary.

### 1.4.2 Threatened Species Conservation Act 1995

The Threatened Species Conservation Act (TSC Act) 1995 includes schedules that list threatened species, populations and ecological communities and key threatening processes. The objectives of the TSC Act are to:

- ▶ Conserve biological diversity and promote ecologically sustainable development, to prevent the extinction and promote the recovery of threatened species, populations and ecological communities.
- ▶ To protect the critical habitat of those threatened species, populations and ecological communities that are endangered.
- ▶ To eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities.
- ▶ To ensure that the impact of any action affecting threatened species, populations and ecological communities is properly assessed.
- ▶ To encourage the conservation of threatened species, populations and ecological communities by the adoption of measures involving co-operative management.



The Proposal is not expected to impose a significant negative effect on any local populations of native biota, including threatened species, Endangered Ecological Communities (EEC's) and their habitats listed on the TSC Act, which occur on the study site or in adjoining habitats.

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list "Clearing of native vegetation" as a KEY THREATENING PROCESS on Schedule 3 of the Act. Listing of Key Threatening Processes is provided for by Part 2 of the Act.

#### **1.4.3 Environment Protection and Biodiversity Conservation Act 1999**

The Commonwealth Environment Protection and Biodiversity Conservation Act (EPBC Act) makes it an offence for a person to undertake an action that has the potential to significantly impact on a matter of 'national environmental significance' (NES) without first obtaining a permit from the Commonwealth Minister for Environment and Heritage. Matters of national environmental significance include: declared World Heritage areas; declared Ramsar wetlands; listed threatened species and ecological communities; listed migratory species; listed marine species; nuclear actions; and the environment of Commonwealth marine areas.

#### **1.4.4 Noxious Weeds Act 1993 (NSW)**

This VMP also considers the landowner's obligations to control weeds listed as noxious and/or environmental in the LGA. During the revegetation activities, site owners are legally obliged to 'fully and continuously suppress and destroy' any noxious weed colonisation.

A total of six (6) listed noxious weeds were found during the flora assessment. Weed control methodologies outlined in this plan should be implemented upon initiation of clearing works to decrease the chances of site infestation by invasive noxious weed species.

#### **1.4.5 Other Legislation and Policies**

Other legislation and policies that may be relevant to the VMP include:

- ▶ Bathurst Interim Local Environmental Plan 2005.
- ▶ Central West Catchment Management Authority Guidelines.



## 2. Site Description

### 2.1 Locality

The study area is located in the Macquarie River Valley of the Central West Catchment Management Authority (CMA). The township of Sofala is located approximately 42 kilometres north of Bathurst and is located within the Bathurst Regional Council LGA. The subject site is defined as the riparian zone of the Turon River from Golden Point, 1,500 metres upstream of Crossley Bridge at Sofala to 500 metres downstream of the bridge. The Turon River, a tributary of the Macquarie River has a catchment area of 883 km<sup>2</sup> at Sofala. The location of the site and details of the area of concern in this VMP are shown in Appendix A, Figure 1.

### 2.2 Legal Description

The planning and cadastral details of the subject site are provided below in Table 3 and shown on Figure 1.

**Table 1 Legal Description**

Timbertop Reserve	Existing lands
Title Information	Lot 7021 DP1124360 and various strips of Crown Land with no Lot and DP number
Ownership	Bathurst Regional Council
Location	Sofala
Total Area	Approximately 2,000 m of Riparian Land
Zoning	2 (v) Village

### 2.3 Physical Description

### 2.4 Climate

The Commonwealth Bureau of Meteorology website provides climatic information for the study area taken from Bathurst Airport weather station (closest station to site). A review of this data indicated that the mean rainfall peaks in December and ranges from 31 to 73 mm. Mean daily maximum temperatures range from 26.3 to 28.4°C in summer to 11.8 to 13.4°C in winter with mean minimum temperatures ranging from 11.5 to 13.6°C in summer down to 1.0 to 1.9°C in winter.

### 2.5 Landforms and Soils

The surrounding landform surrounding the site moves from undulating hills to steep, rocky country often covered with dense native vegetation. The immediate channel of the Turon River is characterised by gravel shoals that are mobile in flooding events with the defined channel moving in a lateral manner after such events.

The dominant underlying geology of the Bathurst region is the Bathurst Granite with basalt occurring at Mount Panorama and Mount Stewart. The Bathurst Granite is dominated by intermediate parent materials, which form such soils as the non-calcic brown soils and yellow soils in the less well drained locations (Terra Consulting 2003).





The *Non-Calcic Brown Soils* are the dominant soils of Bathurst and occur on slopes of undulating to rolling hills on the Bathurst Granite. Topsoils range from sandy loam to loam. They have a moderate water holding capacity, are pH neutral, have moderate chemical fertility and have a moderate erosion hazard.

## 2.6 Hydrology

The Turon River flows through Sofala southwest into the Macquarie River. The catchment area to the gauging station, commenced in 1947 and located approximately 200m upstream of the Crossley Bridge, is approximately 883 km<sup>2</sup>.

At Sofala the Turon River has a gravel bed and hence is potentially subject to erosion during flood events. A review of historical data implies that erosion has historically occurred.

A review of gauging data since 1947 revealed the largest recorded flood at Sofala is the 1986 event. The 1986 event had an estimated peak flow that exceeded the 1% AEP flow that was derived from a flood frequency analysis.

## 2.7 Built Environment

The study area is essentially a crown reserve, located to the north of the township of Sofala. The study area provides passive recreation opportunities for the local community.

The village of Sofala was once a thriving gold mining town and remains Australia's oldest surviving gold town from this era. The area attracts visitors to see gold mining relics and the many historic buildings within the township.

## 2.8 Surrounding Land Uses

The site is primarily set in a rural area with surrounding land uses and features including:

- ▶ The neighbouring township of Sofala.
- ▶ Agricultural landscapes, predominately sheep and cattle grazing.
- ▶ Large areas of natural biodiversity.



## 3. Field Assessment Methodology

### 3.1 Vegetation Mapping and Sampling

#### 3.1.1 Preliminary Vegetation Mapping

A preliminary vegetation map was compiled from aerial photography interpretation using a GIS. Polygons delineating varying canopy colour, texture and density were mapped prior to field investigations. Preliminary vegetation types were assigned to these polygons for field verification.

#### 3.1.2 Floristic Field Sampling

The accuracy of the preliminary vegetation map was tested using four detailed quadrats (i.e. 20 X 20 m) measuring plant cover-abundance (i.e. Braun-Blanquet scale) and 10 rapid quadrats (i.e. 10 X 10 m) measuring plant species presence/ absence. Survey results were analysed and used to adjust polygon classification.

#### 3.1.3 Vegetation Classification

The vegetation cover of the riparian zone was classified using the State standard for vegetation classification (i.e. BioMetric Vegetation Type database – DECC (2008a)).

#### 3.1.4 BioMetric Analysis

A larger 50 X 20 m plot measuring key vegetation and fauna habitat features was also completed at each of the detailed quadrat sampling locations. Data obtained from these larger plots was collected in a manner consistent with the methods specified by the BioBanking Assessment Methodology (DECCW, 2009). This data was used to evaluate vegetation condition against the reported benchmark values for the comparable BioMetric vegetation type (DECC, 2008a).

Further details regarding BioMetrics are included in Section 4.3.

#### 3.1.5 Stem Counts and Density

The number of stems contributing to the native tree canopy of vegetation contained within the site was counted within each of the sampling locations. Stem density was calculated by dividing the total number of stems counted within each detailed or rapid plot by the area of that plot.

### 3.2 Plant Species Lists

A plant list separated into native and exotic species was compiled from the site data collected at each sampling location. The detailed lists are included as Appendix B.

### 3.3 Tree Canopy Density and Stem Counts

Stem density was compared to the tree canopy cover data collected in the 50 X 20 m plot then compared to the benchmark range for tree canopy cover for the relevant BioMetric vegetation type. A benchmark stem count was estimated from this analysis and used to estimate the current condition of each mapped vegetation polygon within the site in terms of its stem count per hectare.



## 4. Vegetation of the Site

### 4.1 Vegetation Overview

The tree canopy of vegetation cover occurring within the Turon River is almost exclusively dominated by River Oak (*Casuarina cunninghamiana*). Other native tree canopy species commonly observed within this vegetation type across its natural extent include Blakely's Red Gum (*Eucalyptus blakelyi*), Yellow Box (*Eucalyptus melliodora*), Manna Gum (*Eucalyptus viminalis*) although occurrences of these trees within the site were upslope of the riparian environment.

### 4.2 Vegetation Classification

Vegetation dominated by River Oak within the Macquarie River catchment are described as the "River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)" (DECCW, 2008a). This vegetation forms part of the 'Eastern Riverine Forests' vegetation class and 'Forested Wetlands' vegetation formation and is not currently recognised as a vulnerable or endangered ecological community. Figure 1 (Appendix A) shows the extent of this vegetation across the site.

This vegetation typically forms on gravels, sands and loams on various substrates along major watercourses in the NSW South Western Slopes Bioregion and western edge of the Southern Highlands Bioregion including the Macquarie River and its main tributaries. Estimated clearing of this vegetation type within the South Western Slopes Bioregion ranges between 45% to 85% of pre-European cover. Areas where clearing extents exceed 70% classify as overcleared landscapes.

The characteristic shrub midstory of River Oak dominated vegetation within the Central West CMA is restricted to a few species including *Callistemon sieberi*, Silver Wattle (*Acacia dealbata*), *Hymenanthera dentata*. Of these only *Hymenanthera dentata* was detected within the midstory of the sites natural vegetation.

The groundcover stratum is generally grassy herbaceous. Species commonly characterising this stratum include Bracken (*Pteridium esculentum*), *Lomandra longifolia*, *Urtica incisa*, *Microlaena stipoides* var. *stipoides*, Tussock Grass (*Poa labillardierei*), *Austrodanthonia racemosa*, *Cynodon dactyloides*, *Geranium solanderi* var. *solanderi*, *Acaena novae-zealandiae*, Kidney Weed (*Dichondra repens*), *Carex* spp, *Juncus* spp. Most of these species were recorded within the site in varying densities with highest native plant cover associated with vegetation located the furthest distance from the Sofala village (lowest area of disturbance).

#### 4.2.1 Floristics

Appendix B contains detailed species list for the site collected during field surveys. A discussion of the native and exotic species of the site is provided as follows.

#### Native Plants

A total of 19 native plant species was observed within the native vegetation of the sites riparian zone (Refer to Table 6, Appendix B, for a list of native species found on site). Most common was the River Oak, which forms a dominant tree canopy cover of varying height and density. The only native shrub observed was *Hymenanthera dentata* although its densities were low. The native plant cover in the groundcover stratum was limited by the extent of exotic species. Species such as *Urtica incisa*, Kidney Weed and *Geranium solanderi* var. *solanderi* were the



most commonly observed natives.

### Exotic Plants

A total of 27 exotic species were observed within the native vegetation cover of the site (Refer to Table 7 Appendix B, for a list of exotic species found on site). These mostly consisted of forbs and grasses with the most dominant forb being Hemlock (*Conium maculatum*) in areas adjacent to the Sofala village and Cobblers Pegs (*Bidens pilosa*) in areas furthest from the village. Non-groundcover exotic species observations include the tree Willow (*Salix* spp.) and shrub Large-leaved privet (*Ligustrum lucidum*), with the greatest densities of these species being west of the Turon River bridge crossing.

The riparian zone includes 3 weed species listed as category 4 species under the NSW Noxious Weeds Act and 6 species listed as noxious under the noxious weed declarations for Upper Macquarie County Council (Appendix B). These species include, Hemlock, Blackberry, Large-leaved Privet, and Willow. Further details on their significance are included in Sections 4.2.2, 7.3.2 and 7.9.1 and Table 2 below).

A targeted bush regeneration program will be established to treat these and other weeds on site and all weed control and bush regeneration activities are to be completed by a suitably qualified contractor.

#### 4.2.2 Noxious Weeds

The following weeds observed on site are declared as noxious within the LGA. Treatment of these weeds throughout the study area will be a priority of the management program. A complete list of weeds identified as noxious within the LGA is included as Appendix C.

**Table 2 Noxious Weeds Identified on Site**

Botanical Name	Common Name	Category
<i>Ailanthus lucidum</i>	Tree-of-heaven	4
<i>Conium maculatum</i>	Hemlock	4
<i>Ligustrum lucidum</i>	Large-leaved Privet	4
<i>Myrsiphyllum asparagoides</i>	Bridal Creeper	4
<i>Rubus fruticosus</i> agg. Spp.	Blackberry	4
<i>Salix</i> Spp.	Willows	5
Class 1 - State Prohibited Weed. Class 1 weeds are also notifiable weeds.		
Class 2 - Regionally Prohibited Weed. Class 2 weeds are also notifiable weeds.		
Class 3 - Regionally Controlled Weed.		
Class 4 - Locally Controlled Weed.		
Class 5 - Restricted Weed. Class 5 weeds are also notifiable weeds.		



### 4.3 BioMetric Analysis of Native Vegetation

The BioMetrics Vegetation Types database contains 'bench marks' for each vegetation class for each catchment management authority area except for the Sydney Metro and Hawkesbury/Nepean Catchments which have benchmarks described for each vegetation type. Benchmarks are quantitative measures that describe the range of variability in condition of vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement. Vegetation with relatively little evidence of modification generally has minimal timber harvesting (few stumps, coppicing, cut logs), minimal firewood collection, minimal exotic weed cover, minimal grazing and trampling by introduced herbivores or over-abundant herbivores, minimal soil disturbance, minimal canopy dieback, no evidence of recent fire or flood, not subject to high-frequency burning, and positive evidence of recruitment of native species.

Benchmarks are based on ten site attributes (things such as species richness, vegetation condition and habitat resources etc.) and are used in the methodology to provide a comparable and quantitative measure of the current and predicted future condition of native vegetation. Benchmarks include 'upper and lower' values, depending on vegetation condition, for these attributes.

The benchmark conditions for "River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)" are presented in Appendix D. These metrics represent the expected natural variation within this vegetation type.

GHD has used these benchmarks to help determine the level of thinning that may be implemented on the site while maintaining the vegetation within benchmark conditions. GHD proposes to maintain the vegetation at lower benchmark.

### 4.4 Stratum Cover and Stem Density

#### 4.4.1 Tree Canopy Cover

A tree canopy cover ranging from 15-43% projected foliage cover is considered to be within benchmark condition for "River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)". Field data collected from the 50 X 20 m plots identified varying tree canopy cover ranging from 19 to 51%, which represents vegetation within and above benchmark conditions. This data was used in combination with aerial photographic interpretation to estimate canopy cover for each polygon resulting in some areas of native over-story cover being below benchmark conditions.

#### 4.4.2 Stem Density

The density and height of the River Oak tree canopy varies in accordance with time since disturbance and the extent of that disturbance. Stem density varied considerably from 1-33 stems / 100 m<sup>2</sup> with mean stem density being approximately 15 stems / 100 m<sup>2</sup>. Areas of greatest River Oak density generally coincided with mobile stream sediments where there was evidence of considerable and frequent fluvial activity. Figure 1 thematically shows the estimated stem density for each native vegetation polygon identified within the site.

From the data and from aerial photographic interpretation it is estimated that a stem density range between 1000-1500 stems/ ha coincides with BioMetric benchmark conditions for 'native over-story cover' of "River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)". However, polygons classified as within





benchmark condition for tree canopy cover are associated with young stems of an even age class. As considerably fewer stems of an older age class would be required to achieve a benchmark condition it is considered that there is scope to investigate a reduced stem density to that below benchmark conditions provided long term management allowed for the development of a mature tree canopy.

The shrub understory was largely absent except for the occasional presence of the native *Hymenanthera dentata*. This shrub rarely exceeded 1 m in height and was generally <5% cover. Groundcovers were largely attributed to exotic species with living foliage coverage generally exceeding 50%. Native species comprised a minor insignificant part of the groundcover stratum, with greatest native species presence found in the downstream parts of the site (away from the main disturbance sources found in the Sofala township).

## 4.5 Fauna

The riparian environments of the Turon River, in this locality, provide suitable habitat for a range of terrestrial and aquatic fauna.

### 4.5.1 Terrestrial Species

Reptiles that occupy riparian environments of the locality commonly include the Eastern Water Dragon (*Physignathus lesueurii*), Eastern Water-skink (*Eulamprus quoyii*), Dark-flecked Garden Sunskink (*Lampropholis delicata*) and Pale-flecked Garden Sunskink (*Lampropholis guichenoti*). The Red-bellied Black Snake (*Pseudechis porphyriacus*) is particularly dependant on the riparian environments of the locality where it preys on frogs, small reptiles and mammals.

Patches of riparian vegetation with complex vegetation structure provide suitable habitat for small passerine species such as the Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*), Striated Thornbill (*Acanthiza lineata*) and Red-browed Finch (*Neochmia temporalis*). Raptors such as the Collared Sparrowhawk (*Accipiter cirrocephalus*) and Little Eagle (*Hieraaetus morphnoides*) are also known to occur locally and often move along riparian corridor foraging on smaller passerine species.

Ponded areas provide suitable habitat for the Pacific Black Duck (*Anas superciliosa*) and Australian Wood Duck (*Chenonetta jubata*) with dense growths of macrophytes providing suitable habitat for species such as Australian Reed-Warbler (*Acrocephalus australis*). The White-necked Heron (*Ardea pacifica*) and White-faced Heron (*Egretta novaehollandiae*) are likely to forage along the river edge foraging for aquatic macroinvertebrates, fish and frogs. The Sacred Kingfisher (*Todiramphus sanctus*) would also use open bodies of water where small fish occur.

The riparian corridor also supports local and regional movements of species such as the Pied Currawong (*Strepera graculina*), Grey Currawong (*Strepera versicolour*) and the threatened Gang-gang Cockatoo (*Callocephalon fimbriatum*). Seasonal breeding visitors to the riparian corridor include the Fan-tailed Cuckoo (*Cacomantis flabelliformis*), Brush Cuckoo (*Cacomantis variolosus*) and Shining Bronze-Cuckoo (*Chalcites lucidus*).

Species commonly occupying partially and totally cleared peripheral lands frequent include the Australian Magpie (*Cracticus tibicen*), Grey Butcherbird (*Cracticus torquatus*) and Welcome Swallow (*Hirundo neoxena*), Nankeen Kestrel (*Falco cenchroides*) and Wedge-tailed Eagle (*Aquila audax*).

Native mammal fauna found generally along the Turon River Natives occupying cleared and uncleared environments include the Eastern Grey Kangaroo (*Macropus giganteus*) and Common Wallaroo (*Macropus robustus*).



Riparian forests coincident with larger vegetation patches are likely to support the occurrence of Yellow-footed Antechinus (*Antechinus flavipes*), Sugar Glider (*Petaurus breviceps*), Red-necked Wallaby (*Macropus rufogriseus*) and Swamp Wallaby (*Wallabia bicolor*) and Common Wombat (*Vombatus ursinus*).

A variety of microbat fauna occurs within the locality including Free-tail bats (*Mormopterus* sp.), White-striped Freetail-bat (*Tadarida australis*), Gould's Wattled Bat (*Chalinolobus gouldii*), Chocolate Wattled Bat (*Chalinolobus morio*), Gould's Long-eared Bat (*Nyctophilus gouldi*), Large Forest Bat (*Vespadelus darlingtoni*) and Little Forest Bat (*Vespadelus vulturnus*). Rarer species may include the threatened Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) and Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)

Mammal fauna also includes exotic species such as European cattle, Goat, Fox and Rabbit.

#### 4.5.2 Aquatic Ecology

The riparian environments of the Turon River provide suitable habitat for many frog species including the endangered Booroolong Frog (*Litoria booroolongensis*), which is regarded as an obligate stream species (i.e. exclusively lives within the stream environment). This species is known to occur upstream of Sofala. More common riparian species such as Lesueur's Frog (*Litoria lesueuri*) and Perons Tree Frog (*Litoria peronii*) also occur within the Turon River catchment.

Mammal fauna that exclusively occupy aquatic environments include the Water-rat (*Hydromys chrysogaster*) and Platypus (*Ornithorhynchus anatinus*). Platypus were observed swimming in a large pool downstream of Crossley Bridge during field surveys.

The river would also support a number of native fish species as well as the introduced European Carp. The field team observed several schools of this species during field surveys.



## 5. Flooding Analysis

### 5.1 Overview of Flood Study

A Floodplain Risk Management Study, including a hydrologic and hydraulic analysis, has been completed for Sofala (Cardno Willing 2007). This study has built upon a previous hydrologic study completed by SMEC (2003).

Key features of the data used for the flood study and the adopted methodology include:

- ▶ A stream gauging station located approximately 200 m upstream of the Crossley Bridge and having a gravel bed, has been maintained on the Turon River at Sofala (Station No 421026) since 1947. There was a period from late 1956 to early 1973 when the gauge was inoperable. The gauging station has reportedly been gauged to a maximum height of approximately 7.1 m.
  - ▶ The Turon River was indicated to have a catchment area of approximately 883 km<sup>2</sup> to the gauging station. The river has a gravel bed.
  - ▶ The largest historical flood during the gauging period was the 1986 event which had a recorded peak flow rate of approximately of 158,850 ML (approximately 1,840 cubic metres per second).
  - ▶ The available gauging data indicates that there has been a progressive increase in the zero discharge water level for the gauge – the more recent change has presumably resulted from aggradation (either natural or anthropogenic) at the gauging site. Cardno (2007) reported an increase of approximately 0.5 m in the cease to flow level over a 5 month period in late 1986 and early 1987, soon after the large flood of August 1986.
  - ▶ Design flow rates for the hydrologic and hydraulic analyses reported by Cardno (2007) were extracted using a flood frequency analysis of the historical data. This is a common technique adopted for the determination of design flow rates.
  - ▶ A HEC-RAS flow analysis has been completed for the flood level assessment using cross sections surveyed in 2003 (Cardno 2007). Since there has been significant historical change in levels, refer text earlier in this Section, it cannot reasonably be assumed that the sections from 2003 would represent those that would occur during times of peak flow in large flood events. Cardno (2007) indicated that SMEC had to use unexpectedly low stream roughness values to achieve flood level calibration for the 1986 flood event.
  - ▶ The hydraulic analysis examined the effect of adjusting both the bed levels and the stream roughness for parts of the length of the study reach. Results of the assessment indicated as follows:
    - Adjusting the bed level by 300 mm to represent aggradation of the bed upstream of Crossley Bridge and separately over the entire study area did not have a significant effect on the design flood levels.
    - Reducing the main channel stream roughness to a value of 0.035 along the main channel of the entire reach lead to a significant reduction in the predicted upstream flood level of up to 1.17 m at the upstream end of the study reach.
- Reducing the main channel stream roughness to a value of 0.035 along the main channel of the river and also the overbank areas did not lead to a significant additional reduction in the predicted upstream flood level as compared to that of just reducing the level for the main channel of the Turon River.



- ▶ Examination of the HEC-RAS model does not show it reflecting, as much as anticipated, an effect of the bend in the Turon River located downstream of the Crossley bridge or the backwater effect of the Crossley bridge.
- ▶ Flow velocities were not reported by Cardno (2007). An examination of the computer model results indicated:
  - The flood level touches the Crossley Bridge girders for events in excess of approximately the 25 to 30 ARI design event (by interpolation).
  - Predicted flow velocities along the main channel of the Turon River were generally in the range from 2.8 to 4.6 m/s for the modelled scenarios for the 1986 flood event.
  - Predicted flow velocities along the main channel of the Turon River were generally in the range from 3.6 to 6.6 m/s for the modelled extreme event.
  - In all events analysed, the greatest predicted flow velocities are experienced at the Crossley Bridge indicative of the flow constriction at this location.

Thus for large design events, significant scour would likely initiate near the Crossley Bridge and then potentially migrate upstream. The potential effect of bed erosion during flood events cannot be considered within the HEC-RAS model. An initial assessment suggests that the scour at the Crossley Bridge could be in the order of 2 to 3 m during the peak of the flood and this would reduce during the recession limb of the flood.

It is anticipated that scoured sediment from the Crossley Bridge location would be deposited downstream in areas where the flow velocity is reduced. This could exacerbate flooding levels along the Sofala reach. However, it is not considered that actions such as dredging, to manage sediment and the potential aggradation occurring along the study reach, would provide any substantive flood level reductions. This is supported by the Cardno (2007) study, which indicated changes in bed levels did not have a significant effect on the design flood levels. Additionally, such actions may require the preparation of an EIS as dredging or excavation in or within 40 metres of a watercourse is 'designated development' under the *Environmental Planning and Assessment Act 1979*.

While the above comments are critical of the analysis that has been used for the previous assessments, it is unlikely that use of a two dimensional flow analysis would provide a significantly better definition of the flow conditions unless it is a mobile bed model. Collation of the required information for a two dimensional model (more detailed topographic survey and sediment profile determination) would be expensive and it is recommended that Council consider the benefits likely to be obtained from such an analysis, and the costs, before embarking on such an analysis.

## 5.2 Proposed Impacts to Native Vegetation

Removal of native vegetation will, as a general principle, lead to a reduction in design flood levels. We are of the opinion that the Cardno predicted effects may have given an optimistic prediction of the potential flood level benefits of the vegetation clearing along the Turon River.

Achieving a clearing that corresponds to a Manning n roughness value of 0.035 would involve almost total clearing of vegetation as this is roughness value that is normally used to represent a relatively smooth grass cover.

The proposed vegetation thinning will, however, have a positive effect on the reducing of the stream roughness.



## 6. Rehabilitation Direction

### 6.1 Site Opportunities and Constraints

Proposed works adjacent to the Turon River provide opportunities in riparian system management. Opportunities embraced in the program include:

- ▶ Diversifying existing vegetation communities present within the site.
- ▶ Achieve balanced flood mitigation outcomes with riparian function.
- ▶ Removing weed infestations.

Constraints encountered during project design include:

- ▶ The potential for proposed works, if not managed correctly, to significantly alter riparian system function through bank erosion, reduced nutrient filtering capacity and changes to stream behaviour.
- ▶ The potential impact to aquatic communities and water quality through sedimentation and other changes following clearing of native vegetation.
- ▶ Ongoing maintenance that will be required to maintain the reduced vegetation cover.
- ▶ Addressing other potential issues (signage, other relevant legislation, other site areas, public relations, community involvement, etc).

### 6.2 Project Tasks and Objectives

This VMP has been prepared giving consideration to the current DECCW guidelines (*How to Prepare a Vegetation Management Plan, Draft Version 7, 2007*). This requires the VMP to address the following issues:

- ▶ A description of the site assessment and determination of potential constraints (eg. flora and fauna species lists, habitat and corridor values, hydrology, fire issues, services, drainage, topography, weeds, etc);
- ▶ Definition of project tasks (description of all tasks necessary to implement the plan).
- ▶ Analysis of flooding behaviour.
- ▶ Details on site preparation (protection of existing plants, erosion control, site works, weed control, soil amelioration, seed collection, etc).
- ▶ Consideration of Key Threatening Processes (KTP).
- ▶ Description of bush regeneration, weed control and 'thinning' activities.
- ▶ Description of maintenance program.
- ▶ Description of monitoring and review process.
- ▶ Preparation of a program of works.
- ▶ Preparation of plant species lists, as well as maps and diagrams.
- ▶ Liaison with project team members, government agencies and local groups.
- ▶ Summary of community engagement.
- ▶ Summary of recreational strategy.
- ▶ Addressing other potential issues (signage, other relevant legislation, other site areas, public relations, community involvement, etc).





- ▶ Preparation of an estimate of costs for the restoration works.

### 6.3 Description of Key Terms

The following key terms are used throughout the description of the proposed rehabilitation program.

- ▶ **Regeneration** - Refers to natural regeneration of the vegetation community.
- ▶ **Revegetation** - Refers to the planting of tube stock or similar grown from local provenance seed to re-establish vegetation.
- ▶ **Restoration**- Refers to a combination of restoration activities and management techniques to restore native vegetation.
- ▶ **Practical completion**-Refers to the completion of installation of revegetation activities.
- ▶ **Establishment**- Refers to the minimum 24 month maintenance program applied to revegetation work to ensure plant establishment.
- ▶ **Final Completion**- Refers to the successful completion of the entire restoration program in accordance with the VMP.



## 7. Strategy for Removal and Revegetation of Flora Species

### 7.1 Overview

The following information provides a detailed description of all activities required to implement the VMP. The required activities were determined using field investigations to visually assess, record (photograph) and identify the different native vegetation zones at the site, any threatened or endangered species and the current habitat and wildlife corridor connectivity, as well as assess soil types and on site hydrology for potential erosion hazards.

This information was supplemented by desktop research of existing reports pertaining to the site, and current vegetation maps and restoration guidelines. The preparation of this VMP also involved liaison with the following stakeholders and/or review of their relevant documents pertaining to the proposed works:

- ▶ Office of Environment and Heritage (OEH)
- ▶ Central West CMA
- ▶ BRC
- ▶ Relevant community groups
- ▶ Relevant land owners

Details of the works program described in this VMP will be included in a Detailed Implementation Plan.

### 7.2 Riparian Corridor Zones of the Water Management Act

The WMA describes two distinct management zones associated with riparian vegetation, these being the Core Riparian Zone (CRZ) and the Vegetated Buffer (VB).

- ▶ A Core Riparian Zone (CRZ) is the land contained within and adjacent to the channel. The Department will seek to ensure that the CRZ remains, or becomes vegetated, with fully structured native vegetation (including groundcovers, shrubs and trees).

The width of the CRZ from the banks of the stream is determined by assessing the importance and riparian functionality of the watercourse, merits of the site and long-term use of the land. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the CRZ.

- ▶ A Vegetated Buffer (VB) protects the environmental integrity of the CRZ from weed invasion, micro-climate changes, litter, trampling and pollution. There should be no infrastructure such as roads, drainage, stormwater structures, services, etc. within the VB. The recommended width of the VB is 10 metres but this depends on merit issues.

### 7.3 Vegetation Removal Strategy

#### 7.3.1 Native Vegetation Removal

Strategies for the removal of native plant species, namely River Oak (*Casuarina cunninghamiana*), have been based on the recommendations of the Sofala Floodplain Risk Management Study (2007) and the field assessments carried out by GHD (July, 2011). These field assessments included the calculating of stem densities on a per hectare basis, as shown in



Appendix A, Figure 2. The Sofala Floodplain Risk Management Study recommended that the casuarinas in the immediate upstream vicinity of the Crossley Bridge be removed, so as to help mitigate structural damage to the bridge during large flooding events.

Based on the conclusions drawn from an analysis of the Sofala Floodplain Risk Management Study by GHD (Section 5, above), it is recommended that the River Oaks be thinned to maintain a stems per hectare ratio that would be at the lower end of benchmark for that vegetation community (see section 4.3 for explanation of Benchmark for this vegetation type). This recommendation allows for positive outcomes for reducing the impact of flooding and maintaining a functioning ecosystem.

The objective of this thinning program will be to maintain a stem density of less than 720 stems per hectare throughout the study area. Large areas of the study area have plant densities significantly higher than this, including the reach immediately to the north of the Sofala village and east of the bridge, as shown by the dark orange and red shading in Figure 2. Details of the quantum of thinning required will be included in the Implementation Plan.

It is recommended that saplings and emergent seedlings be removed by hand with root systems left in situ. Hand removal would involve sawing the saplings and seedlings off at ground level and applying an appropriate selective herbicide such as Grazon™ DS. This method would restrict the disturbance of bed sediments, limiting the potential for erosion during small to moderate flood events.

### **7.3.2 Removal of Willows and other Woody Weeds**

All willow species in Australia are introduced and in most parts they have replaced the original Casuarina vegetation along the Macquarie River and its tributaries. They have been found to have adverse effects on the natural river system for a variety of reasons, including being of less habitat value to native species, disrupting in-stream biota through differences in chemical quality and seasonality of leaves and other plant debris dropped into the stream, and possibly producing root exudates detrimental to establishment of native species.

In the Macquarie River system willows have increased through rooting of broken off fragments, with a major recruitment having followed the 1998 floods. Seeding is also occurring and many are hybrids between species (Upper Macquarie County Council, 2008).

Various species of Willows (*Salix spp.*) have been identified along the banks of the Turon River, with a concentration of mature Willows either side of the Crossley Bridge at Sofala.

Though willow removal is desirable, in New South Wales it is necessary to obtain approval from the NSW Office of Water before removing any vegetation from within 20 metres of a river or watercourse. It may be necessary to submit a plan for replacement vegetation in order to prevent erosion of the bank.

Staged removal commencing in the upper reaches of the catchment and working down is desirable. In addition to bank destabilisation and streambed degradation removal of willows over large lengths of stream should be avoided because of locally raised water temperature, provision of sites for erosion, colonisation particularly of other exotic species and threat to infrastructure such as bridges (Terra Consulting, 2003).

It is recommended that the root ball of the Willows be left in-situ to reduce the potential for erosion on the stream banks. Hand plantings can also commence around the root ball to increase the rate at which native revegetation can occur.



## 7.4 Site Protection

To ensure the success of the restoration program it will be necessary to control access into those areas of the riparian zones where works are being undertaken.

Fencing will be limited to temporary fencing to delineate works zone until completed.

## 7.5 Erosion Control

To mitigate the potential for erosion on the river bank it is recommended that the removal of larger environmental woody weeds be conducted as part of a staged program. It is also recommended that the root balls of these species be left in-situ to reduce the potential for soil erosion.

In areas where mature River Oaks have been removed or where large areas of weeds have been removed it may be necessary to broadcast native seed or do some supplementary planting to again restrict erosion. It is further suggested that areas where weed removal and/or River Oak thinning has taken place that these areas be fenced off to stock.

The following activities are recommended in locations where the proposed works leave areas of the banks with exposed topsoil that would be susceptible to erosion during rain events.

In locations where the exposed area is relatively small (only several square meters) the area should be covered with branches and other woody debris secured to the bank using U nails or similar.

In locations where there are larger areas of exposed topsoil these areas should be covered with Jute matting (or similar) fix appropriately. These areas should then be planted within the matting using the species shown in Table 3.

## 7.6 Revegetation Program

There will be limited revegetation works within the site. Works will be confined to areas where weed removal has taken place and soil is exposed to reduce the potential for erosion and river bank instability. It is envisaged that small pockets of hand planting will be conducted in these and the following sections briefly explain the techniques used.

To implement the VMP, GHD recommends the following techniques be employed. Each of the techniques proposed are described below with Table 3 outlining which species are suited to each revegetation technique.

### 7.6.1 Seed Collection

To allow for enough lead-in time for the propagation of provenance species, seed collection should start as soon as approval for the Section 91 licence is granted. A licence may be required under section 91 of the Threatened Species Conservation Act 1995 if an action is likely to result in:

- ▶ harm to, or picking of, a threatened species, population or ecological community;
- ▶ damage to critical habitat; or
- ▶ damage to a habitat of a threatened species, population or ecological community.

The Office of Environment and Heritage will assess the application to determine whether it is likely to have a significant impact on threatened species in accordance with the Environmental Planning and Assessment Act 1979 and may include conditions which limit any potential



impacts to threatened species.

(<http://www.environment.nsw.gov.au/threatenedspecies/S91TscLicenceForm.htm>).

Experienced and qualified bush regeneration staff will perform seed collection activities. All seed collection, management, cleaning and storage will be in accordance with *Florabank Seed Collection Guidelines* (prepared by Greening Australia and now accepted as industry best practice). A copy can be provided if required.

All plant material to be used throughout the project will be of local provenance, collected from within a 5 km radius of the site. The species collected should be consistent with those of the River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions community, as listed in Table 3.

### **7.6.2 Plant Propagation**

Plant propagation refers to the germinating of collected seed and the 'growing on' of plants in enviro cells, hiko cells or forestry tubes. All plants will be produced from local provenance seed. This activity should be managed by a suitably qualified and experienced native plant production nursery.

### **7.6.3 Installation of Native Tube stock**

The vegetation to be restored on site will consist of appropriate mixes of mid-storey and groundcover species from the River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions community as shown in Table 3. The general percentage structural composition of canopy to middle storey to groundcovers in these communities is approximately 40%: 40%.

Most plants will be planted as hiko or enviro cells. All shrub species will be suitably guarded to prevent herbivory and weed competition, and to encourage optimum growing conditions. Guards will comprise a plastic tree guard and three bamboo stakes. Ground covers and grasses will not need to be guarded.

In general, autumn is the best season for planting as summer temperatures can be too high for young plants to establish and frosts in winter impede survival rates. Planting in early spring can be effective as long as a suitable watering regime is implemented. All plants will be installed by hand.

#### **Hand Installation**

Hand installation requires the planting hole to be a minimum of 25% larger than the planting container and its edges will be suitably 'roughed' prior to plant installation. The planting hole will then be backfilled with soil and firmly tamped down by hand and foot.

### **7.6.4 Native Seed Dispersal Techniques**

#### **Hand Broadcasting of Native Seed**

To supplement the establishment of native shrubs and lower story species GHD recommends native grass seed is hand broadcast throughout the maintenance period of the restoration program (Suggested species are outlined in Table 3). This will add further diversity to the site, and assist with erosion control.





## 7.7 Species for Use in Revegetation Activities

The following species are recommended for use in the rehabilitation program. Plantings will be limited to middle and lower storey species as the overall program includes a reduction in canopy species to assist with flooding implications.

**Table 3 Plant Schedule**

Botanical Name	Common Name	Density	Revegetation Activity
<b>Middle Storey:</b>			
<i>Acacia implexa</i>	Hickory Wattle	1 per m2	Planting
<i>Bursaria spinosa</i>	Black thorn	1 per m2	Planting
<i>Callistemon sieberi</i>	River bottlebrush	1 per m2	Planting
<i>Leptospermum myrtifolium</i>	Myrtle tea-tree	1 per m2	Planting
<b>Groundcovers:</b>			
<i>Commelina cyanea</i>	Scurvy weed	4 per m2	Broadcasting (cuttings)
<i>Cymbopogon refractus</i>	Barbed wire grass	4 per m2	Planting/broadcasting
<i>Dichondra repens</i>	Kidney Weed	4 per m2	Broadcasting (cuttings)
<i>Geraniumsolanderi</i>	Native Geranium	4 per m2	Planting
<i>Lomandra longifolia</i>	Mat rush	4 per m2	Planting
<i>Microlaena stipoides</i>	Weeping meadow grass	4 per m2	Planting
<i>Oplismenus aemulus</i>	Basket Grass	4 per m2	Broadcasting (cuttings)
<i>Pratia purperescens</i>	Whiteroot	4 per m2	Broadcasting (cuttings)
<i>Poa labillardieri</i>	Large tussock grass	2 per m2	Planting/broadcasting

Note: all works required within the bed of the river and within the first 3m of the riparian zone must be completed by hand. No machinery will be permitted to enter this zone during the implementation of this VMP.

## 7.8 Maintenance Program - Revegetation

The completion of the revegetation (planting works) and target weed control activities will be considered the date of 'Practical Completion' for the revegetation works and will signal the commencement of the five year plant maintenance program. The completion of the five year maintenance program will be considered as 'Final Completion' for the revegetation works. Maintenance activities will include such things as watering, herbicide spraying and general maintenance.

Four general maintenance visits have been scheduled throughout each of the first two years of the maintenance period. During the final three years of the maintenance period, three visits per year have been scheduled.



### 7.8.1 General Maintenance

General maintenance activities will include repairing damaged tree guards, monitoring survival rates, installing replacement plants where required, weeding inside the tree guards and continued follow-up spot spraying.

### 7.8.2 Maintenance Spraying

To ensure the success of the revegetation activities it is essential to control weed infestation. Weeds compete with the newly installed plants for nutrients and water thereby limiting their survival and growth rates.

Areas where revegetation activities are dominated by hand planting will have Round-up® Biactive herbicides applied using 'back packs'. Backpack spraying of chemicals should be conducted in suitable conditions (preferably in the morning and prior to rain or windy conditions) and should be restricted to spraying around the guarded plant. Only suitably qualified and experienced contractors will carry out all spraying. All contractors should be aware of the handling and using of chemicals near a waterway to avoid contamination of nearby rivers and streams.

### 7.8.3 Maintenance of stem density

A long term maintenance strategy will be required to maintain the recommended stem density of 720 stems per ha. The monitoring program will include stem counts in 20m x 20m plots to provide an estimate of natural regeneration and potential increase in the density of stems through time. Should the results of the monitoring program indicate an increase in stem density, further 'thinning' will be required. It is recommended stems be removed via the 'cut and paint' method leaving the root system in situ.

## 7.9 Bush Regeneration and Weed Control

GHD recommends noxious weeds are treated in a targeted weed control program prior to any revegetation work and that all remaining weeds be included in the bush regeneration program.

All weed control and bush regeneration activities are to be completed by a suitably qualified contractor.

### 7.9.1 Target Weed Control

This component of the restoration program refers to the control of listed noxious weeds such as Hemlock and Large-leaved Privet. This program requires specialised equipment and chemicals and will be managed by appropriately trained and experienced staff. Control of these plants usually requires several treatments and is most effective during summer.

Table 4 lists the noxious weeds identified on site, their control category and control techniques.

### Noxious Weeds

The *Noxious Weeds Act 1993* provides for the declaration of noxious weeds in local government areas. Landowners and occupiers must control noxious weeds according to the control category specified in the Act. Public authorities must control noxious weeds according to the control category to the extent necessary to prevent their spread to adjoining land.

Upper Macquarie County Council is a single purpose local government authority, established by the Governor under Section 387 of the *Local Government Act 1993*, for the area of the Bathurst



Regional Council. The study area contains six species declared as noxious weeds in shown in Table 4 below.

**Table 4 Noxious Weeds Recorded in the Study Area and Recommended Control Techniques**

Common name	Scientific name	Control Category and Control Techniques
Blackberry	<i>Rubus fruticosus</i> agg. Spp.	Category 4 Cut and paint crown/lignotuber with undiluted Roundup or Garlon and diesel immediately for isolated plants. Slash large populations and spray re-growth with selective herbicide Garlon, Grazon or Brushoff at flowering/fruited stage.
Bridal Creeper	<i>Myrsiphyllum asparagoides</i>	Category 4 Hand remove (i.e. by crowning with a knife) isolated plants after removing and bagging fruit. Spray large populations with Brushoff at flowering stage.
Hemlock	<i>Conium maculatum</i>	Category 4. Individual plants and localised patches should be hand pulled or hoed before flowering. When hand pulling hemlock, heavy rubber gloves should be worn to prevent contamination from plant toxins. Slashing just prior to flowering may provide effective control, but sometimes new growth is produced, requiring further treatment.
Large-leaved Privet	<i>Ligustrum lucidum</i>	Category 4. Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup Biactive ® immediately before fruited stage. Hand remove or spot spray seedlings with 1:100 Roundup Biactive ®.
Tree-of-heaven	<i>Ailanthus altissima</i>	Category 4. Cut and paint base of trunk or drill/chisel trunk (>10cm diameter) and inject with undiluted Roundup Biactive ® immediately before fruited stage. Hand remove or spot spray seedlings with 1:100 Roundup Biactive ®.
Willows	<i>Salix</i> spp.	Category 5

Summary of responsibilities for treatment:

- ▶ For Category 4 ‘the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority’.
- ▶ For Category 5 ‘The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with’.



## 7.10 Bush Regeneration Program

A structured bush regeneration program will be implemented along sections of the creek, concentrating on areas of heavy weed infestation. The majority of the program will focus on the control of perennial and annual weeds. The site has only scattered specimens of woody weeds, with greatest densities being west of the Crossley Bridge and these will be treated as part of the target weed control activities (described in section 7.9.1 above). Weeds to be targeted include large woody weeds such as Large-leaved Privet and Blackberry and a variety of other herbaceous weeds, including Cobblers Peg, Hemlock, Bridal Creeper and Fleabane.

The treatment of Willows is referred to in Section 7.3.2 above.

The bush regeneration program will run over the entire length of the overall restoration program. It is recommended that 6 primary bush regeneration sessions occur, per year in the first two years and then a further 4 follow-up sessions per year occurring in the remaining period.

The 5 year maintenance program will run concurrently with the bush regeneration program.

## 7.11 Monitoring and Reporting

In order to accurately evaluate the success of the restoration works, GHD recommends an initial report be prepared at 'Practical Completion' of the works and then summary reports be prepared annually throughout the maintenance period. These reports should be brief, approximately one page, and include a copy of a field monitoring sheet (or similar).

The monitoring and evaluation program should address the following issues:

- ▶ Plant growth, percentage cover and survival rates.
- ▶ Plant losses through herbivory, disease, vandalism, storm damage or other factors.
- ▶ Weed regrowth and control measures.
- ▶ Plant replacement.
- ▶ Guard repair and weeding inside guards.
- ▶ Monitoring of Casuarina regrowth via the establishment of representative 20m x 20m plots. Stem counts should be completed every 12 months for the first 5 years with results extrapolated on a per hectare basis. Council and OEH may wish to extend this monitoring program in a modified form beyond the life of this VMP.
- ▶ Monitoring of growth of existing Casuarinas to provide development of mature tree canopy to maintain benchmark conditions for this vegetation classification.

The annual monitoring reports should also contain recommendations by the restoration contractor to the client in regard to issues affecting the ongoing success, or otherwise, of the restoration works, and the possible need for additional activities that may be required outside the normal maintenance program.



## 8. Recreation Strategy

Providing opportunities for community interaction with the natural environment can help create a feeling of 'community ownership' over their natural resources and can increase people's awareness as to the importance of managing these resources.

### 8.1 Passive Recreation

This VMP includes a Recreational Strategy (see Figure 2, Appendix A) that would allow the community passive access and educational opportunities. Generally, passive recreation involves non-motorised activities that promotes appreciation of natural surroundings, is compatible with other passive recreational pursuits, does not significantly impact on the cultural, natural and/or historical values of an area and requires minimal visitor facilities.

The areas recommended for passive recreational activities are shown in Appendix A. Activities such as bush walking, bird watching, photography, and jogging would be encouraged. These areas are deemed suitable for passive recreation, as although biodiversity values are considered to be high, the activities proposed would have a minimal impact on the natural environment.

The strategy includes the construction and maintenance of a pathway network, as shown in Appendix A, that provides passive movement along the southern edge of the riparian corridor. The proposed path network would also link two designated areas managed for recreation (one on each side of the river) and include a 'loop' walk on the northern side of the river. This network could be expanded to include walking paths through the crown lands to the west of the Crossley Bridge.

### 8.2 Educational Signage

The township of Sofala has a rich history due to its previous gold mining boom. Interpretive signage already exists relating to this historical past. Opportunities exist to enhance the educational opportunities associated with Sofala's history by incorporating additional signage along the proposed walking tracks.

The information relating to the town's history could also be supplemented with signage highlighting the environmental importance of the corridor as well as the activities associated with the implementation of this VMP to reduce flooding impacts.

Experience has shown that by educating the community they develop a greater appreciation for the need to protect and manage natural resources.





## 9. Economic Evaluation of Implementation

### 9.1 Fee Estimate

A summary of indicative costs for the rehabilitation program is provided in Table 5, below. These figures have been provided for estimating purposes only. Detailed costings would be provided by the organisation successful in implementing these works.

**Table 5 Estimated Costs of Rehabilitation Program**

Item Number	Task	Description	Approx. Cost
<b>Removal Strategy</b>			
1.	Removal of woody weeds	Target control and removal of woody weeds (Based on team of 4 for 12 days)	\$ 16,200
2.	<i>Casuarina cunninghamiana</i> removal	Selective thinning of native vegetation. (Based on team of 2 for 20 days)	\$ 27,000
3	<i>Erosion control (contingency for exposed topsoil)</i>	Installation of brush matting and/or Jute matting as required	\$ 9,000
<b>Bush Regeneration and Weed Control</b>			
4	<i>Site Preparation</i>	Installation of temporary fencing	\$ 800
5.	<i>Section 91 Licence</i>	Application for Section 91 Licence	\$ 1,200
6.	<i>Seed Collection</i>	Collection and cleaning of seed (Based on 2 days collecting and 2 days cleaning)	\$ 2,460
7.	<i>Planting</i>	Hand planting (Based on approx. 500 plants)	\$ 2,400
8.	<i>Hand Broadcast native seed</i>	Hand broadcast native seed (Based on 2 days)	\$1,360
9.	<i>Bush Regeneration</i>	Primary Bush Regeneration (Based on 6 sessions per year over the first two years)	\$ 19,200
10.		Follow-up Bush Regeneration (Based on 8 sessions per year over two years)	\$ 12,000
11.	<i>General Maintenance</i>	General Maintenance (11 visits over five years)	\$ 9,570
12	<i>Maintain stem density</i>	Additional thinning (five visits over five years)	\$ 4,350
13.	<i>Project Management</i>	Ongoing Project Management	\$ 1,960
14.	<i>Monitoring/Reporting</i>	Monitoring/Reporting	\$ 10,500
<b>Total (ex GST)</b>			<b>\$118,000,650</b>



**Note:** The cost estimates presented in this section are typically developed based on extrapolation of recent similar project pricing, budget quotes for some equipment items, industry unit rates and GHD experience. The accuracy of these estimates is not expected to be better than about  $\pm 25\%$  for the scope of work described in this report. A more accurate breakdown of costs would be calculated after preparation of the Detailed Implementation Plan.



## 10. Conclusion

The VMP provides a description of the riparian system of the Turon River at Sofala. The VMP also describes a framework for the implementation of vegetation management initiatives at Sofala including the removal of vegetation, weed control and bush regeneration activities, plant species, planting techniques and maintenance requirements for the site. Implementation of the VMP will:

- ▶ Assist in managing flooding risks to the Sofala community.
- ▶ Provide an ecologically valuable and healthy riparian corridor system, through time.
- ▶ Improve the condition of areas of existing native vegetation, through bush regeneration.
- ▶ Manage vegetation within the 'lower benchmark' values for the River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions.
- ▶ Be undertaken in a staged manner and use methods that limit the potential for erosion of the bed and banks of the river channel.



## 11. References and Recommended Reading

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## Appendix A

# Figures

**Figure 1 Location of Study Area and Plant Densities**

**Figure 2 Recreational Strategy**



751,500

751,000

750,500

751,500

751,000

750,500



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Job Number 22-15807  
 Revision A  
 Date 07 Oct 2011

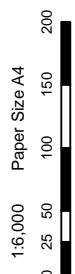
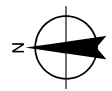
Bathurst Regional Council  
 Sofatala Vegetation Management Plan



CLIENTS | PEOPLE | PERFORMANCE



LEGEND  
 □ Flora Plots  
 □ Site Boundary



### River Oak Stem Count

### Figure 1

Level 3, 24 Honeyeagle Drive, Newcastle NSW 2300, Australia T 61 2 4979 9999 F 61 2 4979 9988 E ntimail@ghd.com W www.ghd.com

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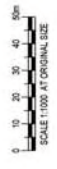
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- LEGEND**
- WALKING TRAIL
  - REVEGETATION AREA
  - PASSIVE RECREATION AREAS
  - HIGH WEED INFESTATION AREAS
  - LOW WEED INFESTATION AREAS



BATHURST REGIONAL COUNCIL

# SOFALA VEGETATION MANAGEMENT PLAN

date: **SEPT 2011**

job no: **22-15807**

drawing: **SK001-RA**





Appendix B  
**Plant Species Lists**

Native Vegetation Recorded on Site  
Introduced Species Recorded on Site



**Table 6 Native Vegetation found on Site**

<i>Scientific name</i>	Common name
<i>Senecio sp. 'bipinnate leaf'</i>	Groundsel
<i>Senecio sp. 'linear leaf'</i>	Groundsel
<i>Casuarina cunninghamiana</i>	River Oak
<i>Dichondra repens</i>	Kidney Weed
<i>Cyperus lucidus</i>	Leafy Flat Sedge
<i>Geranium solanderi</i>	Native Geranium
<i>Lomandra longifolia</i>	Spiny-headed Mat-rush
<i>Aristida vagans</i>	Threeawn Speargrass
<i>Microlaena stipoides</i>	Weeping Grass
<i>Enneapogon nigricans</i>	Niggerheads
<i>Cynodon dactylon</i>	Couch
<i>Cymbopogon refractus</i>	Hedgehog Grass
<i>Austrostipa scabra var. falcata</i>	Speargrass
<i>Austrodanthonia sp.</i>	Wallaby Grass
<i>Persicaria</i>	Knotweed
<i>Urtica incisa</i>	Stinging Nettle
<i>Rumex brownii</i>	Swamp Dock
<i>Acaena novae-zelandiae</i>	Bidgee-widgee,
<i>Hymenanthera dentata</i>	

**Table 7 Exotic Species found on Site**

<i>Scientific name</i>	Common name (where applicable)
<i>Amaranthus albus</i>	Tumble-weed
<i>Conium maculatum</i>	Hemlock
<i>Cyclosporum leptophyllum</i>	Slender Celery
<i>Asparagus asparagoides</i>	Smilax (Bridal Creeper)
<i>Arctotheca calendula</i>	Capeweed
<i>Bidens pilosa</i>	Cobblers Peg
<i>Cirsium vulgare</i>	Spear Thistle
<i>Conyza sp.</i>	Fleabane



<i>Scientific name</i>	Common name (where applicable)
<i>Hypochaeris glabra</i>	Smooth Catsear
<i>Lactuca saligna</i>	Willow-leaved Lettuce
<i>Silybum marianum</i>	Variiegated Thistle
<i>Arenaria leptoclados</i>	Lesser Thyme-leaved Sandwort
<i>Echium sp.</i>	Bugloss
<i>Cynoglossum suaveolens</i>	
<i>Tagetes minuta</i>	Stinking Roger
<i>Sonchus oleraceus</i>	Common Sowthistle
<i>Euphorbia lathyris</i>	Caper Spurge
<i>Euphorbia peplus</i>	Petty Spurge
<i>Fumaria capreolata</i>	Climbing Fumitory
<i>Vicia villosa</i>	Russian Vetch
<i>Trifolium arvense subsp. arvense</i>	Haresfoot Clover
<i>Medicago sp.</i>	Medic
<i>Stachys arvense</i>	
<i>Pyracantha rogersiana</i>	
<i>Plantago lanceolata</i>	Lambs Tongue
<i>Papaver somniferum</i>	Poppy
<i>Oxalis sp.</i>	Buttercup
<i>Ligustrum lucidum</i>	Broad-leaved Privet
<i>Anagallis arvense</i>	
<i>Modiola caroliniana</i>	Red-flowered Mallow
<i>Pennisetum clandestinum</i>	Feather-grass
<i>Setaria gracilis</i>	
<i>Phalaris aquatica</i>	Phalaris
<i>Rosa rubiginosa</i>	Sweet Briar
<i>Solanum nigrum</i>	Nightshade
<i>Solanum chenopodioides</i>	Nightshade
<i>Solanum americanum</i>	Nightshade
<i>Datura stramonium</i>	Common Thornapple
<i>Ailanthus altissima</i>	Tree-of-heaven





<i>Scientific name</i>	Common name (where applicable)
<i>Veronica sp.</i>	Speedwell
<i>Salix sp.</i>	Willow
<i>Asperula sp.</i>	Woodruff
<i>Rubus ulmifolius</i>	Blackberry
<i>Verbena rigida</i>	Purple Top
<i>Viola odorata</i>	Violet



## Appendix C

# Noxious Weeds

Summary of Declared Noxious Weeds in the LGA and Control Techniques



## Noxious weed declarations for Upper Macquarie County Council

Note: this control area includes the local council area of **Bathurst Regional Council**.

The following weeds are declared noxious in the control area of Upper Macquarie County Council:

Weed	Class	Legal requirements
African boxthorn [ <i>Lycium ferocissimum</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
African feathergrass [ <i>Pennisetum macrourum</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
African lovegrass [ <i>Eragrostis curvula</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
African turnipweed [ <i>Sisymbrium runcinatum</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
African turnipweed [ <i>Sisymbrium thellungii</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
Alligator weed [ <i>Alternanthera philoxeroides</i> ]	2	Whole of NSW except the local control authorities listed as control class 3 The plant must be eradicated from the land and the land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
Anchored water hyacinth [ <i>Eichhornia azurea</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
Annual ragweed [ <i>Ambrosia artemisiifolia</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
Arrowhead [ <i>Sagittaria montevidensis</i> ]	4	The plant may not be sold, propagated or knowingly distributed. This is an <a href="#">All of NSW</a> declaration
Artichoke thistle [ <i>Cynara cardunculus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
Athel pine [ <i>Tamarix aphylla</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
Bathurst/Noogoora/Hunter/South American/Californian/cockle burr [ <i>Xanthium</i> species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Bear-skin fescue [ <i>Festuca gautieri</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration



Weed	Class	Legal requirements
Black knapweed [ <i>Centaurea nigra</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Blackberry [ <i>Rubus fruticosus aggregate species</i> ]  except cultivars Black satin, Chehalem, Chester Thornless, Dirksen Thornless, Loch Ness, Murrindindi, Silvan, Smoothstem, Thornfree	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed  This is an <a href="#">All of NSW</a> declaration
Bridal creeper [ <i>Asparagus asparagoides</i> ]	4	The plant may not be sold, propagated or knowingly distributed.  This is an <a href="#">All of NSW</a> declaration
Broomrapes [ <i>Orobanche species</i> ]  Includes all <i>Orobanche</i> species except the native <i>O. cernua</i> variety <i>australiana</i> and <i>O. minor</i>	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Burr ragweed [ <i>Ambrosia confertiflora</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Cabomba [All <i>Cabomba</i> species except <i>C. furcata</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Cayenne snakeweed [ <i>Stachytarpheta cayennensis</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Chilean needle grass [ <i>Nassella neesiana</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Chinese violet [ <i>Asystasia gangetica</i> subspecies <i>micrantha</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Clockweed [ <i>Gaura parviflora</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Columbus grass [ <i>Sorghum x alnum</i> ]	3	The plant must be fully and continuously suppressed and destroyed
Corn sowthistle [ <i>Sonchus arvensis</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Dodder [ <i>Cuscuta species</i> ]  Includes All <i>Cuscuta</i> species except the native species <i>C. australis</i> , <i>C. tasmanica</i> and <i>C. victoriana</i>	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration



Weed	Class	Legal requirements
East Indian hygrophila [Hygrophila polysperma]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
English broom [Cytisus scoparius]		See Scotch broom
Espartillo [Amelichloa brachychaeta, Amelichloa caudata]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Eurasian water milfoil [Myriophyllum spicatum]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Fine-bristled burr grass [Cenchrus brownii]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Fountain grass [Pennisetum setaceum]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Gallon's curse [Cenchrus biflorus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Glaucous starthistle [Carthamus glaucus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Golden dodder [Cuscuta campestris]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Golden thistle [Scolymus hispanicus]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Gorse [Ulex europaeus]	3	The plant must be fully and continuously suppressed and destroyed
Green cestrum [Cestrum parqui]	3	The plant must be fully and continuously suppressed and destroyed
Harrisia cactus [Harrisia species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed  This is an <a href="#">All of NSW</a> declaration
Hawkweed [Hieracium species]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Hemlock [Conium maculatum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Horsetail [Equisetum species]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration





Weed	Class	Legal requirements
Hymenachne [Hymenachne amplexicaulis]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Johnson grass [Sorghum halepense]	3	The plant must be fully and continuously suppressed and destroyed
Karoo thorn [Acacia karroo]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Kochia [Bassia scoparia] except Bassia scoparia subspecies trichophylla	1	except B.scoparia subspecies trichophylla The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Lagarosiphon [Lagarosiphon major]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Lantana [Lantana species]	4	The plant may not be sold or knowingly distributed.  This is an <a href="#">All of NSW</a> declaration
Leafy elodea [Egeria densa]	4	The plant may not be sold, propagated or knowingly distributed.  This is an <a href="#">All of NSW</a> declaration
Lippia [Phyla canescens]	4	The plant must not be sold, propagated or knowingly distributed by any person other than a person involved in hay or lucerne production. The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.  This is an <a href="#">All of NSW</a> declaration
Long-leaf willow primrose [Ludwigia longifolia]	4	Whole of NSW except the local control authorities listed as control class 3 or 4 The plant may not be sold, propagated or knowingly distributed.  This is an <a href="#">All of NSW</a> declaration
Long-style feather grass [Pennisetum villosum]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Mesquite [Prosopis species]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Mexican feather grass [Nassella tenuissima]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Mexican poppy [Argemone mexicana]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Miconia [Miconia species]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Mimosa [Mimosa pigra]	1	The plant must be eradicated from the land and the land must be kept free of the plant



Weed	Class	Legal requirements
		This is an <a href="#">All of NSW</a> declaration
Mossman River grass [ <i>Cenchrus echinatus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <a href="#">All of NSW</a> declaration
Nodding thistle [ <i>Carduus nutans</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Noogoora burr [ <i>Xanthium</i> species]		See Bathurst/Noogoora/Hunter/South American/Californian/cockle burr
Pampas grass [ <i>Cortaderia</i> species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Parkinsonia [ <i>Parkinsonia aculeata</i> ]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Parthenium weed [ <i>Parthenium hysterophorus</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <a href="#">All of NSW</a> declaration
Pond apple [ <i>Annona glabra</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <a href="#">All of NSW</a> declaration
Prickly acacia [ <i>Acacia nilotica</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant
		This is an <a href="#">All of NSW</a> declaration
Prickly pear [ <i>Cylindropuntia</i> species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
		This is an <a href="#">All of NSW</a> declaration
Prickly pear [ <i>Opuntia</i> species except <i>O. ficus-indica</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
		This is an <a href="#">All of NSW</a> declaration
Privet (Broad-leaf) [ <i>Ligustrum lucidum</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Privet (Narrow-leaf/Chinese) [ <i>Ligustrum sinense</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Red rice [ <i>Oryza rufipogon</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with
		This is an <a href="#">All of NSW</a> declaration
Rhus tree [ <i>Toxicodendron succedaneum</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
		This is an <a href="#">All of NSW</a> declaration



Weed	Class	Legal requirements
Rubbervine [ <i>Cryptostegia grandiflora</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Sagittaria [ <i>Sagittaria platyphylla</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Salvinia [ <i>Salvinia molesta</i> ]	2	The plant must be eradicated from the land and the land must be kept free of the plant
Scotch broom [ <i>Cytisus scoparius</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Scotch, Stemless, Illyrian and Taurian thistles [ <i>Onopordum</i> species]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Senegal tea plant [ <i>Gymnocoronis spilanthoides</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Serrated tussock [ <i>Nassella trichotoma</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Siam weed [ <i>Chromolaena odorata</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Silverleaf nightshade [ <i>Solanum elaeagnifolium</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Smooth-stemmed turnip [ <i>Brassica barrelieri</i> subspecies <i>oxyrrhina</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Soldier thistle [ <i>Picnomon acarna</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Spiny burrgrass [ <i>Cenchrus incertus</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Spiny burrgrass [ <i>Cenchrus longispinus</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority and the plant may not be sold, propagated or knowingly distributed
Spotted knapweed [ <i>Centaurea stoebe</i> subspecies <i>micranthos</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
St. John's wort [ <i>Hypericum perforatum</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Star thistle [ <i>Centaurea calcitrapa</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan



Weed	Class	Legal requirements
		published by the local control authority
Sweet briar [ <i>Rosa rubiginosa</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Texas blueweed [ <i>Helianthus ciliaris</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Tree-of-heaven [ <i>Ailanthus altissima</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Tropical soda apple [ <i>Solanum viarum</i> ]	2	All of NSW except the local control authorities listed as a class 3 noxious weed The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Water caltrop [ <i>Trapa</i> species]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Water hyacinth [ <i>Eichhornia crassipes</i> ]	2	Whole of NSW except the local control authorities listed as control class 3 or 4 The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Water lettuce [ <i>Pistia stratiotes</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Water soldier [ <i>Stratiotes aloides</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Wild radish [ <i>Raphanus raphanistrum</i> ]	4	The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority
Willows [ <i>Salix</i> species]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration
Includes all <i>Salix</i> species except <i>S. babylonica</i> , <i>S. x reichardtii</i> , <i>S. x calodendron</i>		
Witchweed [ <i>Striga</i> species]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Striga species except the native <i>Striga parviflora</i>		
Yellow burrhead [ <i>Limnocharis flava</i> ]	1	The plant must be eradicated from the land and the land must be kept free of the plant  This is an <a href="#">All of NSW</a> declaration
Yellow nutgrass [ <i>Cyperus esculentus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with  This is an <a href="#">All of NSW</a> declaration



Appendix D  
Benchmark Conditions of the BioMetric Vegetation Type  
identified within the Site





**Table 8 Benchmark Conditions of the BioMetric Vegetation Type identified within the Site**

Veg Type Name	Native plant species richness	Native over-storey cover		Native mid-storey cover		Native ground cover (grasses)		Native ground cover (shrubs)		Native ground cover (other)		Number of trees with hollows	Total length of fallen logs
		Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper		
River Oak forest and woodland of the NSW South Western Slopes and South Eastern Highlands Bioregions (Benson 85)	21	15	43	1	20	1	35	0	5	5	20	1	50

Presented in Table 9 are the results collected from the four 50 X 20 m BioMetric survey plots. This data shows within benchmark conditions for most BioMetric categories except for native mid-storey cover, exotic species cover, trees with hollows and total fallen logs.



**Table 9 Plot Data for River Oak forest and woodland on the NSW South Western Slopes and Southern Highlands Bioregions (Benson 85) within the site.**

Plot name	Native plant species richness	Native over-storey cover	Native mid-storey cover	Native ground cover (grasses)	Native ground cover (shrubs)	Native ground cover (other)	Exotic Species Cover	Number of trees with hollows	Total length of fallen logs
Detailed Plot 1	7	51	0	2	0	22	86	1	2
Detailed Plot 2	5	34	0.5	4	0	6	76	0	0
Detailed Plot 3	4	41	0.5	12	0	10	60	0	20
Detailed Plot 4	8	19	0	22	0	40	64	0	8

This data represents the current vegetation condition of site vegetation or baseline conditions with ongoing monitoring of these plots can be used to measure the effects of management works conducted within the riparian corridor. The objective of management works would be to maintain conditions consistent with benchmark values whilst undertaking stem thinning exotic plant removal. Benchmark measures associated with fallen logs and trees with hollows are likely to adjust naturally over time during the management period without specific intervention.



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**Document Status**

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	L Gallagher	D Williams		P Parker		9/11/11

# **Appendix F** – Hydraulic and Geomorphic Impact Assessment

GHD 2015





**Bathurst Regional Council**  
Sofala Flood Mitigation Project  
Hydraulic and Geomorphic Impact Assessment

July 2016

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# Appendices

Appendix A - Model flow level results

# 1. Introduction

GHD Pty Ltd (GHD) has been engaged by Bathurst Regional Council (Council) to prepare an environmental impact assessment (EIA) to assess potential impacts from flood mitigation works proposed to be undertaken along approximately 500 metres of riparian zone along the Turon River near the township of Sofala (project site), NSW (refer to Figure 1-1).

As part of the EIA process, consultation with various stakeholders was undertaken to inform the scope of the EIA. The NSW Department of Primary Industries – Water (DPIW: formerly the NSW Office of Water) requested that the EIA specifically include:

- Hydrological modelling of existing watercourses.
- Description of objectives to be achieved through alterations to the flow regime.
- Geomorphic analysis of channel including identification of controls for stability such as vegetation, bed-forms and bedrock.
- Geomorphic analysis of existing instability such as bed and bank erosion and sediment movement during bank-full flows.
- Identification of potential measures to achieve the desired objectives.
- Hydrological and geomorphic analysis of potential measures to ensure bed and bank stability is maintained within the site, in addition to upstream and downstream reaches.
- Appropriate stabilisation if mechanical removal is undertaken and/or root-balls are excavated.

This report has been prepared to address the abovementioned DPIW requirements and is a supporting document to the EIA.

## 1.1 Background and project description

The Sofala Floodplain Risk Management Study (FRMS: Cardno Willing, 2007) included recommendations for flood mitigation works to manage flood risks to the Sofala community.

The FRMS recommended that the River Oaks (*Casuarina cunninghamia*) in the immediate upstream vicinity of the Crossley Bridge be removed to help mitigate potential structural damage to the bridge during large flooding events (Cardno Willing, 2007). GHD (2011) recommended that the River Oaks be thinned as much as practicable in order to reduce potential risk to the Crossley Bridge as well as assist in maintaining a functioning ecosystem.

The objective of the proposed thinning program would be to maintain a density of less than 720 stems per hectare throughout the project site. Large areas of the project site currently have significantly higher plant densities, including the reach immediately north of Sofala village and upstream of Crossley Bridge. Removal of large woody weeds (e.g. Willows) would also be undertaken. Trees would be cut close to their base and root balls would be retained to maintain bank stability (GHD 2011).

The proposal subject to assessment in this report comprises the following key aspects to occur within the project site (refer to Figure 1-1):

- Selective thinning of River Oaks to reduce the density of native riparian vegetation in the project site. Felling of trees (including large woody weeds) will be carried out by hand to minimise ground disturbance. Access would be via an existing access track within the Sofala township on the southern side of the river and where possible, existing access tracks on the northern side of the river.

- Construction and maintenance of a footpath network to provide for passive movement along the southern edge of the riparian corridor and a loop walk on the northern side of the river.
- Revegetation with a more diverse and suitable species composition in the disturbed area near Crossley Bridge.

The proposed works will be undertaken within 40 m of the Turon River and are therefore within waterfront land as defined by the *Water Management Act 2000* (WM Act). Under the WM Act, local councils are exempt from the need to obtain a controlled activity approval for any controlled activities they carry out on waterfront land.

## **1.2 Limitations**

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**SOFALA VEGETATION MANAGEMENT PLAN**

## 2. Methodology

To address the geomorphological assessment requirements requested by DPIW, the following components of work were undertaken:

- Desktop assessment.
- Site investigation.
- Hydrologic and hydraulic assessment of existing and proposed conditions.

The methodology is further detailed in the following sections.

### 2.1 Desktop assessment

A desktop assessment of existing information (existing reports, GIS data and aerial imagery) was undertaken to identify and preliminarily map waterway geomorphic conditions through the project site.

### 2.2 Site investigation

A site investigation was undertaken on 28 January 2015 to identify the current physical characteristics of the Turon River through the project site.

Information recorded during the site investigation included:

- Nature, location and extent of existing waterway bed and bank geomorphic features (e.g. pools, riffles).
- Nature and location of existing instabilities and controls (e.g. bedrock, logs).
- Nature of channel bank and bedload materials.

Photos were taken to record physical conditions at the time of the investigation.

### 2.3 Hydrology, hydraulics and sediment transport

A HEC-RAS (the Hydrologic Engineering Corps River Analysis Software) hydraulic model was previously developed for the project site by Cardno Willing (2007). The model was reviewed and updated to reflect the existing conditions of the project site. The model was used to estimate bank full flow velocities, shear stress and stream power along the subject reach for both the existing and post-mitigation conditions of the Turon River. The existing and post-mitigation conditions were represented within the model by different roughness parameters (Manning's n).

The modelling allows for the estimation of the potential impacts to flow levels, velocities and shear stress as a result of the proposed mitigation measures. The results of the hydraulic modelling will also allow for the estimation of the potential geomorphic impacts of the proposed mitigation measures, including changes to sediment transport and bank stability.

## 3. Existing waterway morphology

The catchment area of the Turon River at the project site is approximately 900 km<sup>2</sup>. Under the River Styles™ framework (Brierley and Fryirs, 2005), the Turon River can be classified as a *Partly Confined Gravel Bed River with Bedrock Controlled Discontinuous Floodplains*. Typically, the channel of such watercourse systems are bound on one side by a bedrock valley slope and by a floodplain (of limited longitudinal extent) on the other. The high degree of bedrock control within these systems results in a channel planform (position within the valley floor) that is very stable. As a result, watercourse systems of this class typically respond to disturbances through lateral channel expansion and localised incision.

At the project site, the Turon River exhibits an active low flow channel inset within a broader macro-channel. The macro-channel margins comprise of either bedrock or terrace materials composed of either colluvial (hillslope derived fan deposits) or alluvial sediments. The more significant geomorphic features within the macro-channel are the low flow channel and the inset bench/floodplain complexes (Figure 3-1). The morphology of these features is described in more detail below.

### 3.1 Low flow channel

The low flow channel is generally 10 m to 20 m wide and is characterised by a series of shallow pools (Photo A Figure 3-2) separated by riffles and runs (Photo B Figure 3-2). Deeper bedrock forced pools are located where the low flow channel abuts bedrock valley margins (Photo C Figure 3-2). Bank attached and mid-channel gravel bars are evident within the low flow channel of riffle zones (Photo B Figure 3-2).

Banks of the low flow channel vary in height but are typically less than 1 metre high. These are composed of gravel sized sediments (2 mm to 64 mm) set within a matrix of sand and silt (Photo D Figure 3-2). Bed sediments are dominated by coarse gravel to cobble sediments (16 mm to 256 mm) with the bulk of particles being less than 100 mm. Bed controls such as exposed bedrock bars were not identified.

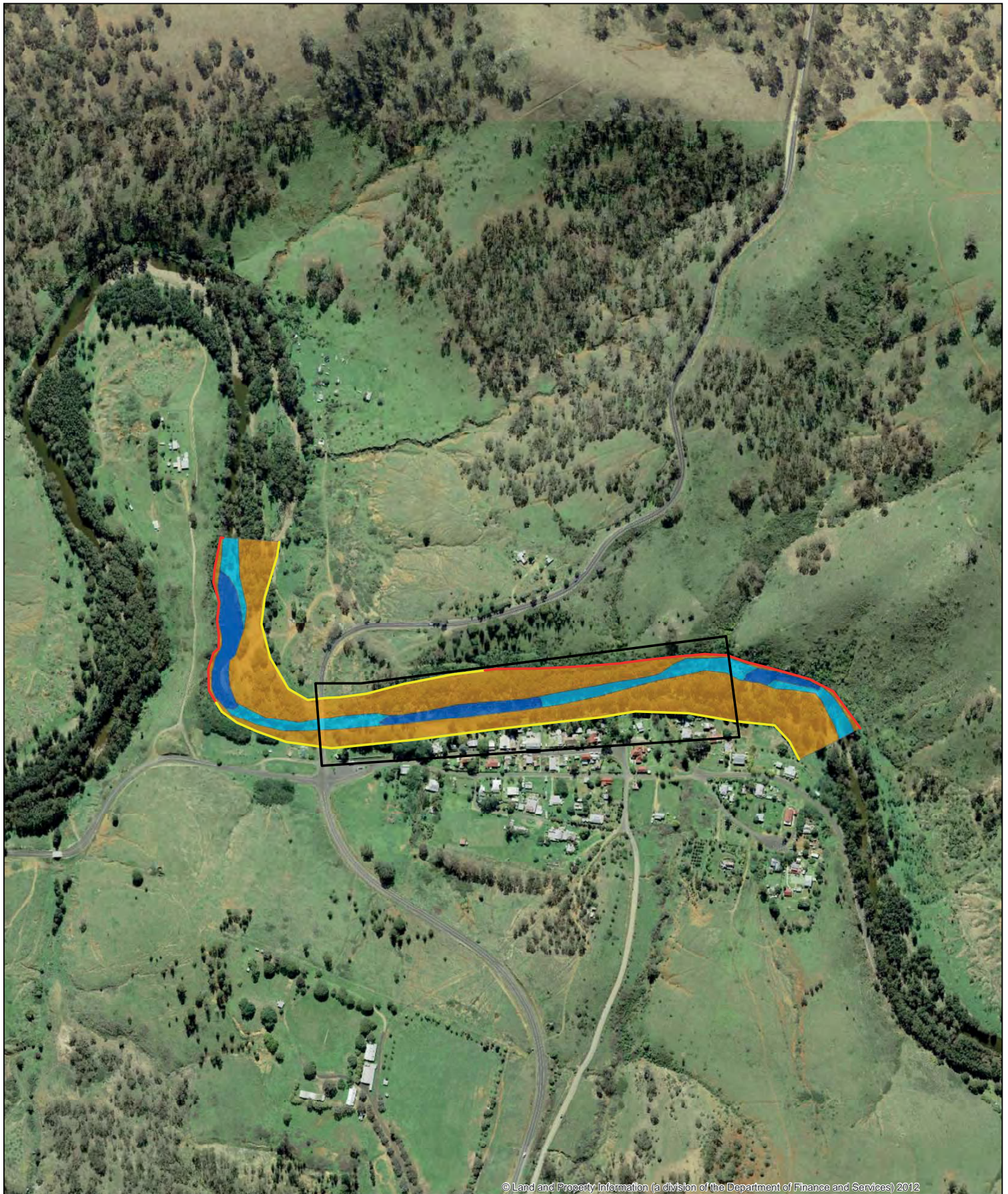
### 3.2 Inset bench/floodplain complexes

Inset bench floodplain complexes 20 m to 40 m wide extend along both sides of the low flow channel through the project site. These inset features are typically densely vegetated, principally with River Oak (Photo A Figure 3-3) and approximately 1 m to 3 m above the invert of the adjacent low flow channel.

The surface materials of the inset benches and floodplains vary from sand and silt dominated within the upstream reaches of the project site (Photo B Figure 3-3) to dominantly gravel sized sediments within the downstream reaches where woody vegetation is sparser (Photo C Figure 3-3).

The adjoining alluvial/colluvial terrace margin along the southern bank (adjacent to the Sofala township) has a surface level approximately 5 m to 6 m above the invert of the adjacent low flow channel. The resultant bank at this margin, although relatively steep, is typically stable and vegetated with a range of exotic and native species. Some sections of this bank exhibit evidence of past erosion which have been protected with loose rock (Photo D Figure 3-3).










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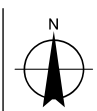
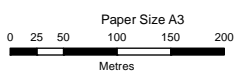
LEGEND  Project Site

**Macro-Channel Margins**

-  Alluvial/Colluvial
-  Bedrock

**Macro-Channel Features**

-  Inset Floodplain
-  Low Flow Channel - Pool
-  Low Flow Channel - Riffle/Run



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**Key Geomorphic Features**

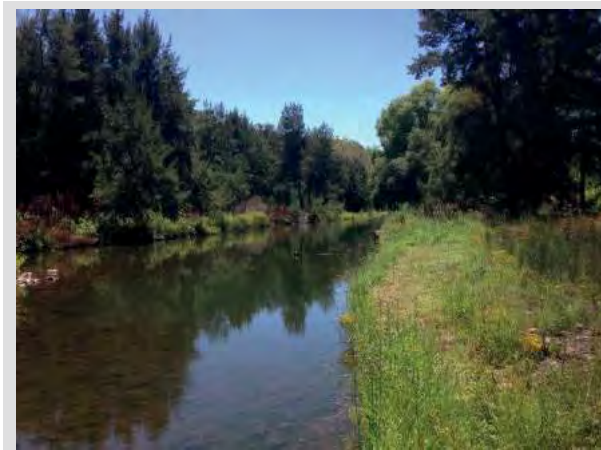
**Figure 3-1**

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Data source: LPI, DTDB (2012) /Aerial imagery (2015). Created by: glampert





A) Shallow pool along the low flow channel.



B) Riffle/run with small bank attached bar.



C) Deeper bedrock forced pool.



D) Upstream view displaying gravel dominated banks of the low flow channel

**Figure 3-2 Low flow channel photographs**





A) Dense stand of river oaks with debris at bases.



B) Sand and silt dominated bench/floodplain surface near upstream extent of the project site.



C) Gravel dominated bench/floodplain surface near the gauge.



D) Terrace margin with rock protection.

**Figure 3-3 Inset bench/floodplain complex photographs**

## 4. Hydraulic and geomorphologic impact assessment

This section provides an assessment of the potential hydraulic and geomorphologic impacts associated with the proposal.

### 4.1 Hydraulic assessment

The existing HEC-RAS hydraulic model (the Cardno model) was used to estimate changes between the existing and proposed design flood event levels, velocities and shear stress through the project site. The Cardno model was revised as discussed in Section 4.2. Roughness parameters (Manning's n) in the revised model were then adjusted to reflect the difference between the existing and post-mitigation conditions for a range of design flood events. The layout of the model is included in Figure 4-1.

### 4.2 Revisions to the Cardno model

In reviewing the Cardno model, the following issues were identified and modified accordingly:

- The bank stations used in the Cardno model that differentiate between the channel and over bank components of the cross- sections did not align with the proposed works as indicated in Figure 4-1. That is, the bank stations within the Cardno model are positioned near the high terrace/bedrock margin of the macro-channel. Hence, to better represent the proposed works within the model, the bank stations were moved to align with the margins of the low flow channel to allow adjustment of the Manning's n values across the entire overbank areas.
- The Mannings n used in the Cardno model (Table 4-1) to represent the roughness of overbank areas upstream of the bridge represented the conditions of the Turon River in 1986 and are considered low for the existing densely vegetated nature of the inset bench/floodplain complexes.

**Table 4-1 Cardno model Manning's n values**

Over left bank	Channel	Over right bank
Upstream of the bridge		
0.06 ( <i>light brush</i> ) 0.045 ( <i>high grass</i> )	0.06 ( <i>clean, winding, with stones and pools</i> ) 0.04 ( <i>clean, straight, some stones and weeds</i> )	0.06 ( <i>light brush</i> ) 0.045 ( <i>high grass</i> )
Downstream of the bridge		
0.045 ( <i>high grass</i> )	0.04 ( <i>clean, straight, some stones and weeds</i> )	0.045 ( <i>high grass</i> )

The Cardno model was developed as part of the preparation of the FRMS (refer to Section 1.1). The Cardno model was calibrated to the 1986 flood event, by adjusting the surface roughness parameters (Manning's n) until the modelling flood levels matched, as close as practical, the observed flood levels.

It is understood the Turon River included significantly less vegetation prior to the 1986 flood, especially trees. Therefore, the calibrated roughness values are no longer considered to be representative of the existing conditions within the Turon River.

It is important to note that the Manning's n values used in the Cardno model were considered low by Cardno Willing for the conditions present at the site. While the calibration method adopted by Cardno Willing is appropriate, the resulting calibrated Manning's n represent the river conditions at one point in time (i.e. 1986). With continued vegetation growth, the conditions of the Turon River today are significantly different to those of 1986, meaning that the calibrated Manning's n values are no longer representative.

In order to accurately estimate the potential change to flow velocities and shear stresses as a result of the proposed works, Manning's n values representing existing and proposed conditions were adopted in the revised model.

#### **4.2.1 Existing conditions Manning's n**

The low flow channel area consists of a gravel/cobble based meandering stream, which are typically represented with a roughness value of 0.04 (Chow; 1959). This adopted value is consistent with that used for the channel in the Cardno model, although applied to a narrower channel section in the revised model.

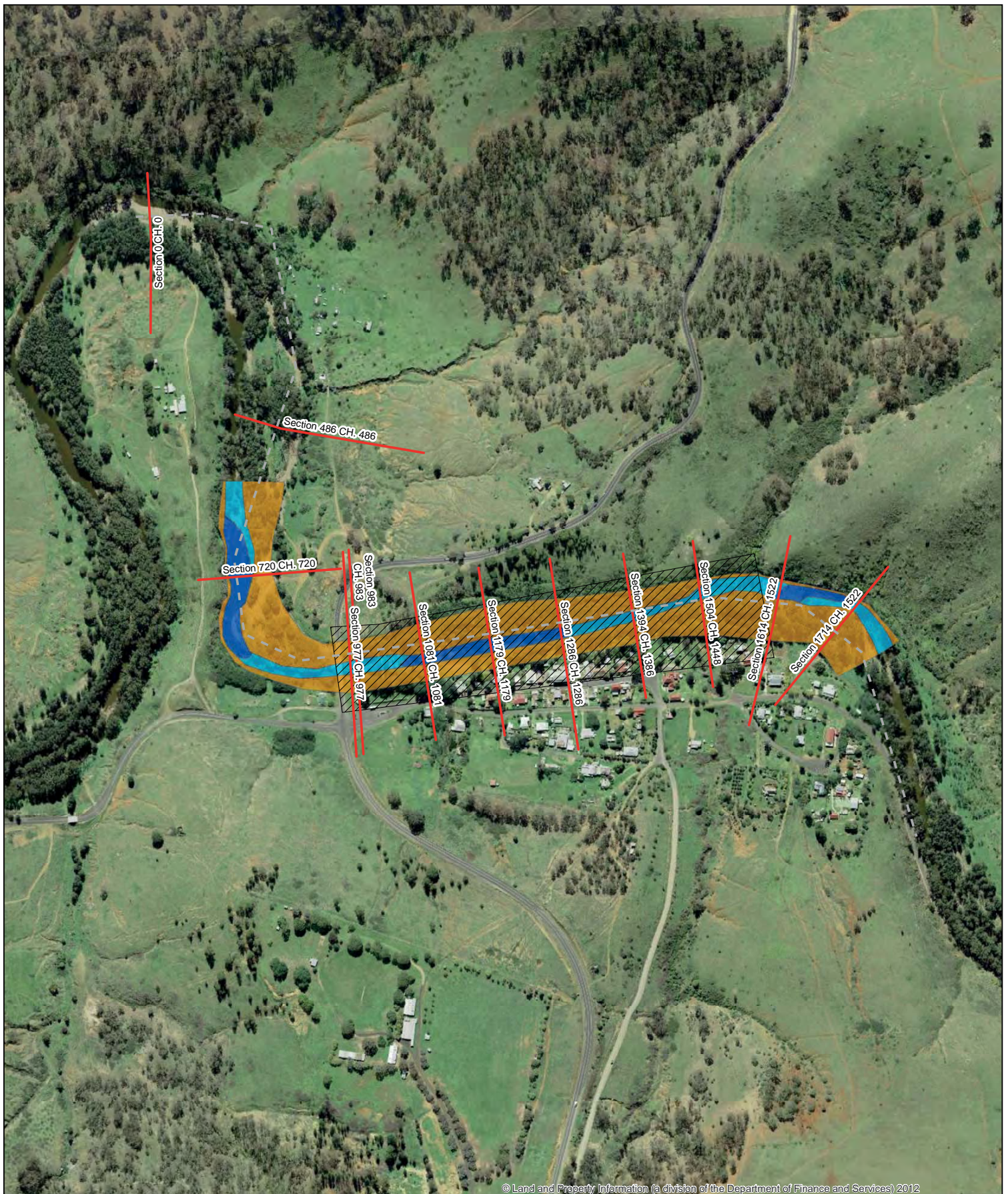
A Manning's n of 0.1 is considered more representative of the densely vegetated overbank areas upstream of the bridge. Chow (1959) indicates that a roughness of 0.1 is suitable for a *heavy stand of timber, a few down trees, little undergrowth with a flood stage reaching branches*. This is supported with the site observations of the reach upstream of the bridge.

#### **4.2.2 Proposed conditions Manning's n**

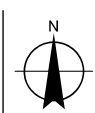
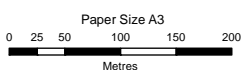
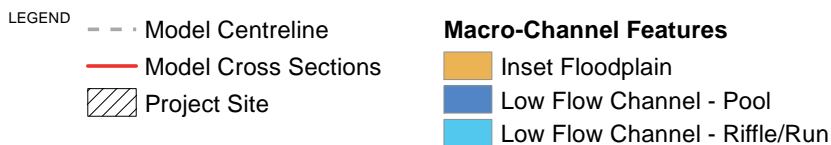
The relative hydraulic effects of the proposed vegetation thinning (Figure 4-2) were simulated within the model by adjusting the Manning's n value for the overbank components of the cross-sections in HEC-RAS. It is proposed that vegetation clearing would seek to remove undesirable vegetation types and thin out river oaks with stems typically between 100 mm and 200 mm diameter to a density of approximately 750 stems per hectare.

To consider this proposed vegetation thinning in HEC-RAS, a Manning's n of 0.06 was adopted for the proposed overbank conditions based on a category of light brush and tree stand (Chow, 1959). This value was applied to the over bank areas of the model cross-sections located within the project site. The existing conditions Manning's n of 0.04 for the low flow channel was maintained.





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Hydraulic Model Cross Sections

Figure 4-1

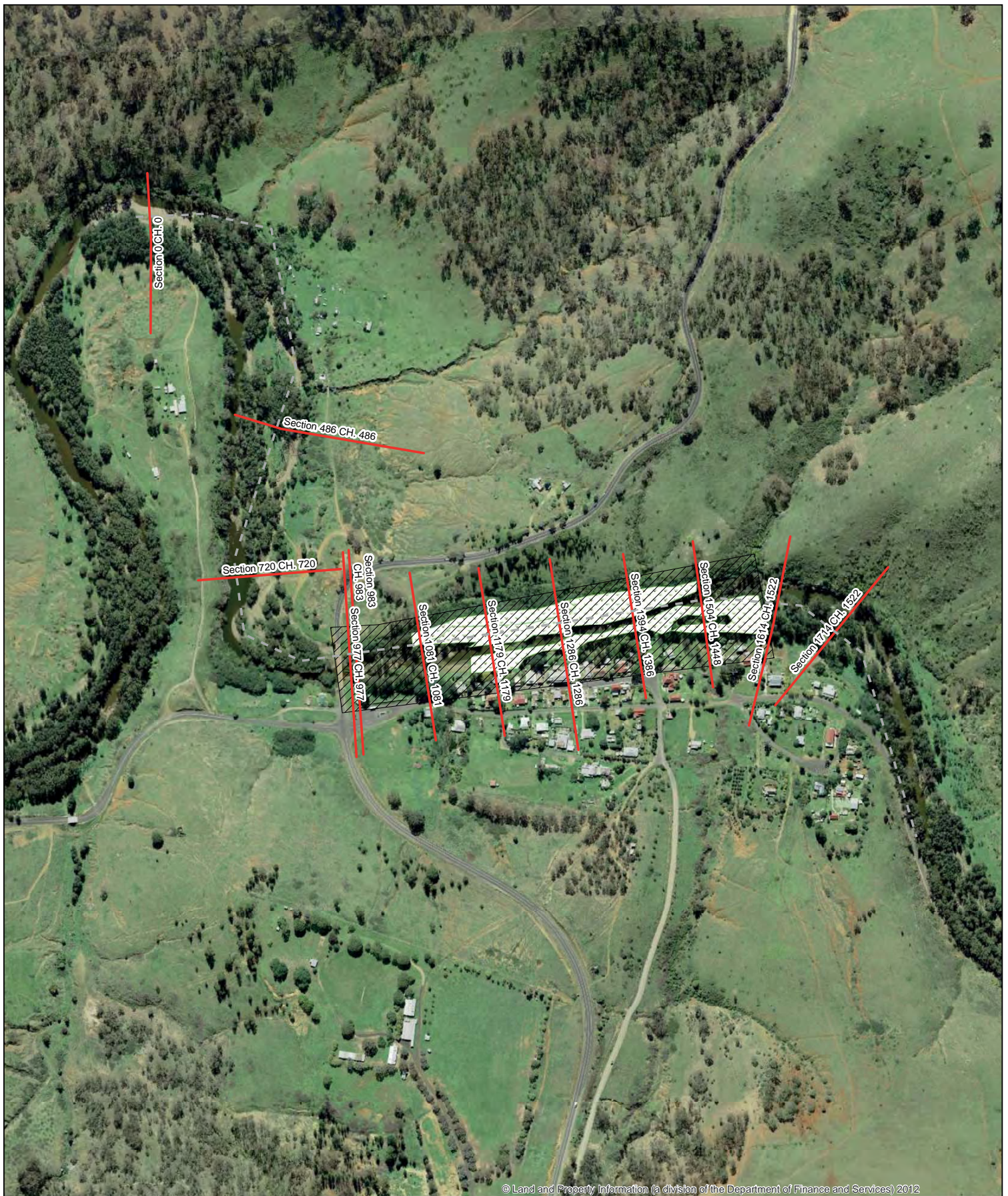
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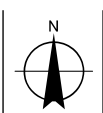
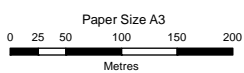
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- LEGEND**
- - - Model Centreline
  - Model Cross Sections
  - ▨ Project Site
  - ▤ Proposed Areas of Thinning to <750 Stems/ha



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Assessed Vegetation Clearing

Figure 4-2

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### 4.3 Hydrology

Table 4-2 summarises the peak flood flows for a range of design and historical flood events modelled by Cardno Willing (2007). Design flow rates were estimated from a flood frequency analysis (FFA: Cardno Willing 2007) of the historical data from flow gauging station No 421026 located approximately 200 m upstream of the Crossley Bridge. The FFA included an estimation of the confidence limits associated with each design flood event. From Table 4-2 it can be seen that these confidence limits are relatively wide, indicating a high degree of uncertainty in the peak flow estimates. Table 4-2 shows that the 1986 flood event is comparable to the 100 year average recurrence interval (ARI) design flood.

**Table 4-2 Hydrological conditions from Cardno Willing (2007)**

Event	Estimated peak flow (m <sup>3</sup> /s)		
	5% confidence	Expected	95% confidence
<b>FFA and design floods</b>			
PMF	-	5515	-
100 year ARI	598	1422	3378
50 year ARI	553	877	1391
20 year ARI	451	632	884
10 year ARI	289	405	556
<b>Historical flood events</b>			
2005 flood	-	370	-
1986 flood	-	1838	-

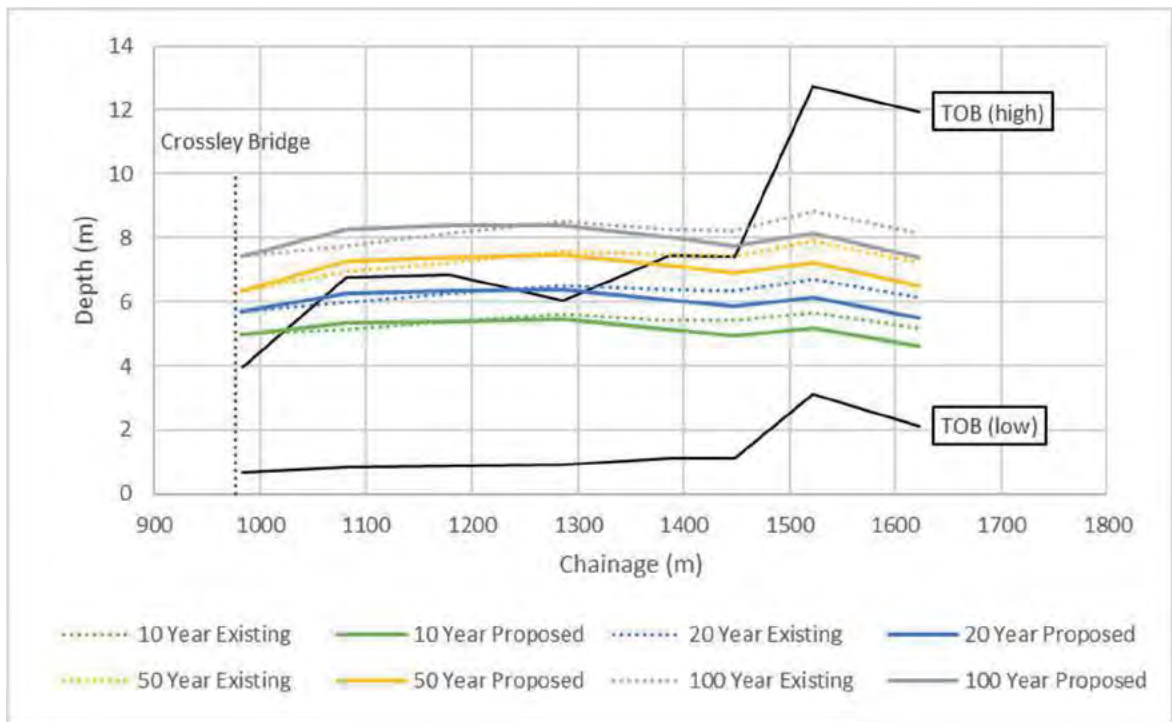
For the purposes of this assessment, only the peak flow conditions of the design flood events have been considered.

### 4.4 Hydraulic results

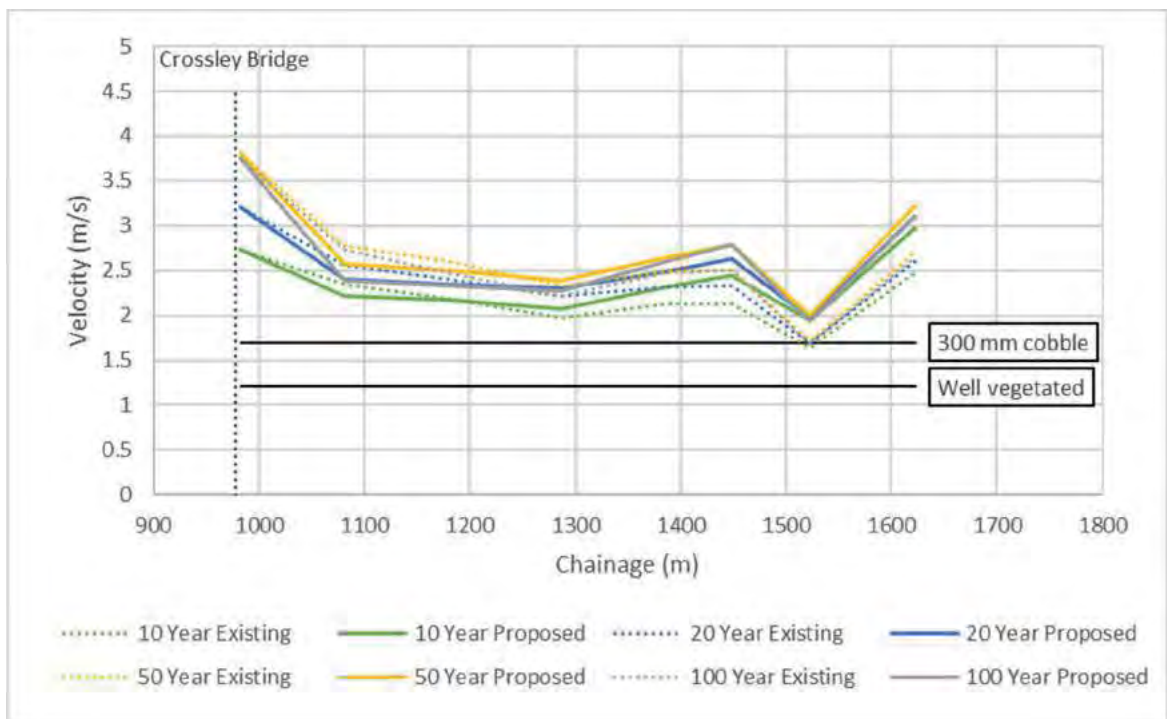
The results of the revised HEC-RAS modelling are reported in the following sections for existing and proposed conditions. The modelled flow level results for the existing and proposed conditions are provided as a long profile graph in Appendix A.

The maximum modelled depths, velocities and shear stresses for the existing and proposed conditions are summarised in Figure 4-3, Figure 4-4 and Figure 4-5 respectively. In the immediate 200 to 300 m upstream of the Crossley Bridge, the modelling indicates that the proposed works may result in increased flow depths associated with reduced flow velocities (up to approximately 0.3 m/s: refer to Figure 4-4). Further upstream, flow depths are predicted to decrease in response to the proposed works.

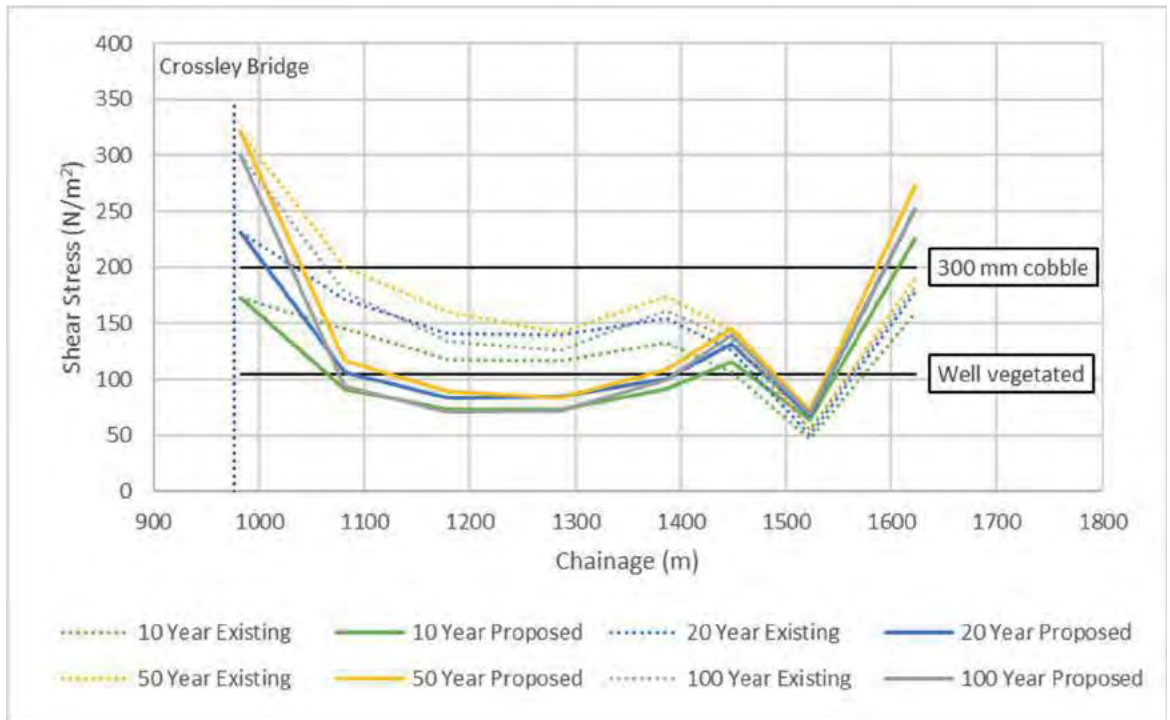
The modelling indicates that shear stresses are expected to be reduced for most of the modelled reaches of the Turon River (refer to Figure 4-5). Within the upper reaches, the modelling indicates the proposed works potentially increase the shear stress (refer to Figure 4-5), however the increased stresses remain below the stability threshold estimated for the bed and bank material in these areas, which includes exposed bed rock within the channel banks.



**Figure 4-3 Maximum modelled flood depths**



**Figure 4-4 Maximum modelled flow velocities**



**Figure 4-5 Maximum modelled shear stresses**

Table 4-3 provides the differential results comparing the pre- and post- project conditions for flow depth, average velocity and shear stress for a range of locations and modelled flood events.

**Table 4-3 Proposed conditions differential results**

Station Chainage (m)	10 year ARI			20 year ARI			50 year ARI			100 year ARI		
	Flood Depth (m)	Average Velocity (m/s)	Shear (N/m <sup>2</sup> )	Flood Depth (m)	Average Velocity (m/s)	Shear (N/m <sup>2</sup> )	Flood Depth (m)	Average Velocity (m/s)	Shear (N/m <sup>2</sup> )	Flood Depth (m)	Average Velocity (m/s)	Shear (N/m <sup>2</sup> )
983 Ch. 983	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1081 Ch. 1081	0.2	-0.1	-53.4	0.3	-0.2	-66.0	0.3	-0.2	-83.9	0.5	-0.3	-84.7
1179 Ch. 1179	0.0	0.0	-44.8	0.1	0.0	-57.7	0.2	-0.1	-71.4	0.2	-0.1	-62.1
1286 Ch. 1286	-0.2	0.1	-43.8	-0.1	0.1	-54.6	-0.1	0.1	-58.4	-0.1	0.1	-53.4
1394 Ch. 1386	-0.3	0.2	-42.0	-0.3	0.2	-53.8	-0.3	0.2	-65.2	-0.2	0.1	-62.5
1504 Ch. 1448	-0.5	0.3	8.9	-0.5	0.3	5.5	-0.5	0.3	1.1	-0.5	0.3	3.7
1614 Ch. 1522	-0.5	0.3	17.8	-0.6	0.3	17.7	-0.7	0.3	17.5	-0.7	0.2	15.4
1714 Ch. 1622	-0.5	0.5	66.0	-0.6	0.5	74.1	-0.7	0.5	82.4	-0.8	0.5	70.0

## 4.5 Geomorphic impacts

Table 4-3 indicates that the proposed works are likely to result in changes to flow velocities and shear stresses upstream of Crossley Bridge. Typically, velocities for both the existing and proposed conditions exceed reference erosion thresholds for cobbles of 300 mm and well-vegetated surfaces through this reach.

Shear stress is generally considered to be a better indicator of erosion potential (Fischenich, 2001). Given that the modelled shear stresses typically decrease in response to the proposed works, the potential for an increase in erosion risk for most of the project site is considered low.

It is noted that the modelled shear stress increases within the reaches upstream of the proposed works, with peak flow shear stress estimates for Section 1714 (chainage 1622) increasing by approximately 40%. However, the modelled shear stresses for the existing conditions at this section are relatively high, ranging from approximately 170 to approximately 190 N/m<sup>2</sup>. These values exceed the reference shear stress threshold values for vegetated surfaces, typically in the range of 100 to 150 N/m<sup>2</sup> (Fischenich, 2001). Section 1714 (chainage 1622) occurs at a tight bend in the river, where the outside bank consists of a bedrock valley margin. Within river bends, higher flow energies are typical along the outside bank. Hence, while the average shear stress at this location is relatively high, the bedrock margin on the outside bank restricts the potential for any significant increase in actual erosion risk under the proposed conditions.

The shear stress reductions through the middle to downstream extent of the project site indicate the potential for increased sediment deposition and aggradation. To examine the potential for aggradation, a sediment transport threshold analysis was undertaken for proposed conditions. Sediment moves when the Shields parameter ( $T^*$ ) exceeds a critical value for incipient motion ( $T^*_c$ ), which is calculated as a function of bed slope (Lamb et. al., 2008) where

$$T^*_c = 0.15 S^{0.25}, \text{ and} \quad \text{Eq. 1}$$

$$T^* = T_b / ((\rho_s - \rho)gD_2) \quad \text{Eq 2}$$

Where,

$T_b$  is the bed shear stress;

$\rho_s$  is the density of sediment (2,500 kg/m<sup>3</sup>);

$\rho$  is the density of water (1000 kg/m<sup>3</sup>);

$g$  is acceleration due to gravity (9.8 m/s<sup>2</sup>);

$S$  is the channel slope (m/m); and

$D_2$  is the length of the intermediate particle axis of the median particle size.

From equation 1, the channel bed slope of 0.0025 m/m provides a Shields parameter value of 0.033. Rearranging equation 2 and adopting the Shields parameter value of 0.033 for the critical value for incipient motion ( $T^*_c$ ), allows estimation of the maximum particle size that may be mobilised under different flow stages and bed shear stress.

Based on this analysis, particle sizes up to at least 100 mm have the potential to be transported under the proposed conditions for all flow events modelled. However, the bulk of bed load sediment transported by the Turon River at the site, as evidenced by sediments of the more mobile bar deposits, consists of particle sizes less than 50 mm. Hence, based on the hydraulic model results, the potential risk for significant aggradation in the downstream section is considered low.



## 5. Discussion and recommendations

It must be acknowledged that there is a level of uncertainty in the hydraulic modelling results, which will influence the ability to reasonably quantify potential hydraulic and morphologic impacts in response to the proposed works. Due to inherent uncertainties in input values (e.g. roughness values, inflow hydrology and so on), it is considered that this uncertainty is unlikely to be resolved using more detailed hydraulic modelling (i.e. two dimensional modelling).

Nevertheless, the estimated hydraulic and morphologic risks associated with the proposed works are considered low for the majority of the modelled reach, with the hydraulic modelling results indicating that there are some localised potential hydraulic and morphologic risks associated with the proposed works. These risks are:

- An increased risk of erosion in the area upstream of Section 1179 as flow velocities are predicted to increase while modelled shear stress increase further upstream at Section 1714 (chainage 1622).
- A potential for channel bed aggradation through much of the modelled reach as shear stress values are predicted to generally decrease, with the greatest reductions in the middle to downstream sections of the project site. If bed aggradation did occur, this may also increase maximum flood flow levels. Cardno (2007), however, determined flood levels upstream of Crossley Bridge where not very sensitive to bed level change and the impact of bed aggradation on flooding risks is considered limited.
- An increased flooding risk for buildings adjacent to the river approximately 200 to 300 metres upstream of Crossley Bridge as flow depths are predicted to increase.

Given the potential morphologic risks of erosion and aggradation, if the proposed works are carried out, it is recommended that a monitoring program be implemented to assess the morphological responses. This monitoring program should include the following components to be undertaken immediately prior to implementation of the works and subsequently following flood events with peak discharge greater than 300 m<sup>3</sup>/s:

- Survey of six cross-section transects located in the vicinity of the six hydraulic model Sections 1714 to 1063.
- Particle size analysis of bed sediments within the low flow channel at each of the six survey transects.
- Visual inspection including the establishment of fixed photograph monitoring locations.

The monitoring program may be incorporated into the ongoing monitoring and maintenance program for the proposed works. The results of the monitoring should be routinely reviewed to identify any morphological adjustments that may impact on the hydraulic or ecological functioning of the river. In the event that substantial morphological adjustments are identified, it is recommended guidance from appropriate river management professionals be obtained to identify suitable remediation options.

To further minimise potential morphological impacts during the works implementation phase, the following recommendations are made:

- Erosion and sediment control measures should be established prior to construction. Erosion and sediment control measures should be implemented on slopes approaching the waterway to prevent sediment discharge to waterways. This may include the use of sediment traps, vegetation and diversion berms, and other control measures, all of which should be appropriately maintained and inspected regularly.
- Stabilise disturbed areas and reinstate with appropriate vegetation as quickly as practicable after implementation of the works.
- All stockpiled material should be kept remote from the waterway to avoid sediment and debris entering the waterway.
- Implementation of the works should be avoided during periods of heavy rainfall and flooding.
- Control the route used by any machinery into and out of the works site.
- Where practical, avoid use of heavy machinery with the works site.
- No disturbance by machinery within 3 metres of the low flow channel banks.
- Avoid mechanical removal of vegetation as far as practicable.
- Clear vegetation by cutting trees as close as possible to the base of the trunk and retain root balls.
- Remove all debris generated from the proposed work from the works site and dispose of appropriately.

With adoption of the above monitoring and mitigation recommendations, it is considered that there is a low risk for any substantial morphological change along the Turon River in response to the proposed works.

While the morphological risks are considered relatively low, the potential increased flooding risk upstream of Crossley Bridge is most likely due to reduced attenuation of flood flows within the project site. In addition, the modelling indicates that no change in flood depths is expected to occur downstream of Crossley Bridge, indicating that Crossley Bridge is likely to act as a hydraulic control, limiting flow rates entering the downstream reaches. This highlights the potential influence Crossley Bridge has on upstream hydraulics, with the influence considerably heightened in the event of a partial debris blockage of the bridge during a flood event. As a result, mitigation of the increased upstream flood level risk is unlikely to be realised without substantial modification of the bridge.

## 6. References

Cardno Willing (2007) Sofala Flood Risk Management Study. Report prepared for Bathurst Shire Council.

Chow, V. T (1959) *Open Channel Hydraulics*, McGraw Hill, New York.

Fischenich C. (2001) Stability Thresholds for Stream Restoration Materials. EMRRP Technical Notes Collection (ERDC TNEMRRP- SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

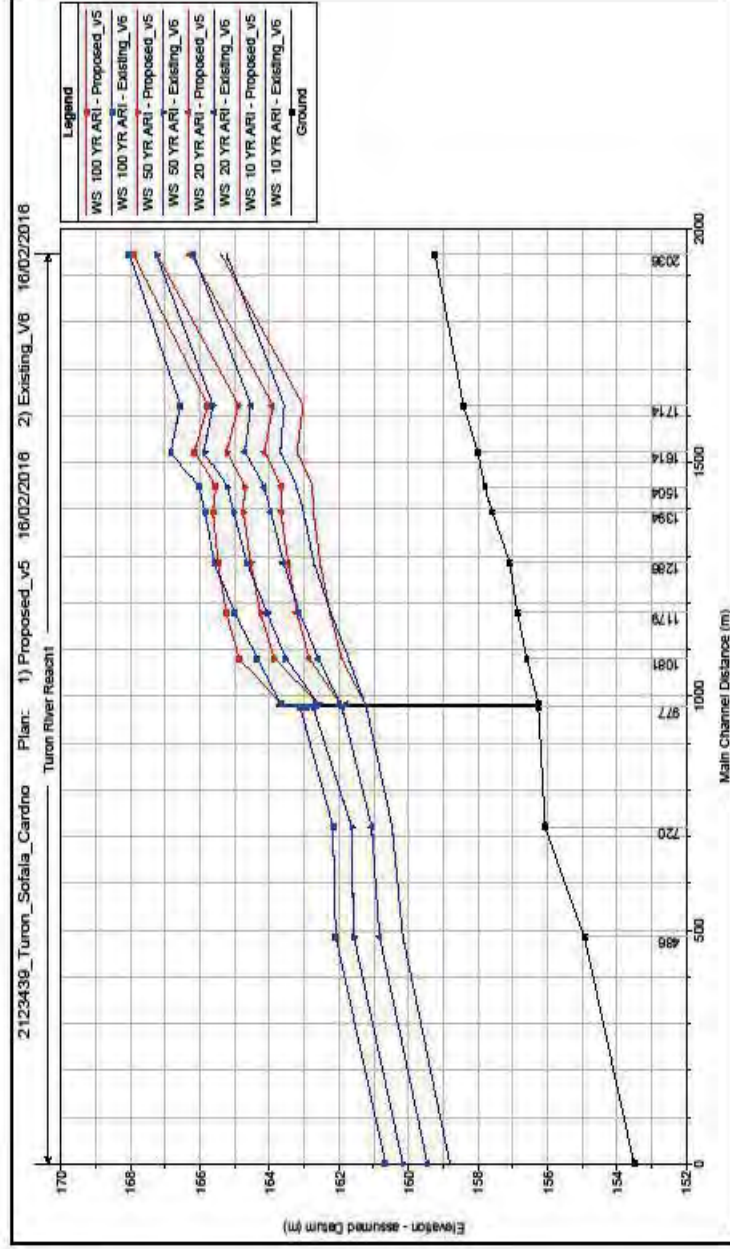
Lamb, M. P., Dietrich, W. E. & Venditti, J. G. (2008) Is the critical Shields stress for incipient sediment motion dependent on channel-bed slope? *J. Geophys. Res.* 113, F02008.

# Appendices

# **Appendix A** - Model flow level results



**Figure A1 – Long Profile of Existing and Proposed Modelled Flow Levels**



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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	G Lampert	A Wyatt	<i>A.Wyatt*</i>	G Marshall	<i>G.Marshall*</i>	23/02/2016
1	G. Lampert	A.Wyatt	<i>A.Wyatt*</i>	G.Marshall	<i>G.Marshall*</i>	13/07/2016

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# **Appendix G** – Database searches



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 17/12/14 12:43:54

## [Summary](#)

### [Details](#)

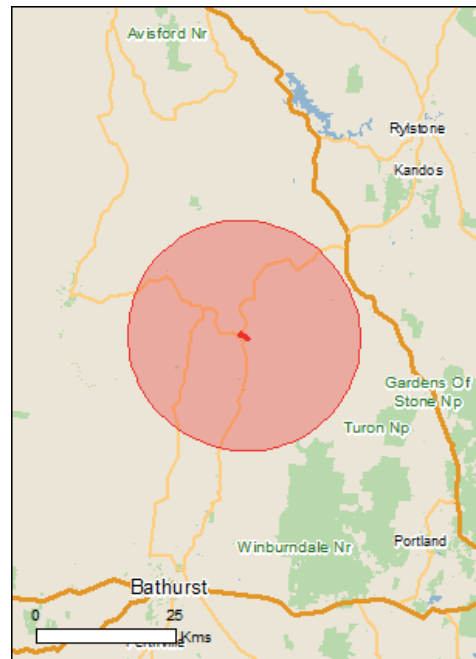
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

### [Caveat](#)

### [Acknowledgements](#)



This map may contain data which are  
©Commonwealth of Australia  
(Geoscience Australia), ©PSMA 2010

[Coordinates](#)

Buffer: 20.0Km





# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Areas:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	1
<a href="#">Listed Threatened Species:</a>	24
<a href="#">Listed Migratory Species:</a>	11

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	2
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	12
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Commonwealth Reserves Marine:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">Place on the RNE:</a>	4
<a href="#">State and Territory Reserves:</a>	1
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	33
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None

## Details

### Matters of National Environmental Significance

#### Listed Threatened Ecological Communities [\[ Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<a href="#">White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland</a>	Critically Endangered	Community likely to occur within area

#### Listed Threatened Species [\[ Resource Information \]](#)

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Anthochaera phrygia</a> Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
<a href="#">Botaurus poiciloptilus</a> Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Polytelis swainsonii</a> Superb Parrot [738]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
<b>Fish</b>		
<a href="#">Maccullochella peelii</a> Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
<b>Frogs</b>		

Name	Status	Type of Presence
<a href="#">Litoria booroolongensis</a> Booroolong Frog [1844]	Endangered	Species or species habitat likely to occur within area
<b>Insects</b>		
<a href="#">Paralucia spinifera</a> Bathurst Copper Butterfly, Purple Copper Butterfly, Bathurst Copper, Bathurst Copper Wing, Bathurst-Lithgow Copper, Purple Copper [26335]	Vulnerable	Species or species habitat likely to occur within area
<b>Mammals</b>		
<a href="#">Chalinolobus dwyeri</a> Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Dasyurus maculatus maculatus (SE mainland population)</a> Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
<a href="#">Nyctophilus corbeni</a> South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
<a href="#">Petrogale penicillata</a> Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
<a href="#">Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)</a> Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pseudomys novaehollandiae</a> New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
<b>Plants</b>		
<a href="#">Asterolasia elegans</a> [56780]	Endangered	Species or species habitat may occur within area
<a href="#">Euphrasia arguta</a> [4325]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Lepidium hyssopifolium</a> Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
<a href="#">Philothea ericifolia</a> [64942]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Prasophyllum petilum</a> Tarengo Leek Orchid [55144]	Endangered	Species or species habitat likely to occur within area
<a href="#">Prasophyllum sp. Wybong (C.Phelps ORG 5269)</a> a leek-orchid [81964]	Critically Endangered	Species or species habitat likely to occur within area
<a href="#">Thesium australe</a> Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
<b>Reptiles</b>		
<a href="#">Aprasia parapulchella</a> Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Hoplocephalus bungaroides</a> Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species		[ Resource Information ]
--------------------------	--	--------------------------

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
------	------------	------------------

#### Migratory Marine Birds

[Apus pacificus](#)

Fork-tailed Swift [678]		Species or species habitat likely to occur within area
-------------------------	--	--

#### Migratory Terrestrial Species

[Haliaeetus leucogaster](#)

White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
-------------------------------	--	--

[Hirundapus caudacutus](#)

White-throated Needletail [682]		Species or species habitat likely to occur within area
---------------------------------	--	--

[Merops ornatus](#)

Rainbow Bee-eater [670]		Species or species habitat may occur within area
-------------------------	--	--

[Monarcha melanopsis](#)

Black-faced Monarch [609]		Species or species habitat known to occur within area
---------------------------	--	---

[Myiagra cyanoleuca](#)

Satin Flycatcher [612]		Species or species habitat known to occur within area
------------------------	--	---

[Rhipidura rufifrons](#)

Rufous Fantail [592]		Species or species habitat likely to occur within area
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#### Migratory Wetlands Species

[Ardea alba](#)

Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
----------------------------------	--	--

[Ardea ibis](#)

Cattle Egret [59542]		Species or species habitat likely to occur within area
----------------------	--	--

[Gallinago hardwickii](#)

Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
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[Rostratula benghalensis \(sensu lato\)](#)

Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
---------------------	-------------	--

### Other Matters Protected by the EPBC Act

Commonwealth Land	[ Resource Information ]
-------------------	--------------------------

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

#### Name

Commonwealth Land - Australian Telecommunications Commission  
 Commonwealth Land - Commonwealth Trading Bank of Australia

Listed Marine Species	[ Resource Information ]
-----------------------	--------------------------

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
------	------------	------------------

#### Birds

[Apus pacificus](#)

Fork-tailed Swift [678]		Species or species habitat likely to occur
-------------------------	--	--

Name	Threatened	Type of Presence
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		within area  Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat likely to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]		Species or species habitat likely to occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat known to occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat known to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat likely to occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

## Extra Information

### Places on the RNE [ [Resource Information](#) ]

Note that not all Indigenous sites may be listed.

Name	State	Status
<b>Natural</b>		
<a href="#">Winburndale Nature Reserve (1977 boundary)</a>	NSW	Registered
<b>Historic</b>		
<a href="#">Crudine General Cemetery</a>	NSW	Indicative Place
<a href="#">Sofala Courthouse (former)</a>	NSW	Registered
<a href="#">Sofala Settlement</a>	NSW	Registered

### State and Territory Reserves [ [Resource Information](#) ]

Name	State
Winburndale	NSW



**Invasive Species****[ Resource Information ]**

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Acridotheres tristis</a>		
Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
<a href="#">Alauda arvensis</a>		
Skylark [656]		Species or species habitat likely to occur within area
<a href="#">Anas platyrhynchos</a>		
Mallard [974]		Species or species habitat likely to occur within area
<a href="#">Carduelis carduelis</a>		
European Goldfinch [403]		Species or species habitat likely to occur within area
<a href="#">Columba livia</a>		
Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
<a href="#">Passer domesticus</a>		
House Sparrow [405]		Species or species habitat likely to occur within area
<a href="#">Passer montanus</a>		
Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
<a href="#">Streptopelia chinensis</a>		
Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
<a href="#">Sturnus vulgaris</a>		
Common Starling [389]		Species or species habitat likely to occur within area
<a href="#">Turdus merula</a>		
Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
<b>Mammals</b>		
<a href="#">Bos taurus</a>		
Domestic Cattle [16]		Species or species habitat likely to occur within area
<a href="#">Canis lupus familiaris</a>		
Domestic Dog [82654]		Species or species habitat likely to occur within area
<a href="#">Capra hircus</a>		
Goat [2]		Species or species habitat likely to occur within area
<a href="#">Felis catus</a>		
Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
<a href="#">Feral deer</a>		
Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
<a href="#">Lepus capensis</a>		
Brown Hare [127]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
<a href="#">Mus musculus</a> House Mouse [120]		Species or species habitat likely to occur within area
<a href="#">Oryctolagus cuniculus</a> Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
<a href="#">Rattus rattus</a> Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
<a href="#">Sus scrofa</a> Pig [6]		Species or species habitat likely to occur within area
<a href="#">Vulpes vulpes</a> Red Fox, Fox [18]		Species or species habitat likely to occur within area
<b>Plants</b>		
<a href="#">Asparagus asparagoides</a> Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
<a href="#">Cytisus scoparius</a> Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
<a href="#">Genista monspessulana</a> Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
<a href="#">Genista sp. X Genista monspessulana</a> Broom [67538]		Species or species habitat may occur within area
<a href="#">Lycium ferocissimum</a> African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
<a href="#">Nassella neesiana</a> Chilean Needle grass [67699]		Species or species habitat likely to occur within area
<a href="#">Nassella trichotoma</a> Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
<a href="#">Opuntia spp.</a> Prickly Pears [82753]		Species or species habitat likely to occur within area
<a href="#">Pinus radiata</a> Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
<a href="#">Rubus fruticosus aggregate</a> Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
<a href="#">Salix spp. except S.babylonica, S.x calodendron &amp; S.x reichardtii</a> Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
<a href="#">Senecio madagascariensis</a> Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area



# Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
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- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

## Noxious weed declarations

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### Noxious weed declarations for Upper Macquarie County Council

Note: this control area includes the local council areas of - **Upper Macquarie County Council - Bathurst Regional - Blayney - Lithgow - Oberon**

Weed	Class	Legal requirements
<a href="#">African feathergrass</a> [ <i>Pennisetum macrourum</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">African turnip weed</a> [ <i>Sisymbrium runcinatum</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">African turnip weed</a> [ <i>Sisymbrium thellungii</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Anchored water hyacinth</a> [ <i>Eichhornia azurea</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Annual ragweed</a> [ <i>Ambrosia artemisiifolia</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Artichoke thistle</a> [ <i>Cynara cardunculus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Athel tree / Athel pine</a> [ <i>Tamarix aphylla</i> ] Weed of National Significance	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Bear-skin fescue</a> [ <i>Festuca gautieri</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Black knapweed</a> [ <i>Centaurea xmoncktonii</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Blackberry</a> [ <i>Rubus fruticosus aggregate species</i> ] except cultivars Black satin Chehalem Chester Thornless Dirksen Thornless Loch Ness Murrindindi Silvan Smooth stem Thornfree	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed This is an <a href="#">All of NSW</a> declaration
<a href="#">Boneseed</a> [ <i>Chrysanthemoides monilifera subspecies monilifera</i> ] Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Bridal veil creeper</a> [ <i>Asparagus declinatus (syn. Asparagus crispus, Myrsiphyllum declinatum)</i> ] A Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration



<a href="#">Broomrapes</a> [ <i>Orobanche species except the native O. cernua variety australiana and O. minor</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Burr ragweed</a> [ <i>Ambrosia confertiflora</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Cabomba</a> [ <i>All Cabomba species except C. furcata</i> ] Weed of National Significance	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Cayenne snakeweed</a> [ <i>Stachytarpheta cayennensis</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Chinese violet</a> [ <i>Asystasia gangetica subspecies micrantha</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Clockweed</a> [ <i>Gaura parviflora</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Corn sowthistle</a> [ <i>Sonchus arvensis</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Dodder</a> [ <i>All Cuscuta species except the native species C. australis, C. tasmanica and C. victoriana</i> ] Includes All Cuscuta species except the native species C. australis, C. tasmanica and C. victoriana	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Espartillo</a> [ <i>Amelichloa brachychaeta, Amelichloa caudata</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Eurasian water milfoil</a> [ <i>Myriophyllum spicatum</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Fine-bristled burr grass</a> [ <i>Cenchrus brownii</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Fountain grass</a> [ <i>Cenchrus setaceus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Frogbit / Spongeplant</a> [ <i>Limnobium laevigatum and L. spongia</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Gallon's curse</a> [ <i>Cenchrus biflorus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Gamba grass</a> [ <i>Andropogon gayanus</i> ] Weed of National Significance	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration

<a href="#">Glaucous star thistle</a> [ <i>Carthamus glaucus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Golden thistle</a> [ <i>Scolymus hispanicus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Hawkweed</a> [ <i>Hieracium species</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Heteranthera / Kidneyleaf mud plantain</a> [ <i>Heteranthera reniformis</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Horsetail</a> [ <i>Equisetum species</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Hydrocotyl / Water pennywort</a> [ <i>Hydrocotyl ranunculoides</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Hymenachne</a> [ <i>Hymenachne amplexicaulis and hybrids</i> ] Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Karoo thorn</a> [ <i>Acacia karroo</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Kochia</a> [ <i>Bassia scoparia</i> ] except <i>Bassia scoparia</i> subspecies <i>trichophylla</i>	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Koster's curse / Clidemia</a> [ <i>Clidemia hirta</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Lagarosiphon</a> [ <i>Lagarosiphon major</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Leafy elodea / Dense waterweed / Egeria</a> [ <i>Egeria densa</i> ]	4	The plant must not be sold, propagated or knowingly distributed This is an <a href="#">All of NSW</a> declaration
<a href="#">Lippia</a> [ <i>Phyla canescens</i> ]	4	The plant must not be sold, propagated or knowingly distributed except incidentally in hay or lucerne This is an <a href="#">All of NSW</a> declaration
<a href="#">Mexican feather grass</a> [ <i>Nassella tenuissima</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Mexican poppy</a> [ <i>Argemone mexicana</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Miconia</a> [ <i>Miconia species</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration

<a href="#">Mikania vine</a> [ <i>Mikania micrantha</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Mimosa</a> [ <i>Mimosa pigra</i> ] Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Mossman River grass</a> [ <i>Cenchrus echinatus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Parthenium weed</a> [ <i>Parthenium hysterophorus</i> ] Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Pond apple</a> [ <i>Annona glabra</i> ] Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Prickly acacia</a> [ <i>Vachellia nilotica (syn. Acacia nilotica)</i> ] A Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Prickly pear</a> [ <i>Cylindropuntia species</i> ] Weed of National Significance	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed This is an <a href="#">All of NSW</a> declaration
<a href="#">Red rice</a> [ <i>Oryza rufipogon</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Rhus tree</a> [ <i>Toxicodendron succedaneum</i> ]	4	The growth of the plant must be managed in a manner that continuously inhibits the ability of the plant to spread and the plant must not be sold, propagated or knowingly distributed This is an <a href="#">All of NSW</a> declaration
<a href="#">Rubber vine</a> [ <i>Cryptostegia grandiflora</i> ] A Weed of National Significance	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Senegal tea plant</a> [ <i>Gymnocoronis spilanthoides</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Siam weed</a> [ <i>Chromolaena odorata</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Smooth-stemmed turnip</a> [ <i>Brassica barrelieri subspecies oxyrrhina</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Soldier thistle</a> [ <i>Picnomon acarna</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Spotted knapweed</a> [ <i>Centaurea stoebe subspecies micranthos</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration

<a href="#">Texas blueweed</a> [ <i>Helianthus ciliaris</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration
<a href="#">Tropical soda apple</a> [ <i>Solanum viarum</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Water caltrop</a> [ <i>Trapa species</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Water lettuce</a> [ <i>Pistia stratiotes</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Water soldier</a> [ <i>Stratiotes aloides</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Witchweed</a> [ <i>Striga species except the native Striga parviflora</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Yellow burrhead</a> [ <i>Limnocharis flava</i> ]	1	The plant must be eradicated from the land and that land must be kept free of the plant This is an <a href="#">All of NSW</a> declaration
<a href="#">Yellow nutgrass</a> [ <i>Cyperus esculentus</i> ]	5	The requirements in the Noxious Weeds Act 1993 for a notifiable weed must be complied with This is an <a href="#">All of NSW</a> declaration



# EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about [Environment Assessments](#) and the EPBC Act including significance guidelines, forms and application process details.

Report created: 06/01/15 10:58:59

## [Summary](#)

### [Details](#)

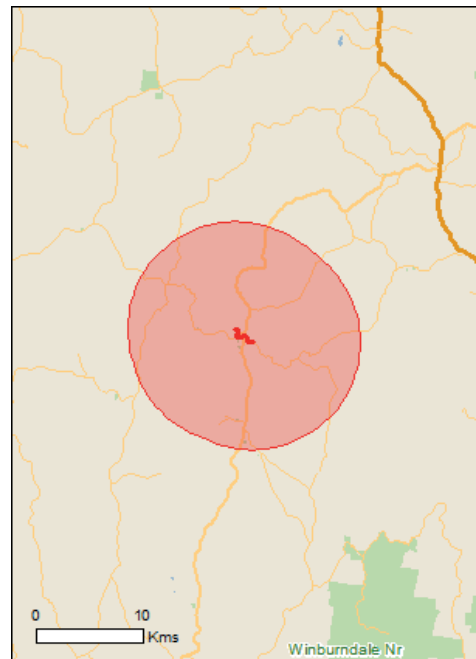
[Matters of NES](#)

[Other Matters Protected by the EPBC Act](#)

[Extra Information](#)

### [Caveat](#)

### [Acknowledgements](#)



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Buffer: 10.0Km





# Summary

## Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the [Administrative Guidelines on Significance](#).

<a href="#">World Heritage Properties:</a>	None
<a href="#">National Heritage Places:</a>	None
<a href="#">Wetlands of International Importance:</a>	None
<a href="#">Great Barrier Reef Marine Park:</a>	None
<a href="#">Commonwealth Marine Areas:</a>	None
<a href="#">Listed Threatened Ecological Communities:</a>	1
<a href="#">Listed Threatened Species:</a>	21
<a href="#">Listed Migratory Species:</a>	11

## Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As [heritage values](#) of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A [permit](#) may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

<a href="#">Commonwealth Land:</a>	2
<a href="#">Commonwealth Heritage Places:</a>	None
<a href="#">Listed Marine Species:</a>	12
<a href="#">Whales and Other Cetaceans:</a>	None
<a href="#">Critical Habitats:</a>	None
<a href="#">Commonwealth Reserves Terrestrial:</a>	None
<a href="#">Commonwealth Reserves Marine:</a>	None

## Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

<a href="#">Place on the RNE:</a>	2
<a href="#">State and Territory Reserves:</a>	None
<a href="#">Regional Forest Agreements:</a>	None
<a href="#">Invasive Species:</a>	32
<a href="#">Nationally Important Wetlands:</a>	None
<a href="#">Key Ecological Features (Marine)</a>	None

## Details

### Matters of National Environmental Significance

#### Listed Threatened Ecological Communities [\[ Resource Information \]](#)

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
<a href="#">White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland</a>	Critically Endangered	Community likely to occur within area

#### Listed Threatened Species [\[ Resource Information \]](#)

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Anthochaera phrygia</a> Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
<a href="#">Leipoa ocellata</a> Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Polytelis swainsonii</a> Superb Parrot [738]	Vulnerable	Species or species habitat may occur within area
<a href="#">Rostratula australis</a> Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
<b>Fish</b>		
<a href="#">Maccullochella peelii</a> Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
<b>Frogs</b>		
<a href="#">Litoria booroolongensis</a> Booroolong Frog [1844]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
<b>Insects</b>		
<a href="#">Paralucia spinifera</a>		
Bathurst Copper Butterfly, Purple Copper Butterfly, Bathurst Copper, Bathurst Copper Wing, Bathurst-Lithgow Copper, Purple Copper [26335]	Vulnerable	Species or species habitat likely to occur within area
<b>Mammals</b>		
<a href="#">Chalinolobus dwyeri</a>		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Dasyurus maculatus maculatus (SE mainland population)</a>		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
<a href="#">Nyctophilus corbeni</a>		
South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
<a href="#">Petrogale penicillata</a>		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat may occur within area
<a href="#">Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)</a>		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
<a href="#">Pseudomys novaehollandiae</a>		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
<b>Plants</b>		
<a href="#">Asterolasia elegans</a>		
[56780]	Endangered	Species or species habitat may occur within area
<a href="#">Euphrasia arguta</a>		
[4325]	Critically Endangered	Species or species habitat may occur within area
<a href="#">Lepidium hyssopifolium</a>		
Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
<a href="#">Philotheca ericifolia</a>		
[64942]	Vulnerable	Species or species habitat likely to occur within area
<a href="#">Thesium australe</a>		
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
<b>Reptiles</b>		
<a href="#">Aprasia parapulchella</a>		
Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area
<a href="#">Hoplocephalus bungaroides</a>		
Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area
<b>Listed Migratory Species</b>		<a href="#">[ Resource Information ]</a>
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
<b>Migratory Marine Birds</b>		
<a href="#">Apus pacificus</a>		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<b>Migratory Terrestrial Species</b>		
<a href="#">Haliaeetus leucogaster</a>		
White-bellied Sea-Eagle [943]		Species or species

Name	Threatened	Type of Presence
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]		habitat likely to occur within area Species or species habitat likely to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat likely to occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat likely to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat likely to occur within area
<b>Migratory Wetlands Species</b>		
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat likely to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

## Other Matters Protected by the EPBC Act

### Commonwealth Land [ [Resource Information](#) ]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Trading Bank of Australia

### Listed Marine Species [ [Resource Information](#) ]

\* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
<b>Birds</b>		
<a href="#">Apus pacificus</a> Fork-tailed Swift [678]		Species or species habitat likely to occur within area
<a href="#">Ardea alba</a> Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
<a href="#">Ardea ibis</a> Cattle Egret [59542]		Species or species habitat likely to occur within area
<a href="#">Gallinago hardwickii</a> Latham's Snipe, Japanese Snipe [863]		Species or species

Name	Threatened	Type of Presence
<a href="#">Haliaeetus leucogaster</a> White-bellied Sea-Eagle [943]		habitat may occur within area  Species or species habitat likely to occur within area
<a href="#">Hirundapus caudacutus</a> White-throated Needletail [682]		Species or species habitat likely to occur within area
<a href="#">Lathamus discolor</a> Swift Parrot [744]	Endangered	Species or species habitat likely to occur within area
<a href="#">Merops ornatus</a> Rainbow Bee-eater [670]		Species or species habitat may occur within area
<a href="#">Monarcha melanopsis</a> Black-faced Monarch [609]		Species or species habitat likely to occur within area
<a href="#">Myiagra cyanoleuca</a> Satin Flycatcher [612]		Species or species habitat likely to occur within area
<a href="#">Rhipidura rufifrons</a> Rufous Fantail [592]		Species or species habitat likely to occur within area
<a href="#">Rostratula benghalensis (sensu lato)</a> Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

## Extra Information

### Places on the RNE [\[ Resource Information \]](#)

Note that not all Indigenous sites may be listed.

Name	State	Status
<b>Historic</b>		
<a href="#">Sofala Courthouse (former)</a>	NSW	Registered
<a href="#">Sofala Settlement</a>	NSW	Registered

### Invasive Species [\[ Resource Information \]](#)

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resources Audit, 2001.

Name	Status	Type of Presence
<b>Birds</b>		
<a href="#">Acridotheres tristis</a> Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
<a href="#">Alauda arvensis</a> Skylark [656]		Species or species



Name	Status	Type of Presence
<a href="#">Anas platyrhynchos</a> Mallard [974]		habitat likely to occur within area Species or species habitat likely to occur within area
<a href="#">Carduelis carduelis</a> European Goldfinch [403]		Species or species habitat likely to occur within area
<a href="#">Columba livia</a> Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
<a href="#">Passer domesticus</a> House Sparrow [405]		Species or species habitat likely to occur within area
<a href="#">Passer montanus</a> Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
<a href="#">Streptopelia chinensis</a> Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
<a href="#">Sturnus vulgaris</a> Common Starling [389]		Species or species habitat likely to occur within area
<a href="#">Turdus merula</a> Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
<b>Mammals</b>		
<a href="#">Bos taurus</a> Domestic Cattle [16]		Species or species habitat likely to occur within area
<a href="#">Canis lupus familiaris</a> Domestic Dog [82654]		Species or species habitat likely to occur within area
<a href="#">Capra hircus</a> Goat [2]		Species or species habitat likely to occur within area
<a href="#">Felis catus</a> Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
<a href="#">Feral deer</a> Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
<a href="#">Lepus capensis</a> Brown Hare [127]		Species or species habitat likely to occur within area
<a href="#">Mus musculus</a> House Mouse [120]		Species or species habitat likely to occur within area
<a href="#">Oryctolagus cuniculus</a> Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
<a href="#">Rattus rattus</a> Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
<a href="#">Sus scrofa</a> Pig [6]		Species or species

Name	Status	Type of Presence
<a href="#">Vulpes vulpes</a> Red Fox, Fox [18]		habitat likely to occur within area  Species or species habitat likely to occur within area
<b>Plants</b>		
<a href="#">Asparagus asparagoides</a> Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
<a href="#">Cytisus scoparius</a> Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
<a href="#">Genista sp. X Genista monspessulana</a> Broom [67538]		Species or species habitat may occur within area
<a href="#">Lycium ferocissimum</a> African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
<a href="#">Nassella neesiana</a> Chilean Needle grass [67699]		Species or species habitat likely to occur within area
<a href="#">Nassella trichotoma</a> Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
<a href="#">Opuntia spp.</a> Prickly Pears [82753]		Species or species habitat likely to occur within area
<a href="#">Pinus radiata</a> Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
<a href="#">Rubus fruticosus aggregate</a> Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
<a href="#">Salix spp. except S.babylonica, S.x calodendron &amp; S.x reichardtii</a> Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
<a href="#">Senecio madagascariensis</a> Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

# Coordinates

-33.074542 149.685297,-33.075261 149.687186,-33.076412 149.687357,-33.07785  
149.687357,-33.079576 149.686842,-33.080008 149.687014,-33.080008 149.690791,  
-33.079576 149.694739,-33.080008 149.69594,-33.081015 149.696112,-33.082165  
149.696112,-33.08346 149.697142,-33.084179 149.698687,-33.084179 149.700404,  
-33.083891 149.700575

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

# Acknowledgements

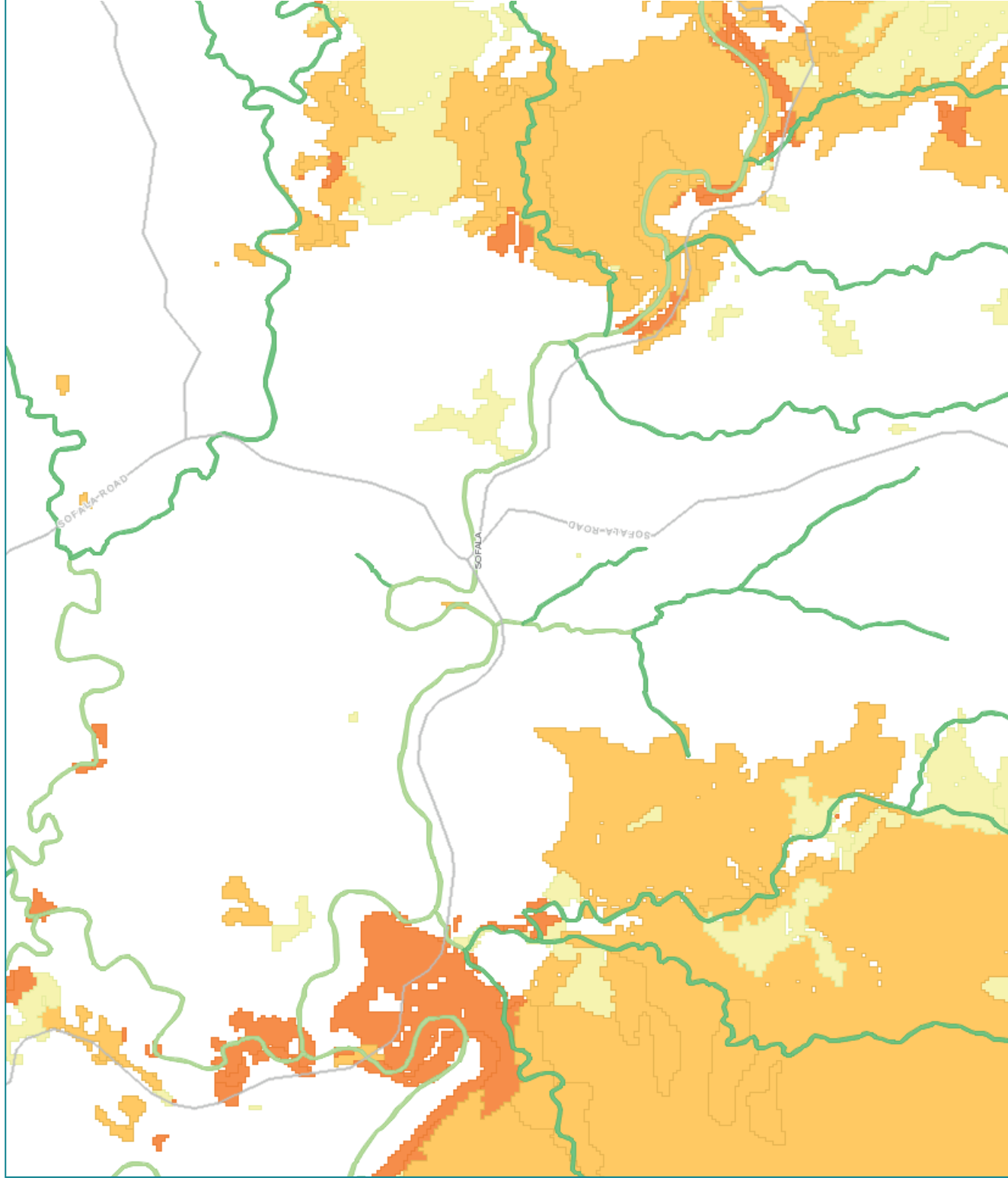
This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- [Department of Environment, Climate Change and Water, New South Wales](#)
- [Department of Sustainability and Environment, Victoria](#)
- [Department of Primary Industries, Parks, Water and Environment, Tasmania](#)
- [Department of Environment and Natural Resources, South Australia](#)
- [Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts](#)
- [Environmental and Resource Management, Queensland](#)
- [Department of Environment and Conservation, Western Australia](#)
- [Department of the Environment, Climate Change, Energy and Water](#)
- [Birds Australia](#)
- [Australian Bird and Bat Banding Scheme](#)
- [Australian National Wildlife Collection](#)
- Natural history museums of Australia
- [Museum Victoria](#)
- [Australian Museum](#)
- [SA Museum](#)
- [Queensland Museum](#)
- [Online Zoological Collections of Australian Museums](#)
- [Queensland Herbarium](#)
- [National Herbarium of NSW](#)
- [Royal Botanic Gardens and National Herbarium of Victoria](#)
- [Tasmanian Herbarium](#)
- [State Herbarium of South Australia](#)
- [Northern Territory Herbarium](#)
- [Western Australian Herbarium](#)
- [Australian National Herbarium, Atherton and Canberra](#)
- [University of New England](#)
- [Ocean Biogeographic Information System](#)
- [Australian Government, Department of Defence](#)
- [State Forests of NSW](#)
- [Geoscience Australia](#)
- [CSIRO](#)
- Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the [Contact Us](#) page.

# Groundwater Dependent Ecosystem Map Report



**GDE, Reliant on surface expression of groundwater (rivers, springs, wetlands)**

- Identified in previous study : fieldwork
- Identified in previous study : desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction

**GDE, Reliant on subsurface groundwater (vegetation)**

- Identified in previous study : fieldwork
- Identified in previous study : desktop
- High potential for groundwater interaction
- Moderate potential for groundwater interaction
- Low potential for groundwater interaction
- No Ecosystems analysed

**GDE, Subterranean (Cave & Aquifers)**

- Identified in previous study : fieldwork
- Identified in previous study : desktop
- No Ecosystems analysed

1:49,624



Data source - Data are assumed to be correct as supplied from Commonwealth, State and Territory data suppliers or referenced projects.

Disclaimer - Use of the information and data contained within this document is at your sole risk. Neither the Bureau nor its agents make any warranties or representations regarding the quality, accuracy, merchantability or fitness for purpose of any material in this document.



GHD Sydney  
133 Castlereagh St  
Sydney New South Wales 2000  
Attention: Sophie Lovett  
Email: sophie.lovett@ghd.com

Date: 29 July 2015

Dear Sir or Madam:

**AHIMS Web Service search for the following area at Lat, Long From : -33.081, 149.6851 - Lat, Long To : -33.074, 149.6963 with a Buffer of 0 meters, conducted by Sophie Lovett on 29 July 2015.**

The context area of your search is shown in the map below. Please note that the map does not accurately display the exact boundaries of the search as defined in the paragraph above. The map is to be used for general reference purposes only.



A search of the Office of the Environment and Heritage AHIMS Web Services (Aboriginal Heritage Information Management System) has shown that:

<b>0</b>	<b>Aboriginal sites are recorded in or near the above location.</b>
<b>0</b>	<b>Aboriginal places have been declared in or near the above location. *</b>

### **If your search shows Aboriginal sites or places what should you do?**

- You must do an extensive search if AHIMS has shown that there are Aboriginal sites or places recorded in the search area.
- If you are checking AHIMS as a part of your due diligence, refer to the next steps of the Due Diligence Code of practice.
- You can get further information about Aboriginal places by looking at the gazettal notice that declared it. Aboriginal places gazetted after 2001 are available on the [NSW Government Gazette \(http://www.nsw.gov.au/gazette\)](http://www.nsw.gov.au/gazette) website. Gazettal notices published prior to 2001 can be obtained from Office of Environment and Heritage's Aboriginal Heritage Information Unit upon request

### **Important information about your AHIMS search**

- The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not be made available to the public.
- AHIMS records information about Aboriginal sites that have been provided to Office of Environment and Heritage and Aboriginal places that have been declared by the Minister;
- Information recorded on AHIMS may vary in its accuracy and may not be up to date .Location details are recorded as grid references and it is important to note that there may be errors or omissions in these recordings,
- Some parts of New South Wales have not been investigated in detail and there may be fewer records of Aboriginal sites in those areas. These areas may contain Aboriginal sites which are not recorded on AHIMS.
- Aboriginal objects are protected under the National Parks and Wildlife Act 1974 even if they are not recorded as a site on AHIMS.
- This search can form part of your due diligence and remains valid for 12 months.

# Bathurst Regional Local Environmental Plan 2014

Current version for 15 July 2015 to date (accessed 29 July 2015 at 22:05)

Schedule 5

<< page >>

## Schedule 5 Environmental heritage

(Clause 5.10)

### Part 1 Heritage items

Suburb	Item name	Address	Property description	Significance	Item no
Abercrombie	Avoca	75 Eglinton Road	Lot 2, DP 875443	Local	I1
Abercrombie	Walmer	87 Eglinton Road	Lot 1003, DP 1151447	Local	I2
Abercrombie River	Abercrombie River timber bridge	Goulburn Road	Part road reserve	Local	I3
Arkell	Long Swamp Cemetery	377 Old Trunk Road	Lot 3, DP 235045	Local	I4
Arkell	Arkell (former inn)	4274 Trunkey Road	Part Lot 19, DP 753022	Local	I5
Bathampton	Bathampton Homestead, stables and brick barn	2021 Mid Western Highway	Part Lot 300, DP 1144793	Local	I6
Bathurst	Shop (former)	26 Bant Street	Lot 1, DP 846171	Local	I7
Bathurst	St Barnabas Anglican Church and hall	36A Bant Street	Lot 95, DP 1142574; Lot 5, DP 573241	Local	I8
Bathurst	St Stanislaus College and curtilage	Bentinck, Havannah and Seymour Streets	Lots 161, 226 and 249, DP 750357; Lots 1 and 2, Section 118, DP 758065; Lots 11– 17, Section 117, DP 758065; Lot 1, DP 705335; Lot 1, DP 815875; Lots 1–4, DP 132171; Lot 100, DP 1163597; Lot 31, DP 598074	Local	I9
Bathurst	Elm trees	Bentinck Street (between Durham and Howick Streets)	Part road reserve	State	I10
Bathurst	Dairy farmers' factory (former convict hospital)	50 Bentinck Street	Lots 1–4, 19–28 and 30, DP 2067; Lot 2, DP 184456	Local	I11
Bathurst	Gladstone Terrace	52, 54, 56, 58 and 60 Bentinck Street	Lots 1–5, DP 1035111	Local	I12
Bathurst	Terrace house	62 Bentinck Street	Lot 50, DP 582025	Local	I13
Bathurst	Terrace cottages and commercial buildings	67, 71 and 73 Bentinck Street and 194, 196, 198, 200 and 202 Howick Street	Lot 1, DP 794613; Lot 1, DP 196982; Lots 1, 2 and 4, DP 34660; Lot 1, DP 708789; Lots 100 and 101, DP 618290	73 Bentinck Street— Local, Others— State	I14
Bathurst	Ithica	247 Bentinck Street	Lot 2, DP 535506	Local	I15
Bathurst	Federation cottage	255 Bentinck Street	Lot 161, DP 1054181	Local	I299

Bathurst	Terrace houses	45, 47, 49, 51, 53, 55, 57, 59, 61 and 63 Carlingford Street	Lots 1–10, DP 249862	Local	I16
Bathurst	Bathurst Town Square (1833) (including St Stephens Presbyterian Church group, All Saint's Cathedral, chancel and cathedral bells, Technical College group, former National School, commercial buildings including 91–93 and 101 William Street and Walshaw Hall and All Saint's School and residence, (former))	Bounded by Church, George, Howick and William Streets	Lot 266, DP 821055; Lot 5, DP 1191425; Lot 1, DP 1155530; Lot 10, DP 1086550; SP 34226; SP 39411, Lots 1 and 2, DP 331749, Lot 1, DP 230882, Lots 1 and 2, DP 774489; Lots 3–9 and 11, Section 151, DP 758065; Lot 1, DP 856918; Lot 1, DP 1096497; Lot 1, DP 197421; Lots A and B, DP 158600; Lot 1, DP 154723; Lot 1, DP 986351	Cathedral Bells—State Others— Local	I17
Bathurst	Kings Parade group (part of Bathurst Town Square)	Bounded by Church, George, Russell and William Streets	Lot 1, Section 71, DP 758065	Local	I18
Bathurst	Bathurst sportsground grandstand, gates and memorial	42 and 48 Durham Street	Part Lot 92, DP 820990; Part Lot 7305, DP 1153071	Local	I19
Bathurst	Georgian cottage	101 Durham Street	Lot 1, DP 196496	Local	I300
Bathurst	Corner shop (formerly Belle-Maine Hotel)	156 Durham Street	Lot A, DP 159516	Local	I20
Bathurst	St Agnes Hostel (former)	202 Durham Street	Lot 132, DP 572300	Local	I21
Bathurst	Bathurst street lamps	George, William, Howick, Church, Russell and Keppel Streets	Part road reserve	State	I22
Bathurst	Old Government House group	1 George Street and 16 Stanley Street	Lots 1 and 2, DP 788005	State	I23
Bathurst	Roman Catholic Chancery Office	84 George Street	Part Lot 3, DP 1076699	Local	I24
Bathurst	Webb's Store group including warehouses, emporium and surrounds	169, 179, 181 and 181A George Street and 121A Keppel Street	Lots 5–9, DP 221430; Lots 11 and 12, DP 748606; Part Lot 2, DP 202916	Local	I25
Bathurst	House	182 George Street	Lot A, DP 150995	Local	I27
Bathurst	House	184 George Street	Lot 1, DP 150765	Local	I28
Bathurst	Bassett House	191 George Street	Lot 1, DP 125440	Local	I26
Bathurst	Hatherley	198 George Street	Lots 1 and 2, DP 715979; Part Lot 8, Section 79, DP 758065	Local	I29
Bathurst	2-storey commercial building	221 George Street	Lot A, DP 371946	Local	I30
Bathurst	Commercial building (formerly variety store and barber's shop)	227 George Street	Lot D, DP 160016	Local	I31

Bathurst	Bathurst Public School—1939 wings and 1935 building	281 George Street	Part Lot 1, Section 38, Local DP 758065		I301
Bathurst	Havannah Street group	91, 93, 95, 97, 99, 101, 103, 105, 107, 109, 111, 113 and 115 Havannah Street	Lots A–E, DP 39282; Lot 1, DP 798297; Lot 24, DP 192843; Lots 11–14, DP 588742; Lot B, DP 197477; Lot 1, DP 734173	Local	I32
Bathurst	Yarras	101 Hope Street	Lot 1, DP 741263	Local	I33
Bathurst	House	130 Hope Street	Lot 1, DP 153252	Local	I34
Bathurst	Bathurst High School—2-storey 1930s wing	190 Hope Street	Part Lot 2, DP 126777	Local	I302
Bathurst	2-storey Victorian commercial buildings	165, 169, 171 and 175 Howick Street	Lot 10, DP 848312; Lots 3 and 6, DP 22751; Lot 1, DP 872268	Local	I35
Bathurst	Bathurst Showground group	Kendall Avenue	Lots 1 and 3, DP 1179068; Lot 1, DP 863087	Local	I36
Bathurst	Bathurst Railway Station, Station Masters residence, cottage, Railway Institute and warehouse buildings	1 Keppel and Havannah Streets	Part Lot 30, DP 1062485	State	I37
Bathurst	Victoria Hotel	3 Keppel Street	Lot 1, DP 126084; Lot 1, DP 66860	Local	I38
Bathurst	Tremain's Mill and silos (former Victoria Mill) and Invincible Flour sign	7–11 Keppel Street	Lot 1, DP 782323; Lot A, DP 389015; Part road reserve	Local	I39
Bathurst	Terraces	20, 22, 24 and 26 Keppel Street	Lot 1, DP 137144; Lot 1, DP 794598; Lot 24, DP 707128; Part Lot 14, DP 192843	Local	I40
Bathurst	Webb's commercial building	23 Keppel Street	Lot 5, Section 86, DP 758065	Local	I303
Bathurst	Centennial terraces	36, 38, 40 and 42 Keppel Street	Lots 9–12, DP 569151	Local	I41
Bathurst	Loxley House	46 Keppel Street	Lot 8, DP 623425	Local	I42
Bathurst	Sparta Corner	81 and 83 Keppel Street and 104 Bentinck Street	Lots A–C, DP 161775	Local	I43
Bathurst	Carrington House (former Masonic Hall)	99 Keppel Street	Lot 21, DP 227089	Local	I44
Bathurst	Hollydene	113 Keppel Street	Lot B, DP 163678	Local	I45
Bathurst	The Bathurst Hall (formerly Oddfellows Hall)	124 Keppel Street	Lot 3, DP 747536	Local	I46
Bathurst	Pentilly	218 Keppel Street	Lot 1, DP 701196	Local	I47
Bathurst	Monteagle	268 Keppel Street	Lot 1, DP 1038347; Lot B, DP 347292	Local	I48



Bathurst	Blair Athol	275 and 281 Keppel Street	Lot N, DP 158416; Lot 46, DP 1006258	Local	I49
Bathurst	Lachlan Inn (former)	57 and 59 Lambert Street	Lot 1, DP 799423; Lot 1, DP 742651	Local	I327
Bathurst	Adar	110 Lambert Street	Lot 1, DP 719457	Local	I50
Bathurst	Post-war residence	319B Lambert Street	Lot 2, DP 1161713	Local	I51
Bathurst	Bathurst-Kelso Railway Bridge	Macquarie River	Part Main Western Railway	State	I52
Bathurst	Denison Bridge	Macquarie River	Over Macquarie River	State	I53
Bathurst	Georgian cottage	67 Morrissett Street	Lot 1, DP 21721	Local	I304
Bathurst	Crago Mill	2A Piper Street	Lot 12, DP 1014089	Local	I54
Bathurst	Attached residences (formerly Railway Hotel)	46–48 Piper Street	Lot 21, DP 591199	Local	I55
Bathurst	House	89 Piper Street	Lot 1, DP 998115	Local	I56
Bathurst	2-storey residence	266 Piper Street	Lot 2, DP 998878	Local	I57
Bathurst	Group of houses	25, 27, 29 and 31 Rankin Street	Lot 1, DP 1082596; Lots 1 and 2, DP 629708; Lot 1, DP 795046	Local	I58
Bathurst	Rankin Cottage	119 Rankin Street	Lot 11, DP 1087179	Local	I59
Bathurst	Terrace of cottages	164, 166 and 168 Rankin Street	Lots 1–3, DP 557358	Local	I60
Bathurst	The Tamarisks	361 Rankin Street	Lot 13, DP 592774	Local	I61
Bathurst	Art Deco apartments	106 Rocket Street	Lot H, DP 19315	Local	I305
Bathurst	Edwardian house	196 Rocket Street	Lot A, DP 158812	Local	I62
Bathurst	Bathurst Courthouse	160, 162 and 164 Russell Street	Lots 2, 3 and 5–7, Section 6, DP 758065	State	I63
Bathurst	Oakstead (formerly Presbyterian manse)	294 Russell Street	Lots 1 and 2, DP 513035	Local	I64
Bathurst	Delaware	320 Russell Street	Lot B2, DP 162336	Local	I65
Bathurst	Miss Traill's House (formerly All Saints Rectory, Entally or Wyoming)	321 Russell Street and 156 Peel Street	Lot 1, DP 112322; Lot A, DP 150593	State	I66
Bathurst	Bishops Court	226 Seymour Street	Lot 1, DP 1038289	Local	I307
Bathurst	Bicentennial, Ohkuma and Peace Parks, Macquarie River and Bathurst Flagstaff site	Stanley and William Streets	Lot 1, DP 126047; Lot 1, DP 126051; Lot 2, DP 1179068; Part road reserve (William Street)	Local	I67
Bathurst	House	60 Stewart Street	Lot 1, DP 741334	Local	I68
Bathurst	Machattie Park group	William Street	Part Lot 1, Section 6, DP 758065	Local	I69
Bathurst	Bathurst Bowling Club (former Police Barracks)	29 William Street	Lot 26, Section 72, DP 758065; Lot 1, DP 247981	Local	I70
Bathurst	Ambulance station	36 William Street	Lots 1 and 2, DP 1126067; Lot 3, DP 47260	Local	I71
Bathurst	Sidgreaves leadlight window shopfront	74 William Street	Part Lot 101, DP 792016	Local	I330

Bathurst	Commercial bank building	86 William Street	Lot 7, DP 602566	Local	I72
Bathurst	Sidgreaves leadlight window shopfront	100 William Street	Part Lot 1, DP 1170805	Local	I329
Bathurst	Cathedral of St Michael and St John and St Mary's School (former)	107 William Street	Part Lot 4, DP 1076699	State	I73
Bathurst	Royal Hotel	108 William Street	Lot 1, SP 72755	State	I74
Bathurst	Commercial building (former Commonwealth Bank)	116 William Street	Lot 1, DP 75330	Local	I75
Bathurst	House group	121, 125, 127 and 129 William Street	Lot 1, DP 150787; Lots 4 and 5, DP 876399	Local	I76
Bathurst	Commercial building (former AMP Society building)	126 William Street	Lot 1, DP 79955	Local	I77
Bathurst	Uniting Church and Chapel group (former Methodist Church)	140A and 140B William Street	Lots 1 and 2, DP 783440	Local	I78
Bathurst	Brooke Moore Centre (former Methodist parsonage and Brooke Moore residence)	142 William Street	SP 13030	Local	I79
Bathurst	Restaurant and residence	166A William Street	Lot 7, DP 666056; Lot 1, DP 530137	Local	I80
Bathurst	Oxford Hotel	170 William Street	Part Lot 18, DP 1137694	Local	I81
Bathurst	House (former Methodist parsonage)	205 William Street	Lots 1 and 2, DP 194438	Local	I82
Bathurst	Terrace cottages	208, 210, 212, 214 and 216 William Street	Lot 1, DP 744180; Lot 1, DP 1043075; Lot 11, DP 1110890; Lot 2, DP 1112500; Lot 1, DP 737817	Local	I83
Bathurst	House (formerly Morven)	219 William Street	Lot 1, DP 509777	Local	I84
Bathurst	The Lindens	227 William Street	Lot 1, DP 798720	Local	I85
Bathurst	Kennington	280 William Street	Lot 11, DP 793618	Local	I86
Bathurst	House (former Bishop's Court)	292 William Street	Lot 1, DP 542931	Local	I87
Bathurst	Holmhurst (former Catholic Presbytery and St Joseph's Orphanage)	306 William Street	Lot 11, DP 258529	Local	I88
Billywillinga	Feltimber	998 Freemantle Road	Part Lot 112, DP 862402	Local	I89
Brewongle	Cheriton (formerly school and residence) excluding 1970s addition and double garage	26 Brewongle School Road	Lot 148, DP 755784	Local	I90

Brewongle	Timber bridge (Asset ID E1000090)	8 Brewongle School Road	Part road reserve	Local	I316
Brewongle	Carlton	673 Brewongle Lane	Part Lot 2, DP 792926	Local	I91
Brewongle	Tregear (formerly Railway House)	752 Brewongle Lane	Part Lot 2, DP 736593	Local	I92
Brewongle	Westham	3118 O'Connell Road	Lot 31, DP 1090350	Local	I93
Brewongle	Private cemetery on The Grange	3249 O'Connell Road	Lot 1, DP 779403	State	I95
Brewongle	The Grange	3249 O'Connell Road	Part Lot 6, DP 880125	State	I94
Brewongle	Mayfield	3390 O'Connell Road	Lot 1, DP 783944	Local	I96
Brewongle	Leeholme Homestead and outbuildings	3664 O'Connell Road and 47 Tarana Road	Part Lots 601 and 602, DP 1186424	Local	I97
Brewongle	Brewongle stone bridge over creek	Tarana Road	Part road reserve	Local	I98
Brewongle	Brewongle road bridges, (3) over railway	Tarana Road	Part road reserve	Local	I99
Brewongle	Lockleigh	607 Tarana Road	Lot 143, DP 755784	Local	I100
Bruinbun to Hill End	The Bridle Track	From the cement bridge at Stony Creek to Beard Street, Hill End	Part road reserve	Local	I101
Caloola	Brownlea	678 Lachlan Road	Part Lot 271, DP 1169462	Local	I102
Caloola	Corrylea Cottage (ruin)	888 Lachlan Road	Part Lot 9, DP 727027	Local	I103
Caloola	Union Church and Cemetery	Trunkey Road	Lot 9, DP 1143484	Local	I105
Caloola	School house and residence (former)	2880 Trunkey Road	Lots 1– 4, Section 4, DP 758213	Local	I104
Caloola	Hardywood Park stone barn	3398 Trunkey Road	Part Lot 26, DP 750364	Local	I106
Clear Creek	Berrimibulla Cottage	280 Clear Creek Road	Part Lot 18, DP 755772	Local	I107
Clear Creek	Clear Creek House	281 Clear Creek Road	Part Lot 2, DP 1117707	Local	I108
Cow Flat	Cow Flat Copper Mine	737 Cow Flat Road	Lot 3, DP 616169	Local	I109
Duramana	Box Hill Cottage and outbuildings	70 Dingers Lane	Part Lot 64, DP 755771	Local	I110
Duramana	St Paul's Anglican Church	7 Glen Outram Lane	Lot 154, DP 755771	Local	I111
Duramana	Bondura Cottage and woolshed	250 The Bridle Track	Part Lot 11, DP 878592	Local	I112
Duramana	Leagar Cottage	375 The Bridle Track	Part Lot 1, DP 563296	Local	I113
Duramana	Stoney Creek Station Shearer's oven and chimney (ruin)	1028 The Bridle Track	Part Lot 106, DP 46495	Local	I114

Eglinton	Eglinton Memorial Hall	Alexander Street	Lot 88, DP 755779	Local	I115
Eglinton	St Luke's Anglican Church (former)	27 Alexander Street	Lot 1, DP 1041156	Local	I116
Eglinton	Blackdown Homestead and outbuildings	90 Eleven Mile Drive	Lot 22, DP 804072	Local	I117
Eglinton	Blackdown mill (former)	158 Eleven Mile Drive	Lot 21, DP 804072	Local	I118
Eglinton	Cangoura Homestead	310 Eleven Mile Drive	Part Lot 10, DP 1016481	Local	I119
Eglinton	Alloway Bank	346 Eleven Mile Drive	Lot 2, DP 855150	Local	I120
Eglinton	Kellosheil Creek stone bridge	Freemantle Road	Part Road Reserve	Local	I121
Eglinton	Eglinton Cottage	40 Hamilton Street	Lot 1, DP 1063138	Local	I122
Eglinton	Kellosheil Water Race	19, 49 and 93 Logan Street	Lot 202, DP 1061137; Lot 57, DP 1070902; Lot 1, DP 121519	Local	I123
Eglinton	Kellosheil	20 Mill Lane	Lot 1, DP 1074494	Local	I124
Eglinton	Westbourne Homestead	192 Mill Lane	Lot 6, DP 594198	Local	I125
Eglinton	Late Victorian Homestead	10 Todd Street	Lot 1, DP 1184970	Local	I126
Eglinton	Margan's House	43 Wellington Street	Lot 26, DP 264087	Local	I127
Evans Plains	Presbyterian Church (former)	849 Mid Western Highway	Lot 1, DP 134796	Local	I128
Evans Plains	Binalong (former university building)	1216 Mid Western Highway	Lot 1, DP 856795	Local	I129
Evans Plains	Timber bridge (Asset ID E1000135)	667 Ophir Road	Part Road Reserve	Local	I324
Evans Plains	Glenroy (former convent)	24 Stewart Street	Lot 102, DP 1156386	Local	I131
Evans Plains	Brooklyn Homestead (former post office)	48 Stewart Street	Lot 1, DP 112699; Lot 1, DP 256929; Lots 1-4, Section 9, DP 758719	Local	I130
Evans Plains	House (former shop)	65 Stewart Street	Lot 2 and Part Lot 1, Section 3, DP 758719	Local	I132
Fitzgerald's Valley	St Stephen's Anglican Church and cemetery	281 Fitzgerald's Valley Road	Lot 401, DP 1142284	Local	I133
Forest Grove	Memorial (migrant camp and war service training)	Limekilns Road	Lots 1-3, DP 813031; Part road reserve	Local	I134
Freemantle	Freemantle Woolshed and Meat House	98 McIntosh Road	Part Lot 15, DP 1093233	Local	I135
Gemalla	Timber bridge (Asset ID E1000131)	2305 Tarana Road	Part Road Reserve	Local	I317
Georges Plains	Mildura	128 Cow Flat Road	Lot 1, DP 878301	Local	I136
Georges Plains	Georges Plains Railway Station (former)	Rockley Street	Part Main Western Railway	State	I137

Georges Plains	St John's Anglican Church and Cemetery (former)	Trunkey Road and Saint Johns Road	Lots 1 and 2, DP 858464	Local	I138
Georges Plains	Native Home	1718 Trunkey Road	Part Lot 1, DP 536250; Part Lot 23, DP 750385; Part road reserve	Local	I139
Georges Plains	Vernacular Cottage	1840 Trunkey Road	Part Lot 202, DP 746028	Local	I140
Georges Plains	Grantham	1878 Trunkey Road	Lot 201, DP 1152878	Local	I141
Georges Plains	Dennis Island Methodist Church and Cemetery	2109 Trunkey Road	Lot 1 DP 996518	Local	I308
Georges Plains	Steel bridge over rail	Wimbledon Road	Adjacent to Lot 1, DP 1111324	Local	I326
Glanmire	Woodside (formerly Woodside Inn)	4823 Great Western Highway	Part Lot 141, DP 1144786	Local	I142
Gorman's Hill	Gorman's Hill Inn (former)	2 Dees Close	Lot 2, DP 881092	Local	I143
Gorman's Hill	St Vincent's Hospital	51 Gormans Hill Road	Lot 12, DP 1159190	Local	I144
Gorman's Hill	Merembra Homestead	218 Gormans Hill Road	Part Lot 141, DP 771779	State	I145
Gorman's Hill	Pair of semi detached houses	48 Lyal Street	Lot 2, DP 1100059	Local	I146
Gorman's Hill	Waterworks and Bathurst Pumping Station	Waterworks Lane	Part Lot 21, DP 1031789	Local	I147
Gowan	Gowan Homestead	28 Gowan Road	Part Lot 3, DP 576419	Local	I148
Hill End	Craigmoor	Beyers Avenue	Lot 116, DP 756905	State	I149
Hill End	Royal Hotel	4 Beyers Avenue	Part Lot 11, DP 1173182	State	I150
Hill End	Great Western Store	Tambaroora Street	Part Lot 2, DP 1173182	State	I151
Hill End	St Paul's Presbyterian Church	34 Tambaroora Street	Lot 8, Section 17, DP 758517	State	I152
Hill End	Post Office and residence	47 Tambaroora Street	Lot 5, Section 16, DP 758517	State	I153
Kelso	House (former Bell's residence)	4 Allambie Boulevard	Lot 1, DP 531750	Local	I154
Kelso	Holy Family School (former Marsden School)	French Smith Place	Lot 46, DP 1172067	Local	I155
Kelso	Woolstone	24 Gilmour Street	Lot 2, DP 841361	Local	I156
Kelso	Holy Trinity Church group (including Anglican Church, Rectory, Pioneer's Cemetery and Holy Trinity Church School Hall (former))	72, 75 and 81 Gilmour Street	Part Lot 1, DP 1114413; Lot 1, DP 650680; Lot 61, DP 816507	State	I157
Kelso	Rosemont	131 Gilmour Street	Part Lot 123, DP 1003224	Local	I158
Kelso	Reinforced concrete bridge (Asset ID	35 Lee Street	Part road reserve	Local	I323



	E1000231)				
Kelso	Littlebourne Homestead	4031 O'Connell Road	Lot 1, DP 867504	Local	I159
Kelso	The Wolery	7 Robinia Close	Part Lot 31, DP 874030	Local	I160
Kelso	Federation barn and farm house	525 Sofala Road	Part Lot 5, DP 244390	Local	I310
Kelso	Georgian House	4-8 Stephens Lane	Lot 190, DP 726958; Part Lot 103, DP 803065	Local	I161
Kelso	Kelsoville (formerly Alma's or Broombee)	30 Sydney Road	Lot 82, DP 789992	Local	I162
Kelso	Kelso Hotel	37 and 39 Sydney Road	Lot 1, DP 986783; Lot 4, DP 1186691; Lot A, DP 159217	Local	I163
Kelso	Kelso Post Office group, (including butcher's shop, post office and general store)	48, 54 and 58 Sydney Road	Lot 1, DP 738707; Lots 1 and 2, DP 571712	Local	I164
Kelso	Residence (formerly Catholic convent building collection)	67 Sydney Road	Lot 8, DP 555024	Local	I165
Kelso	All Nations Hotel (former)	138 Sydney Road	Part Lot 430, DP 1129240	Local	I166
Kelso	Victorian cottage	25 View Street	Lot 21, DP 583154	Local	I309
Killongbutta	Killongbutta (including homestead, woolshed, blacksmith's shop and family cemetery)	762 Killongbutta Road	Part Lot 37, DP 750409; Part road reserve	Local	I167
Kirkconnell	St Mary's Church and Cemetery	184 Sherwood Road	Lot 11, DP 1145959	Local	I168
Kirkconnell	Kirkconnell House	Sunny Corner Road	Part of DP 61171	Local	I169
Laffing Waters	Ardsley	62 Ardsley Lane	Part Lot 1, DP 977426	Local	I170
Limekilns	Sunny Bank Cottage	1775 Limekilns Road	Part Lot 49, DP 755780	Local	I171
Limekilns	Rosedale (formerly Rising Sun Inn)	2392 Limekilns Road	Part Lot 6, DP 755780	Local	I172
Limekilns	Limekilns Public School (formerly Clearvale School and residence)	2642 Limekilns Road	Lot 173, DP 755780	Local	I173
Limekilns	Dulcisvale House	2656 Limekilns Road	Part Lot 2, DP 1086051	Local	I174
Limekilns	Fernbrook marble quarry	281 and 369 Mount Horrible Road	Part Lot 123 and Part Lot 158, DP 755780; Part Lot 1, DP 1115961	Local	I175
Limekilns	Limekilns roasting pit	398 Mount Horrible Road	Part Lot 66, DP 755780	Local	I176
Llanarth	All Saints College (including Barton House, Esrom House and All Saints	70 Eglinton Road	Part Lot 134, DP 1174994	Local	I177

	Chapel)				
Llanarth	Ermington Park (formerly Excelsior)	78 Eglinton Road	Lot 41, DP 849516	Local	I178
Llanarth	Llanarth	120 Eglinton Road	Lot 3, DP 869491	State	I179
Locksley	Clifton house and former servant's accommodation	1371 Tarana Road	Part Lot 1, DP 251968	Local	I180
Mitchell	Bathurst Gaol and Residences	Browning Street	Part Lot 150, DP 750357	State	I181
Mitchell	Charles Sturt University and Agricultural Research Station (including dormitory block, administration block, Ponton Theatre, secretary's residence, brick farm buildings, WWII building, and original farm and farm school buildings)	Browning Street and 353 Panorama Avenue	Part Lot 236 and Part Lot 242, DP 750357; Part Lot 7323, DP 1156317	Local	I182
Mitchell	ADI site (former canteen building— small arms factory)	369 Stewart Street	Part Lot 2, DP 270264	Local	I311
Mitchell	Bunker (former)	379 Stewart Street	Lot 1, DP 134798	Local	I183
Mitchell	Bathurst Golf Club clubhouse	136 Vittoria Street	Lot 246, DP 750357	Local	I184
Mount Panorama	Stone cottage and garage	Brock's Skyline, McPhillamy Park	Part Lot 1, DP 634401	Local	I185
Napoleon Reef	Littleton Barn and former residence	213 Napoleon Reef Road	Lot 99, DP 755784	Local	I186
Napoleon Reef	Little Acres (formerly school and residence)	390 Napoleon Reef Road	Lot 155, DP 755784	Local	I187
O'Connell	O'Connell Public School (original building and residence)	15 Blacks Mill Lane	Lots 1 and 2, DP 797728	Local	I188
O'Connell	Police Station and residence (former)	17 Blacks Mill Lane	Lot 1, DP 799727	Local	I189
O'Connell	Euarra Homestead and observatory	3036 O'Connell Road	Part Lot 1, DP 186074	Local	I191
O'Connell	Milford House	80 Wambool Road	Part Lot 3, DP 869951	Local	I190
Orton Park	Orton Park	285 College Road	Lot 1, DP 854205	Local	I192
Orton Park	Rural Homestead	29 Lagoon Road	Part Lot 24, DP 998285	Local	I312
Orton Park	Rainham	720 Vale Road	Part Lot 37, DP 1173912	Local	I193
Paling Yards	Ulabri House and outbuildings (formerly school and residence)	383 Paling Yards Road	Lot 109 and Part Lot 162, DP 755780	Local	I194
Peel	Eloura	112 Church Street	Lot 2, DP 1116411	Local	I195
Peel	Mount Grosvenor Homestead	227 Rivulet Road	Part Lot 2, DP 745654	Local	I196

Peel	Peel General Cemetery	Sofala Road	Lot 1, DP 1119065	Local	I197
Peel	Brucedale Homestead and outbuildings	1361 Sofala Road	Part Lot 302, DP 1058673	Local	I198
Peel	Windradyne's Grave	1361 Sofala Road	Part Lot 1200, DP 1137225	State	I199
Peel	Roman Catholic Church (former)	1584 Sofala Road	Part Lot 2, DP 844536	Local	I200
Peel	St John the Evangelist Anglican Church	Wellington Street	Lot 7 and Part Lot 8, Section 12, DP 758833; Part Lot 8, DP 650677	Local	I201
Perthville	St Joseph's Convent	Bathurst Street	Lot 5, Section 15, DP 758840; Lots 5-7, Section 16, DP 758840; Lots 1, 2 and 8-12, Section 20, DP 758840; Lots 296, 322 and Part Lot 295, DP 750354	Local	I202
Perthville	Bridge Hotel (former Perthville Hotel)	1 Bridge Street	Part Lot 30, DP 1116694	Local	I203
Perthville	Gestingthorpe	122 Gestingthorpe Road	Part Lot 46, DP 605474	Local	I204
Perthville	Braeton (formerly The Pines)	214 Gestingthorpe Road	Part Lot 2, DP 881704	Local	I205
Perthville	Chatsworth	62 North Street	Lots 3 and 4, Section 2, DP 758840	Local	I206
Perthville	Bridge over Queen Charlottes Vale Creek (Asset ID E1000283)	5 Rockley Road	Part road reserve	Local	I318
Perthville	St Martin's Anglican Church	22 Rockley Street	Lot 2, Section 15, DP 758840	Local	I207
Perthville	Perthville School houses and residence	26 Rockley Street	Part Lots 3 and 4, Section 15, DP 758840; Part Lot 11, DP 619957	Local	I331
Perthville	Sutherwood	435 Rockley Road	Part Lot 3, DP 634400	Local	I208
Perthville	Hen and Chicken Inn (former)	Vale Road	Part Lot 31, DP 1100620	Local	I209
Perthville	Roselands	829 Vale Road	Part Lot 1, DP 875955	Local	I210
Perthville	Perthville Uniting Church	838 Vale Road	Lot 31, DP 1062363	Local	I211
Raglan	Violet Hill (former Springdale and Abbotsford)	5350 Great Western Highway	Part Lot 104, DP 1108551; Part Lots 39 and 70, DP 755781	Local	I214
Raglan	Raglan Well and Windmill (former travelling stock route)	71 Harris Road	Part Lot 2, DP 797296	Local	I212
Raglan	Raglan Railway Station	Main Western Railway		State	I213
Rock Forest	Rock Forest Station	1846 Ophir Road	Part Lot 801, DP	Local	I215

	Homestead		1119001		
Rockley	Club House Hotel and terrace of shops	2 and 4 Budden Street	Lot 1, DP 150217; Lot 1, DP 197238	Local	I216
Rockley	Rockley Mill Museum	12 Budden Street	Lot 1, DP 587037	Local	I217
Rockley	NSW AJS Bank (former), residence and stables	18 Budden Street	Lot B, DP 91290	Local	I218
Rockley	Bunnamagoo Homestead and shearing shed	573 Burruga Road	Part Lot 7, DP 258535	Local	I219
Rockley	Mayfield Cottage	5 Church Street	Lot A, DP 327589	Local	I220
Rockley	Rockley Police Station residence and lockup	6 Church Street	Lot 3, Section 6, DP 758884	Local	I313
Rockley	Post Office and residence (former)	12 Hill Street	Lot 1, DP 121082	Local	I221
Rockley	St Peter's Rectory	21 Hill Street	Lot 342, DP 787943	Local	I222
Rockley	Abercrombie Shire Council Chambers (former)	22 Hill Street	Lot 4, Section 6, DP 758884	Local	I223
Rockley	School of Arts Hall	28 Hill Street	Lot 1, DP 1124226	Local	I224
Rockley	Brewer's Cottage	Lagoon Road	Part Lot 3, DP 863442	Local	I225
Rockley	Corunna	78 Pepper Street	Lot 8, Section 17, DP 758884	Local	I226
Rockley	St Peter's Anglican Church	79 Pepper Street	Lot 343, DP 787943	Local	I227
Rockley	Calais Villa (former Roughley House)	9 Phantom Street	Lots 4–6, DP 1117658	Local	I228
Rockley	St Patrick's Catholic Church and Presbytery	12 Phantom Street	Lots 1 and 2, DP 1162050	Local	I229
Rockley	Culvert Bridge	Rockley Road	Part road reserve	Local	I230
Rockley	Eldan	2419 Rockley Road	Lot 2, DP 32383	Local	I231
Rockley	Pepper's Creek reinforced concrete bridge (Asset ID E1000204)	2436 Rockley Road	Part road reserve	Local	I319
Rockley	Northolme residence and garden	128 Triangle Flat Road	Lots 1–17, Section 26, DP 758884	Local	I232
Rockley	Rockley Cemetery	355 Triangle Flat Road	Lots 1–3, DP 724415; Lot 1, DP 1115701; Lot 7300, DP 1146659; Part road reserve	Local	I233
Sally's Flat	Sally's Flat Catholic Cemetery	2038 Hill End Road	Lot 127, DP 756878	Local	I234
Sofala	Courthouse (former)	1 Davis Street	Lot 1, DP 1074221	Local	I235
Sofala	Gold Commissioner's House (former)	11 Denison Street	Lots 1–4, DP 1008740; Lot 1, DP 659534; Lot 59, DP 758908	Local	I236
Sofala	Royal Hotel	26 Denison Street	Lot 38, DP 84154;	Local	I237

Lot 39, DP 758908

Sofala	Christ Church Anglican burial ground	10 Hargraves Street	Lot B, DP 367041	Local	I238
Sofala	Bridge over the Turon River	Hill End Road	Part road reserve	State	I239
Sofala	Sofala stone road bridges	Hill End Road	Part road reserve	Local	I240
Sofala	Sofala General Cemetery	Sofala Road	Lot 7027, DP 1028357	Local	I241
Sofala	Erskine flat burial ground (Sofala Catholic Cemetery)	Upper Turon Road	Part Lot 7309, DP 1123796	Local	I242
Sofala	Lavender Cottage (formerly Golding's Rest)	141 Upper Turon Road	Part Lot 3, DP 840607	Local	I243
Sofala	Pennyweight Cottage	374 Upper Turon Road	Lot 258, DP 755790; Part Lot 7012, DP 1051934	Local	I244
South Bathurst	Ethelton Cottage (including garden and outbuildings)	23 Ethelton Avenue	Lot 9, DP 603425	Local	I245
South Bathurst	Ben Chifley House (museum)	10 Busby Street	Lot 1, DP 870728	State	I246
South Bathurst	St Joseph's Mount	34 Busby Street	Part Lot 22, DP 1033481	Local	I247
South Bathurst	Glendower (late Victorian Italianate residence)	5 Lloyds Road	Lot 16, DP 709278	Local	I248
South Bathurst	All Hallows	40 Lloyds Road	Part Lot 2, DP 1167541	Local	I314
South Bathurst	Vehicular bridge over railway	Rocket Street	Part road reserve	Local	I249
South Bathurst	Victorian Railway Barracks	Vale Road	Lot 17, DP 1184045; Part railway land	Local	I250
South Bathurst	Farmer's Arms Hotel and stables (former)	27 Vale Road	Lot 1, DP 197242	Local	I251
Stewart's Mount	Strath	296 Ophir Road	Part Lot 1, DP 1170456	Local	I252
Stewart's Mount	Mount Stewart Private Cemetery	296 Ophir Road	Part Lot 1, DP 1170456	Local	I253
Stewart's Mount	Abercrombie House	311 Ophir Road	Lot 1, DP 533876	Local	I254
Sunny Corner	Sunny Corner Mine	Austral Street	Lot 7008, DP 1031145	Local	I255
Sunny Corner	Cottage	981 Bathurst Street	Lot 1, Section 25, DP 758935	Local	I256
Sunny Corner	Sunny Corner Cemetery	Dark Corner Road	Part Lot 7009, DP 1025720	Local	I257
Tambaroora	Tambaroora Roman Catholic Cemetery	Hill End Road	Lot 189, DP 756905	Local	I259
Tambaroora	Tambaroora General Cemetery (former Anglican cemetery)	Hill End Road and Sofala Street	Lots 1-3 and 6, Section 16, DP 758950	Local	I258
Tambaroora	Golden Gully and	Warrys Road	Portion M.T. 29	State	I306



	Archway		within Portion D.L. 1231, Parish Map of Tambaroora		
The Lagoon	The Lagoon	Lagoon Road	Lot 220, DP 750354; Lots 7008 and 7009, DP 1056537; Part road reserve	Local	I261
The Lagoon	Apsley House (former Lagoon Inn)	874 Lagoon Road	Lot 2, DP 807918	Local	I260
The Lagoon	School of Arts Hall	1011 Lagoon Road	Lot 1, Section 47, DP 758968	Local	I262
The Lagoon	Deep Creek stone arch bridge (Asset ID E1000180)	265 Ryans Road	Part road reserve	Local	I319
The Lagoon	The Lagoon Public School	71 Young Street	Lot 1, DP 1073091	Local	I263
The Rocks	Micklegate	29 Houses Lane	Lot 1, DP 999551	Local	I264
The Rocks	Bridge over Rocks Creek	Mitchell Highway	Part road reserve	Local	I265
The Rocks	Lorada	1322 Mitchell Highway	Lot 1, DP 871870	Local	I266
The Rocks	The Rocks (former inn)	1944 Mitchell Highway	Part Lot 91, DP 750414	Local	I267
Triangle Flat	Victorian Cottage	Redbank Road	Lot 136, DP 753032	Local	I269
Triangle Flat	Triangle Flat Catholic Cemetery	286 Triangle Flat Road	Lot 421, DP 1137215	Local	I268
Trunkey Creek	Grove Creek concrete and steel bridge (Asset ID E1000199)	2216 Bald Ridge Road	Part road reserve	Local	I320
Trunkey Creek	Trunkey Creek General Cemetery	Trunkey Cemetery Road	Lot 1, DP 1151032; Lot 1, DP 668411; Lots 1–4, DP 1155544; Lots 7325 and 7326, DP1158393; Part road reserve	Local	I270
Turondale	Turondale Cemetery	Turondale Road	Lot 17, DP 755800	Local	I271
Turondale	Church of the Holy Spirit Anglican Church	2831 Turondale Road	Lot 28, DP 755800	Local	I272
Turondale	Phoenix Station Cottage	2969 Turondale Road	Part Lot 83, DP 755800	Local	I273
Turondale	Coles timber bridge over Turon River (Asset ID E1000139)	3142 Turondale Road	Part road reserve	Local	I321
Upper Turon	Timber bridge (Asset ID E1000128)	1316 Red Hill Road	Part road reserve	Local	I322
Vittoria	Macquarie Woods Cottage	100 Cashens Lane	Lot 136, DP 750375	Local	I274
Vittoria	Bee Keeper's Inn (formerly Halfway House)	2319 Mitchell Highway	Lots 1, 2 and 7–10, Section 21, DP 759029; Lot 175, DP 750414; Lot 176, DP 1081051; Part road reserve	Local	I275
Walang	Green Swamp Inn	281 Walang Drive	Part Lot 184, DP	Local	I276

	(former)		1125708		
Wattle Flat	Wattle Flat Old General Cemetery	Limekilns Road	Lot 7300, DP 1131230; Lot 1, DP 1144147; Lot 1, DP 1144148	Local	I277
Wattle Flat	Little Oakey Mine remains	Sofala Road	Part Lot 315, DP 755790	Local	I279
Wattle flat	Solitary Mine	Sofala Road	Part Lot 7001, DP 1117443	Local	I278
Wattle Flat	Roman Catholic Cemetery	3787 Sofala Road	Lot 7303, DP 1131307	Local	I280
Wattle Flat	Anglican Cemetery and former Holy Trinity Church	3853 and 3855 Sofala Road	Lots 1 and 2, DP 850288	Local	I281
Watton	Watton shearing shed and school house (former)	1659 Freemantle Road	Part Lot 4, DP 247662	Local	I282
West Bathurst	Chifley Memorial Park	Bounded by Commonwealth Street and Kelly Crescent	Crown land	Local	I283
West Bathurst	Terrace houses	267 and 269 Browning Street	Lots 20 and 21, DP 192770	Local	I284
West Bathurst	Bathurst District Hospital (including Victorian building, excluding later additions and new buildings)	363 Howick Street	Lot 100, DP 1126063	State	I285
West Bathurst	Wastewater treatment works (treatment works shed only)	205 Morrissett Street	Part Lot 2, Section 51, DP 758065	Local	I286
West Bathurst	Steel and stone bridge	Vittoria Street	Part road reserve (near Bathurst Gaol)	Local	I325
West Bathurst	Bathurst General Cemetery	Vittoria and Dean Streets	Lot 2, DP 739615; Lot 1, DP 724311; Lot 1, DP 150416; Lot 7031, DP 94619; Lots 7020–7022, DP 1156866	Local	I287
West Bathurst	Catholic Chapel	Bathurst General Cemetery, Vittoria Street	Part Lot 7322, DP 1156866	Local	I328
White Rock	The Scots School (original Karralee buildings)	4173 O'Connell Road	Part Lot 1, DP 860563	Local	I288
White Rock	Wallaroi (formerly Claremont)	99 White Rock Road	Lot 1, DP 882809	Local	I289
White Rock	Group of 3 former Soldiers Settlers' cottages (including barn at 289 White Rock Road)	245, 257 and 289 White Rock Road	Part Lots 116 and 117, DP 755781; Lot 201, DP 791124	Local	I290
White Rock	Uniting Church and cemetery	567 White Rock Road	Lot 55, DP 1063035	Local	I291
White Rock	Rural homestead	772 White Rock	Lot 772, DP 1120744	Local	I315

		Road			
Wiseman's Creek	Mountain View Homestead and General Store (former)	279 Todds Road	Lot 51, DP 757039	State	I292
Wiagdon	Wyagdon	2868 Sofala Road	Part Lot A, DP 442813; Part Lot 1, DP 779247	Local	I293
Yarras	Yarras Homestead and Flour Mill (former)	97 Yarras Lane	Part Lot 1, DP 1105682	Local	I294
Yetholme	Macabee Cottage	187 Maccabees Road	Part Lot 1980 and Lot 1981, DP 1132213	Local	I295
Yetholme	St Paul's Church and Cemetery	Porters Lane	Lot 1, DP 1114188; Lot 2, DP 1114187	Local	I296
Yetholme	Brookland Park (former Bellevue Inn)	4 Porters Lane	Lot 21, DP 555967; Part Lot 1, DP 1127137; Part Lot 4, DP 755805	Local	I297
Yetholme	The Old Schoolhouse	16 Stafford Street	Lot 246, DP 755805	Local	I298

## Part 2 Heritage conservation areas

Description	Identification on <u>Heritage map</u>	Significance
Bathurst Conservation Area	Shown by a red outline with red hatching and marked "C1"	Local
Evans Plains Conservation Area	Shown by a red outline with red hatching and marked "C2"	Local
Hill End Conservation Area	Shown by a red outline with red hatching and marked "C3"	State
Kelso Conservation Area	Shown by a red outline with red hatching and marked "C4"	Local
Peel Conservation Area	Shown by a red outline with red hatching and marked "C5"	Local
Perthville Conservation Area	Shown by a red outline with red hatching and marked "C6"	Local
Rockley Conservation Area	Shown by a red outline with red hatching and marked "C7"	Local
Sofala Conservation Area	Shown by a red outline with red hatching and marked "C8"	Local
Trunkey Creek Conservation Area	Shown by a red outline with red hatching and marked "C9"	Local
Wattle Flat Conservation Area	Shown by a red outline with red hatching and marked "C10"	Local
West Bathurst Conservation Area	Shown by a red outline with red hatching and marked "C11"	Local



## Register of Native Title Claims Details

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### NC2016/002 - Warrabinga Wiradjuri #4

Tribunal file no.	NC2016/002
Federal Court file no.	NSD443/2016
Application name	Warrabinga Wiradjuri #4
State or Territory	New South Wales
Representative A/TSI body area(s)	New South Wales
Local government area(s)	Mid-Western Regional Council
Date filed	26/03/2016
Date claim entered on Register	29/04/2016

### Register extract and attachments

Register extract	<a href="#">RNTCExtract_NC2016_002.pdf</a>
Register extract attachment/s	<a href="#">NC2016 002 RNTC Attachment C Map of claim area.pdf</a>



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### NC2014/001 - Warrabinga Wiradjuri #3

Tribunal file no.	NC2014/001
Federal Court file no.	NSD1057/2014
Application name	Warrabinga Wiradjuri #3
State or Territory	New South Wales
Representative A/TSI body area(s)	New South Wales
Local government area(s)	Mid-Western Regional Council
Date filed	14/10/2014
Date claim entered on Register	30/04/2015

### Register extract and attachments

Register extract	<a href="#">RNTCExtract_NC2014_001.pdf</a>
Register extract attachment/s	<a href="#">Attachment C Map.pdf</a>





## Register of Native Title Claims Details

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### NC2011/006 - Gomeroi People

Tribunal file no.	NC2011/006
Federal Court file no.	NSD2308/2011
Application name	Gomeroi People
State or Territory	New South Wales;
Representative A/TSI body area(s)	New South Wales
Local government area(s)	Armidale Dumaresq Council, Coonamble Shire Council, Gilgandra Shire Council, Glen Innes Severn Shire Council, Gunnedah Shire Council, Guyra Shire Council, Gwydir Shire Council, Inverell Shire Council, Liverpool Plains Shire Council, Mid-Western Regional Council, Moree Plains Shire Council, Muswellbrook Shire Council, Narrabri Shire Council, Tamworth Regional Council, Upper Hunter Shire Council, Uralla Shire Council, Walcha Council, Walgett Shire Council, Warrumbungle Shire Council
Date filed	20/12/2011
Date claim entered on Register	20/01/2012

### Register extract and attachments

Register extract	<b>RNTCExtract_NC2011_006.pdf</b>
Register extract attachment/s	<b>NC2011_006 1. Map of the area covered by the application.pdf</b> <b>NC2011_006 2. Description of area covered by the application.pdf</b>

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Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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