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Review of Environmental Factors

Realignment of Sturt Highway at Sandigo (State Highway No 14)

Prepared for
RTA Technical Services
South Western Region

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Cover photo: Proposed route of new roadworks across Sandy Creek floodplain (Photo - Peter Ryan)

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1 Proposal Identification

Name:	Review of Environmental Factors – Realignment of Sturt Highway at Sandigo
RTA Region:	South Western Region
Local Government Area:	Narrandera Shire Council

2 Introduction

2.1 Introduction

The NSW Roads and Traffic Authority (RTA) proposes to realign the Sturt Highway (State Highway No 14) at Sandigo (the Proposal).

This Proforma 2 Review of Environmental Factors (REF) has been prepared by Environmental Technology Branch (RTA Operations Directorate) on behalf of the RTA South Western Region (RTA Project Services), in accordance with the RTA's Proforma 2 REF as presented in the RTA's *Environmental Impact Assessment Policy Guidelines Procedures, Version 4* (RTA, April 2001).

For the purpose of these works, the RTA is the proponent and determining authority under Part 5 of the *Environmental Planning and Assessment (EP&A) Act 1979*.

The purpose of this REF is to describe the Proposal, to document the likely impacts of the Proposal on the environment, and to detail mitigation measures to be implemented.

The description of the Proposal and the associated environmental impacts have been undertaken in the context of Clause 228 of the *Environmental Planning and Assessment Regulation* 2000, the *Threatened Species Conservation Act 1995* (TSC Act), the *Fisheries Management Act 1994* (FM Act), and the (Commonwealth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

In doing so, the REF helps fulfil the requirements of Section 111 of the EP&A Act that the RTA examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.

The findings of the REF would be considered when assessing:

- Whether the Proposal is likely to have any significant impact on the environment and therefore the necessity for an Environmental Impact Statement (EIS) under Section 112 of the EP&A Act.
- The significance of any impact on threatened species as defined by the TSC Act 1995 and the FM Act 1994, in Section 5A of the EP&A Act 1979 and therefore the requirement for a Species Impact Statement (SIS).
- Whether the Proposal is likely to have significant impacts on Matters of National Environmental Significance or Commonwealth lands, and therefore necessitate referral to the Commonwealth Minister for the Environment.

2.2 Background

The Sturt Highway connects Adelaide with the Hume Highway east of Wagga Wagga forming the major freight connection for South Australia and the Sunraysia District of Victoria with Sydney and the ACT. The link between Wagga Wagga and Narrandera is generally of minimum 100 km/h geometric standard with the one exception between 77km – 79km west of Wagga Wagga. This 2km section has a combination of substandard 300m radius reverse curves with

advisory speeds of 85km/h. The result of this combination has produced a section of highway that is inconsistent with travel conditions on the remainder of the route.

The substandard curves have caused an increase in the accident rate, especially for heavy vehicles. As a result of traffic incidents and concerns, additional advance signposting ('tipping truck' signs) have been installed at this location.

The proposed works are required to improve road safety for motorists, particularly for heavy vehicles, by straightening this section of Highway.

2.3 Methodology

The method in which this document has been prepared is as follows:

1. A site visit was held with the Project Manager on 11 July 2002 to discuss the Proposal and assess the site.

2. Consultation was undertaken with the following authorities and RTA personnel:

   - NSW Department of Land and Water Conservation (DLWC);
   - NSW Fisheries;
   - NSW National Parks and Wildlife Service (NPWS);
   - Narrandera Shire Council;
   - Rural Lands Protection Board;
   - Jim Porter, RTA South Western Regional Environmental Advisor (REA); and
   - Paul House, RTA Aboriginal Program Consultant.

3. Two property owners affected by the Proposal were consulted regarding route alternatives, the need for the Proposal, and impacts on agricultural activities.

4. Searches were conducted on the following databases for the purposes of the REF, to identify any potential issues:

   - Australian Heritage Commission's Register of the National Estate;
   - NSW Heritage Office State Heritage Register;
   - RTA's Heritage and Conservation Register;
   - Council Heritage Listings;
   - NSW NPWS Aboriginal Heritage Information Management System
   - NSW NPWS Wildlife Atlas;
   - National Native Title Tribunal, Native Title Search; and
   - Environment Australia's EPBC Act Database.

5. Reviews of the following documents were undertaken:

   - NSW Fisheries *Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures* 1999.
   - NSW EPA (2000) *NSW SoE, Report for Narrandera Council, River Health Assessed by Macroinvertebrate Assessment.*

6. A literature review and review of documentation was undertaken to determine issues relating to:

   - Local Environmental Plan zoning;
   - State Environmental Planning Policies; and
   - Regional Environmental Plans.

7. Assessment was undertaken in accordance with the *RTA Environmental Impact Assessment Policy, Guidelines and Procedures,* April 2001 and current RTA policies.

3 Proposal Description

3.1 Location

The Proposal is located within the Sandy Creek floodplain approximately 20km south-east of Narrandera (see Figure 1 and Appendix A air photo).

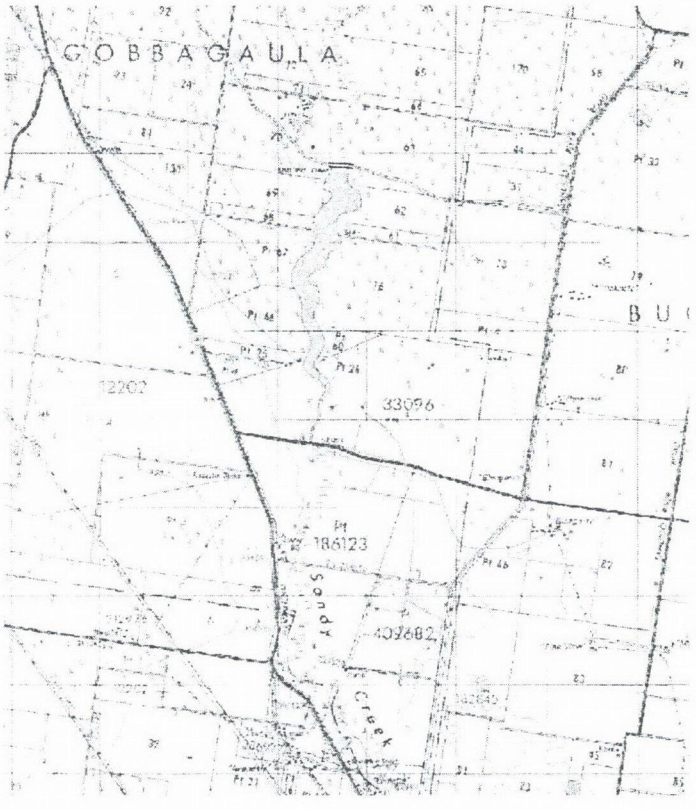


Figure 1: Proposal Site Location (at bend in road west of Sandy Creek)

Source: Data under licence from Pacific Access, 2002 (Not to Scale).

3.2 Description of the Site and Surroundings

The Proposal is located within the Narrandera LGA. Rural development occurs on both sides of the Proposal. The Proposal crosses the Sandy Creek freshwater floodplain including two constructed irrigation channels. The floodplain is approximately 365m wide (from creek bank to bank) where the new road would cross the floodplain. Sandy Creek flows into the Murrumbidgee River (see Appendix A - air photo, and Appendix B – Photographs).

The Proposal site is defined as the area between the existing Sturt Highway and the proposed new length of highway. The Proposal site (ie. works footprint) is shown defined in Appendix A. The Proposal would pass through floodplain wetland vegetation and remnant eucalypt vegetation. The majority of riparian vegetation has been cleared by agricultural practices and provides limited habitat value.

3.3 General Description of the Proposed Works

The new section of road would replace the "Sandigo Bends", an existing section of the Sturt Highway with a high accident rate. The new road would be located approximately 210m (maximum separation) to the north-east of the existing road (see Appendix A). The Proposal would be 1.36km in length, with two (2) 3.5m single carriageway lanes with a 2 to 3m road shoulder. The design travel speed would be 110km/h with a minimum radius of 750m to suit adjacent sections of the Sturt Highway. Access from the local road, Quilters Road, to the Sturt Highway would be provided via the existing north-west arm of the Sturt Highway. The south-

east arm of the existing highway would be handed over to the property owner (W. Anderson), as RTA would have no future need for this section of road. In summary, the Proposal would comprise:

- Placement of a rock layer, a blinding layer (a layer of 20mm nominally sized densely graded sub-base), geotextile material, then a fill/road-base material (25m width x 1.36km length).
- Excavation of two existing irrigation channels, and two culverts (1.2m diameter x 23m length) with headwalls installed at each channel, including backfilling.
- Two culverts (1.2m diameter x 23m length) would also be installed north of the irrigation channels.
- Cut batters at 2:1 (with table drain) and fill batters at 4:1 (2:1 behind guardrail).

The proposed pavement design across the floodplain from 78.3km - 78.65km is:

	14mm seal over 7mm primer seal
150mm	DGB 20
150mm	DGB 20
170mm	DGS 20
300mm	Select fill CBR>30%
1350mm	Fill
	Class B Geotextile(width of formation)
50mm	Blinding Layer (width of formation), MS 75 outside formation width.
500mm	Free draining rock layer - full width (125mm)
	Subgrade CBR of 1% Top 150mm stabilised with 3% hydrated lime, or Class B geotextile.

The proposed pavement design from 77.7km – 78.3km and 78.65km – 79.0km is:

	14mm seal over 7mm primer seal
150mm	DGB 20
150mm	DGB 20
170mm	DGS 20
300mm	Select Fill CBR>15% PI<12. Top 150mm to be lime stabilised with 2% hydrated lime unless the CBR of select is >30%
	Subgrade CBR (to be determined pending test results) Estimated 3%

DGB: 20mm nominally sized densely graded base
DGS: 20mm nominally sized densely graded sub-base
PI: Plasticity index
CBR: Californian Bearing Ratio
MS75: 75mm nominally sized macadem sub-base

3.4 Costs

The Proposal is estimated to cost $2.8 M based on the current design discussed in this REF.

3.5 Timing

The commencement date is proposed for March 2003 with all works to be completed by June 30 2003.

4 Statutory Requirements

4.1 Local Environmental Plan

The Proposal is located within the Narrandera Shire Council (NSC) Local Government Area (LGA). Land-use zonings relevant to the Proposal are outlined in the Narrandera Local Environment Plan (LEP) 1991. The relevant zonings are described in Table 4.1 below.

Location	Current Zoning
Entire Proposal site	1(a) General Rural Zone

Table 4.1: Relevant zonings from Narrandera LEP 1991.

In accordance with the LEP, road construction within zone 1(a) is permissible "Only with development consent". Therefore consent would be required from Council for the Proposal. The works would be also partially undertaken within "Flood liable land" as identified on the Narrandera Local Environmental Plan 1991 map (sheet 2). Road construction within flood liable land also requires the consent of Council.

The LEP adopts the EP&A Model Provisions, subject to the omission of the definitions of "arterial road" and "map" in clause 4(1). "Arterial road" means any existing road indicated on the map by a continuous red band on white between firm black lines. "Map" means the map which supports the LEP.

The Sturt Highway (State Highway No 14) is a "classified road" under the *Roads Act 1993*. The Sturt Highway therefore falls within the definition of "main road" in the EP&A Model Provisions, and not "arterial road" as described above. The Proposal would be located within the currently gazetted road reserve for the Sturt Highway.

There would no be no impact on heritage items listed in Schedule 1 "Heritage Items" of the LEP. The works are accordingly permissible under Schedule 1 (6) of clause 35(a) of the Model Provisions. Consent would not be required from Council for the Proposal.

4.2 Regional Environmental Plan (REP)

Willandra Lakes REP No 1 - World Heritage Property

The purpose of REP 1 is to protect, conserve and manage the World Heritage Property in accordance with any strategic plan of management. The plan also aims to provide a process of consultation with stakeholders on development and related decisions. Willandra Lakes are located approximately 270km west of Sandigo. Due to the large separation distance of the Proposal site and the REP site, the Proposal is does not compromise the aims and objectives of the REP.

Riverina REP No. 1

This plan covers land within a 16km radius of the proposed Australian Defence Communications Facility to be built near Morundah. Its purpose is to protect the operational effectiveness of the new facility. The facility would be located approximately 60km south of Sandigo. The Proposal does not compromise the aims and objectives of the REP.

4.3 State Environmental Planning Policies

SEPP 44 - Koala Habitat Protection

The provisions of SEPP 44 do not apply to proposals assessed under Part 5 of the EP&A Act.. However, the RTA voluntarily addresses SEPP 44 requirements to minimise potential impacts on koalas.

Narrandera local government area is listed in Schedule 1 of SEPP 44. The Proposal site contains River Red Gum (*Eucalyptus camaldulensis*) woodland, and potential koala (*Phascolarctos cinereus*) habitat. The Proposal would remove approximately 0.2 hectares of River Red Gum woodland. Surveys of the area did not identify resident populations of koalas and no recent sightings or historical records exist within the area. The only sightings of koalas in the region occur within Narrandera State Forest where a population has been relocated. The study area does not contain core koala habitat.

4.4 Confirmation of Part 5 Position

For the purposes of these works, the RTA is the proponent of the Proposal. All relevant statutory planning instruments have been examined for the Proposal. The works are permissible under Schedule 1(6) of clause 35(a) of the Model Provisions. Consequently, this Proposal is subject to environmental impact assessment under Part 5 of the EP&A Act. Consent would not be required from Council for the Proposal.

4.5 Licences, Approvals and Permits

The project would be constructed on land within the Sandy Creek floodplain (a prescribed stream). A total of 6ML (100,000L/day for 60 days) of water would be extracted from the irrigation channels, or from the Murrumbidgee River for earthworks compaction and dust suppression. Approval to extract water from the irrigation channels would be required from the Sandy Creek Water Users Association. Approval to extract water from the Murrumbidgee River would be required from DLWC at Leeton.

4.6 Protection of the Environment Operations Act, 1997

The *Protection of the Environment Operations Act* (PoEO) 1997, has repealed the following five Acts: *Clean Air Act* 1961, *Clean Waters Act* 1970, *Pollution Control Act* 1970, *Noise Control Act* 1975, and the *Environmental Offences and Penalties Act* 1989. The PoEO Act consolidates the above Acts and also incorporates the major regulatory and enforcement provisions of the *Waste Minimisation and Management Act* 1995. It is not anticipated that there would be any requirements, for the project, under this Act.

4.7 Commonwealth Environment Protection and Biodiversity Conservation Act, 1999

The Commonwealth environmental assessment process is conducted under the provisions of the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). Under this legislation, any action that:

- has a significant impact on a matter of national environmental significance (an NES matter); or
- has a significant impact on Commonwealth land,

requires Commonwealth environmental impact assessment and approval. If an action does not have one of these effects, it does not trigger the EPBC Act and assessment and approval is undertaken under NSW provisions only.

This assessment has been undertaken in accordance with the EPBC Act and shows that the Proposal is unlikely to have any impact (direct or indirect) on Commonwealth land or on a matter of NES. The Proposal would not require referral to the Federal Minister for the Environment, and approval would proceed under the NSW EP&A Act only.

5 Specialist Studies and Community Stakeholder Involvement

5.1 Specialist Studies

A flora and fauna ecological assessment was undertaken by Charles Sturt University in October/November 2002. A summary of that study is given in Chapter 9. The Flora and Fauna report is included as Appendix C.

5.2 Community and Stakeholder Involvement

The adjoining two (2) property owners were consulted during 2002 to discuss route alternatives, possible land acquisition, and the selection of the preferred option. Both owners verbally expressed an urgent need for the Proposal, as they often attend motor vehicle accidents, and both reported a number of near-miss accidents. Both owners expressed a preference for the preferred option which would have the least effect on their agricultural practices.

5.2.1 Consultation With Government Agencies and Stakeholders

Stakeholders were invited on 2 October 2002 to comment on the Proposal. A summary of issues raised by stakeholders, and the location where these issues are addressed in the REF is presented over the page.

Table 5.2: Government Authority Responses

Government Agency Comments	Section in REF where Addressed
National Parks and Wildlife Service	
A written response to the consultation letter was received on 4 October 2002. It had no concerns on the proposed works.	NA
Rural Lands Protection Board	
A written response to the consultation letter was received on 4 October 2002. It had no objection or comments on the proposed works.	NA
Narrandera Shire Council	
A written response to the consultation letter was received on 11 October 2002. Council made the following comments with regard to the proposed works:	
• The proposed realignment would place the Sturt Highway through the centre of what appears to be an area subject to flooding from the Sandy Creek. It is therefore advised that a flood study be undertaken of the area indicating the effect on the adjoining properties to the realignment as well as those in the immediate area both up and down stream of the proposed work site.	**Section 9.8**
• The two irrigation channels would be affected by the realignment and these facilities need to be identified and the methods explained as to how they would be retained.	**Section 3.3**
• There appears to be significant vegetation that would be removed from the area to permit the road realignment. The re-vegetation plan needs to be considered indicating how the site is to be rehabilitated.	**Section 9.11**
• Silt retention during and after construction would be a major concern in relation to Sandy Creek and measures need to be identified as to how this is to be addressed.	**Section 9.8**
• Due to the narrowing of Sandy Creek in this area as a consequence of the road works, Council recommends consultation with both adjoining land owners and as well as those both up and down stream in the immediate vicinity to ascertain any adverse impacts during periods of flooding.	**Section 2.3, 5.2**
• The existing roads that currently connect to the Sturt Highway would need to be realigned to enable connection with the new section of road. Council would like to know if the current section of Sturt Highway is to be disregarded or form part of the access system for these local property roads. Is this part of the Sturt Highway to be relegated to a local road status.	**Section 3.3**
• What is to happen to the residual land that would be located between the new alignment and the existing Sturt Highway? Whose ownership and responsibility would this parcel of land become?	**Section 3.3**
NSW Fisheries	
A response to the consultation letter was received on 3 October 2002. NSW Fisheries requested that the following issues be considered during preparation of the REF:	**Section 9.8, 9.11**
• Potential impact that the works would have on wetlands and the floodplain in the vicinity of the proposed works.	
• Potential impact that the new road alignment would have on the movement of flood flows and fish passage during these periods.	
• NSW Fisheries attached "NSW Fisheries Requirements for the Preparation of Environmental Planning and Assessment Documents".	
NSW Department of Land and Water Conservation (DLWC)	
A response to the consultation letter was received on 31 October 2002. NSW Fisheries requested that the following issues be considered during preparation of the REF:	**Section 9.8**
• DLWC had concerns about the effect of the new road location on localised flood levels, and that proper sediment erosion control measures were carried out before, during and after construction.	**Section 9.8**

6 Strategic Stage

6.1 General

The Proposal is in accordance with the RTA's mission to "manage road related transport infrastructure and provide safe and efficient access to the road network for the people of NSW".

Further, the RTA's environmental policy (June 2001) states that:

"The RTA will demonstrate due diligence in the provision of its services, manage its work activities in a manner that is consistent with the principles of ecologically sustainable development, and will deliver continuous improvement in environmental performance."

The Proposal has been designed to be consistent with the principles of ecologically sustainable development, by minimising impacts on the environment through the use of mitigation measures.

6.2 Justification and Need for the Proposal

The 2km section of the Sturt Highway at Sandigo ("Sandigo Bends") has substandard 300m radius reverse curves which has produced unsafe travel conditions, especially for heavy vehicles. As a result of incidents and concerns, additional advance signposting ('tipping truck' signs) have been installed at this location. The proposed works are required to improve road safety for motorists, particularly for heavy vehicles, by straightening this section of Highway.

7 Concept Stage

7.1 Objectives of the Proposal

The objective is to realign Sandigo Bends to current Ausroad standards, which would improve road safety for motorists, particularly for heavy vehicles.

7.2 Options Considered

Five options were considered during the project concept development (refer to Appendix D for more details).

Do Nothing Option

This option would not improve road safety. Current inadequate safety levels would persist. The other four options are presented below.

Road alignment options (green, red, blue, black) can also be viewed in Appendix A.

Option A (Green)	*Option B (Red)*	*Option C (Blue)*	*Option D (Black)*
Length 2.03km	Length 2.30km	Length 2.03km	Length 1.36km
OBJECTIVE: provides a road constructed to 110km/h design speed and consistent with existing travel conditions on the adjacent sections of the highway			
Yes	Yes	Yes	Yes
OBJECTIVE: improves road safety			
Reverse curves radii remain but radii increased to 750m Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	*Reverse curves radii remain but radii increased to 750m* Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	*Reverse curves radii remain but radii increased to 750m* Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	Eliminates reverse curves Straightest alignment providing optimum sight distance for overtaking Quilters Road intersection located on a straight with optimum sight distance
OBJECTIVE: provides a road that is flood free			
Yes	Yes	Yes	Yes
OBJECTIVE: provide value for money in terms of road user benefits			
Construction Costs $1.95m *(excl. contingency)* $2.74m Net Present Value $2.75m BCR 2.4	Construction Costs $2.14m *(excl. contingency)* $3.0m Net Present Value $2.5m BCR 2.2	Construction Costs $1.95m *(excl. contingency)* $2.74m Net Present Value $2.75m BCR 2.4	Construction Costs $1.98m *(excl. contingency)* $2.79m Net Present Value $4.3m BCR 3.2
OBJECTIVE: has minimal impact on the flood plain of Sandy Creek			
No impact	No impact	No impact	Minimal impact *Sufficient culverts would be provided to have minimal effect on flooding*
OBJECTIVE: minimises adverse impacts on improved agricultural land			
Approx. 7ha of acquisition from irrigated paddock and 1.5ha unusable residue. One dam to be relocated	Approx. 7ha of acquisition from wheat and irrigated paddock. One dam to be relocated	Approx. 7ha of acquisition from wheat paddock	No impact

Option A (Green)	*Option B (Red)*	*Option C (Blue)*	*Option D (Black)*
OBJECTIVE: affect on improved agricultural land to be shared equally between property owners			
No *All from one owner*	Yes	No *All from one owner*	No *All from one owner*
OBJECTIVE: minimises adverse impacts upon the environment			
Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts on swamp vegetation, hydrology and flooding in Sandy Creek.*
OBJECTIVE: ensures affected landowners are aware of the project, are consulted and have input opportunities throughout the project			
Yes	Yes	Yes	Yes
OBJECTIVE: improves the movement of stock between properties located on the highway			
Minimal *Stock would still use highway to travel between properties. Sight restrictions would exist due to curve obscuring stock.*	Minimal *Stock would still use highway to travel between properties. Sight restrictions would exist due to curve obscuring stock.*	Minimal *Stock would still use highway to travel between properties. Sight restrictions would exist due to curve obscuring stock.*	Yes *Stock would still use old highway to travel between properties with only a short length of travel on the new highway.*
OBJECTIVE: has minimum impact on the existing irrigation channels			
Yes	Yes	Yes	Yes *Irrigation channels would need to be piped under new road*
OBJECTIVE: minimises construction problems			
Minimal Likely impact on Telstra, water and fibre optical cable	Minimal Likely impact on Telstra, water and fibre optical cable	Minimal Likely impact on Telstra, water and fibre optical cable	Minimal No impact on utilities however, does require a rock layer over floodplain

Option D - Preferred Option

Option D is the best performing option in terms of the majority of project objectives. It is consistent with travel conditions on the adjacent sections of highway and provides the optimum sight distance for overtaking and for vehicles entering the Highway from Quilters Road.

The economic performance is superior, largely due to the savings in vehicle operating costs of the shorter alignment.

The option has no impact on "improved" agricultural land and is the preferred alignment of the affected landowners. It provides the safest route for moving livestock from Quilters Road onto the highway, by removing the reverse curves that obscure livestock from motorist's view on the highway.

This option has potential impacts on the environment of the Sandy Creek floodplain, including impacts on wetland and riparian vegetation, fauna, water quality, hydrology and flooding. Of all the options, this option has the greatest impact on the environment. Mitigation measures would be implemented to minimise/manage these environmental impacts as much as possible. The Concept Design is provided in Appendix E.

8 Design Considerations

8.1 Existing Infrastructure

Existing Road: The existing road is a two lane single carriageway, posted at a 85km/h speed limit in the vicinity of the Proposal. Sturt Highway beyond Sandigo bends has a posted 110km/h speed limit.

Traffic movements in the area of the Proposal include northbound and southbound travel on the Sturt Highway which connects Adelaide with the Hume Highway east of Wagga Wagga, forming the major freight connection for South Australia and the Sunraysia District of Victoria with Sydney and the ACT.

One (1) landholder on the south-west side of the Sturt Highway gains access to the highway from Quilters Road. Another landholder gains access to the highway south-east of the Proposal area. Property access would be maintained at all times during construction.

Existing Traffic: Existing traffic in the area of the Proposal consists of a mix of light and heavy vehicle traffic. The following recorded data have been used as the basis for design considerations, and are actual vehicles numbers:

- AADT Light vehicles - 1,380 (2000)
- AADT Heavy vehicles - 520 (2000)
- AADT Total - 1900

Forecast Traffic: Forecast traffic is as follows:

Year	2002	2012	2022	2032
• Light	1450	1890	2250	2690
• Heavy	550	710	850	1010
• AADT	2000	2600	3100	3700

The realignment of the Sturt Highway is not expected to generate any new traffic.
Note: AADT = annual average daily traffic

8.2 Design Parameters

Based on the Preferred Option Report, this Proposal would include the following:

- Realignment of Sturt Highway at Sandigo (1.36km length).
- Placement of a rock layer, a blinding layer (a layer of 20mm nominally sized densely graded sub-base), geotextile material, then a fill/road-base material (25m width x 1.36km length).
- Pavement construction along the new realignment.
- The existing two irrigation channels would be excavated and two culverts (1.2m diameter x 23m length) with headwalls installed at each channel, including backfilling. The existing two irrigation channels are each approximately 10m wide and 2m deep.
- Two culverts (1.2m diameter x 23m length) would also be installed north of the irrigation channels.
- Batter slopes would be topsoiled and grassed.

8.3 Design Outcomes

The outcomes for this Proposal would be:

- Straightening of the Sturt Highway at Sandigo Bends to enable the current travel speed of 85km/h to be raised to 110km/h to suit adjacent sections of the Sturt Highway.
- Access from Quilters Road to the Sturt Highway would be maintained via a north-west link.
- Improved road safety.

8.4 Constraints

The Proposal has the following constraints:

- Road construction within a wetland environment (ie. soft ground).
- Impact of Proposal on floodplain environment.
- Requirements for the maintenance of access to neighbouring properties.
- Statutory environmental obligations.
- Development and pre-construction activities to be completed within the approved time schedule.

8.5 Property & Access

Land uses other than road transport in the immediate vicinity of the Proposal are limited to agricultural activities. All land in the vicinity of the Proposal is zoned general rural. The nearest rural residence is located 400m south of the Proposal. The new road would cross over two irrigation channels on the north-east side of the Sturt Highway.

One (1) landholder on the south-west side of the Sturt Highway gains access to the highway from Quilters Road. Another landholder gains access to the highway south-east of the Proposal area. Property access would be maintained at all times during construction.

8.6 Utilities

Existing utilities in the vicinity include Telstra, water and fibre optical cables. The Proposal would cause no impact on these utilities.

8.7 Stockpile and Compound Sites

The site compound (approximately 0.5ha) would be located within the works footprint (see Appendix A), and mitigation measures would be addressed in the contractor's EMP. The site compound would include ancillary items such as stockpiles and works compounds. On-site temporary works facilities with the Proposal would include a site office, equipment/plant compound area, and materials stockpile sites. All storage and plant maintenance areas would be bunded. The site would be located within the road reserve and no vegetation removal would be required. Should the proposed compound or stockpile sites be located outside of the works footprint, the Regional Environmental Adviser, South Western Region, would be contacted regarding the need for further environmental assessment.

Environmental criteria that would be considered when choosing any alternative site are provided below:

- More than 50 metres from waterways.
- Low conservation significance for flora, fauna and indigenous or non-indigenous heritage.
- Minimum clearing of native vegetation.

- Where possible located in areas previously disturbed.
- More than 250m from residential uses or other activities that may be affected by operational noise or other impacts of construction plant.

8.8 Construction Activities

The Proposal would involve the following activities. Some of the activities would overlap during certain stages of construction:

- Introduction of mitigative measures as outlined in the Environmental Management Plan (EMP) and Erosion and Sedimentation Control Plan (ESCP).
- Establishment of site compounds, stockpile sites, work areas, and boundary fencing.
- Clear vegetation and grubbing (2.2ha), salvage and relocate microhabitat features such as any tree hollows and stumps, and stockpile any material suitable for revegetation.
- Install culverts.
- Import rock mattress across floodplain.
- Import fill, sub-base, and base, compact in layers and test.
- Primer seal and open to traffic.
- Respread topsoil on embankment batters.
- Progressive stabilisation and revegetation of disturbed areas.
- Provision of guard fence and linemarking.

The Proposal would also involve the following associated activities and controls:

- Suitable traffic management controls would be implemented during the construction period and traffic would use the existing roadway.
- A site compound, including amenities and a site office, would be required.
- It is anticipated that utilities would not be affected by the Proposal however, confirmation would be made by ringing "dial before you dig" prior to construction being undertaken.

Installation of culverts: Construction of a temporary dam may be required at the two irrigation channels to enable dewatering of the work sites. The foundation would most likely require excavation to firm base, at 150mm below the base of the culvert. The base of the irrigation culverts would be positioned to provide for water flow when Sandy Creek water levels are low.

Earth Materials: The Proposal would necessitate the excavation of 210m^3 of soil. Excavated soil would be used for fill purposes and/or in rehabilitation works. Fill material (29,912m^3), rock layer (4,480 m^3), clay (13,827m^3), and topsoil (3,916m^3) would be required to construct the road.

The source of earthworks material would be determined by the contractor, using existing quarries. The most likely source of material would be from Wrights Pit operated by Narrandera Shire Council, located approximately 5km east of the Proposal site. Other potential sources include Millbrae Quarry (5km one way), a quarry at Leeton (40km one way), and Walleroobi Quarry (100km one way). Transport of earthworks material would increase traffic on highways but this would be within the capacity of the existing road network. Loads would be covered to minimise dust and spillage. Pavement material would be sourced from Wagga Wagga or other nearby sites.

Truck Movements: The supply of materials for construction of the new road would require up to 25 additional truck movements per day. However during peak construction periods it is expected this could be 30 additional truck movements per day.

Hours of construction: Hours would be between 7am to 6pm Monday to Friday, and 8 am to 1 pm Saturday. No activities would be undertaken on Sunday or on Public Holidays. If the contractor seeks approval to work outside the above standard hours, this would be at the discretion of the RTA's Superintendent.

8.9 Construction Equipment

The work would involve standard road construction earthmoving activities using bulldozers, scrapers, excavators, front-end loaders, vibratory rollers, graders and haul trucks, and standard pavement construction activities and service vehicles.

8.10 Workforce

The workforce required to undertake the works is estimated at 15 to 20 personnel.

8.11 Demand on Resources

The Proposal would necessitate the excavation of 210m^3 of soil. Excavated soil would be used for fill purposes and/or in rehabilitation works. Fill material (29,912m^3), rock layer (4,480 m^3), clay (13,827m^3), and topsoil (3,916m^3) would be required to construct the road. The Proposal would require the consumption of diesel and petrol for excavation/material placement works and transport of earth materials.

Water would be pumped from irrigation channels within the Sandy Creek floodplain. The Proposal would extract a total of up to 100,000ML of water (6ML/day x 60 days).

9 Environmental Assessment

9.1 Biodiversity

Johnstone Centre – Charles Sturt University were engaged to undertake an ecological survey of the Proposal site. Thorough habitat assessment and flora/fauna and aquatics investigations were undertaken. For further detail on the flora and fauna survey refer to the full report located in Appendix C of this REF.

Existing Situation

The Proposal site is defined as the area between the proposed new road and the existing Sturt Highway (see Appendix A).

9.1.1 Flora

Survey Methodology

Line transects of the proposed route were undertaken. The entire length of the site was traversed to ensure a comprehensive coverage. Plants were either identified on site or collected for later identification.

Results

A total of 73 species were identified during the flora surveys. A total of two native trees and six native sub-layer shrub species were identified within the Proposal Site. Three vegetation communities were identified on the Proposal Site: mixed grassland, River Red Gum woodland and ephemeral wetland.

Mixed grassland

The mixed grassland is of low conservation value. This vegetation community occurs throughout the region and is derived from the clearance of Grey Box and River Red Gum woodland. A total of 39 flora species were identified within the mixed grassland community, including a mix of introduced and native ground cover species. The species recorded included two native tree species, Grey Box (*Eucalyptus microcarpa*) and River Red Gum (*Eucalyptus camaldulensis*) and six native sub-layer shrubs including Berry Saltbush (*Atriplex semibaccata*), Climbing Saltbush (*Einadia nutans*), Black Cotton-bush (*Maireana decalvans*) and Black Roly-poly (*Sclerolaeana muricata*).

The canopy cover is less than 1% with only a small number of scattered Grey Box and River Red Gum present. The community contained one mid-stratum layer comprised of the six native sub-layer shrub species listed above. The ground covers were composed of a number of species including White Top (*Austrodanthonia caespitosa*), Plains *Grass (Austrostipa aristoglumis*), Rough Spear-grass (*Austrostipa scabra ssp. falcata*), Wild Oat (*Avena fatua*) and Great Brome (*Bromus diandrus*). Overall 45%of the species identified in this vegetation community were introduced. Approximately 3.2 hectares of mixed grassland occurs within the Proposal Site.

River Red Gum

The River Red Gum woodland is of low conservation value for the region given its lack of interconnection, low number of hollow bearing trees and degraded understorey. A total of 35 species were identified in the River Red Gum woodland, including one native tree species, River Red Gum, one native epiphytic species Box Mistletoe (*Amyema miquelii*) and two native sub-layer shrubs: Berry Saltbush (*Atriplex semibaccata*) and Black Roly-poly (*Sclerolaeana muricata*). The River Red Gum woodland is located on the outer perimeter of the wetland.

River Red Gum was the dominant canopy species and within the three stands identified averaged approximately 20 percent cover. The community contained a sparse mid-stratum layer of Berry Saltbush and Black Roly-poly. The ground was covered in low to moderate amounts of leaf litter and a patchy mosaic of ground covers including White Top, Tufted Burr-daisy (*Calotis scapigera*), Paterson's Curse (*Echium plantagineum*) and Rigid *Panic (Homopholis*

proluta). Overall 43 percent of the species identified in the River Red Gum woodland community were introduced.

A census of hollow bearing trees within the Proposal Site identified only three hollow bearing trees (1 Grey Box, 1 River Red Gum, 1 Stag) within 15 metres of the Proposed realignment centre line. A further 52 young River Red Gum trees not containing hollows also occur within this area. These 55 trees within the Proposal Site may need to be removed as part of the Proposal. Approximately 0.2 hectares of River Red Gum occurs within the Proposal Site.

Ephemeral wetland

The wetland is a natural feature but has been regularly inundated by irrigation supplies and is of moderate conservation value for the region as it supports a diverse range of fauna. A total of 30 species were identified in the ephemeral wetland, 36 percent of species being introduced. River Red Gum was the only canopy species recorded and only occurred as isolated trees.

The wetland community was dominated by Common Rush (*Juncus sp*), particularly in sections of the wetland that undergo minor inundation. The wetland contained a number of open water areas the perimeter of which contained a mixture of Common Rush, *Buttercup (Ranunculus undosus*) and Ribbed Spike-Rush (*Eleocharis plana*) with a transition to Tall Spike-Rush (*Eleocharis sphacelata*) as water depth increased.

A number of emergent species were identified in the open water areas: Broad-leaved Cumbungi (*Typha orientalis*), Milfoil (*Myriophyllum sp.*), Ribbon Weed (*Triglochin procerum*), Wavy Marshwort (*Nymphoides crenata*) and Floating Pondweed (*Potamogeton tricarinatus*). The two irrigation channels are approximately two metres deep and littoral zones are dominated by Tall Spike-Rush. Approximately 1.1 hectares of wetland occurs within the Proposal Site and a further 2.5 hectares of wetland would be fragmented from the current depression by the realignment.

Threatened Flora

Species recorded in the area that are listed as threatened under the *NSW Threatened Species Conservation Act, 1995* (TSC Act) are presented in Appendix C. While there are 4 flora species listed that have a range that extends over the Proposal site, only Western Starwort (*Callitriche cyclocarpa*) has been recorded within five kilometre radius of the Proposal Site. Western Starwort was not present within the Proposal site.

The eight part test was applied to the threatened species, Western Starwort (Appendix C). The assessment indicated that the Proposal would not impact significantly upon this species, and that a Species Impact Statement (SIS) is not required.

No threatened plant species listed under the EP&BC Act 1999 were recorded on the site and none are expected to occur, as the habitat is unsuitable. There are no Threatened Populations or Ecological Communities present.

Impacts

The removal of approximately 3.2 hectares of mixed grassland would not have a significant impact upon vegetation within the local area or region given the magnitude of the clearance and the modified nature of the community.

Approximately 0.2 hectares of River Red Gum woodland would be removed by the Proposal, consisting of one hollow bearing tree, one stag and up to 52 trees without hollows. This loss of woodland to the region and local area is minor and would not significantly impact this community in the region and local area.

The Proposal would result in the removal of approximately one hectare of wetland community and a further isolation of 3.2 hectares of wetland that would be separated from the irrigation flows in Sandy Creek. Therefore a total of 4.2 hectares of wetland community would be impacted by the Proposal. A further 16 hectares of interconnected wetland occurs to the north of the Proposal Site, and contains more diverse habitat than that which exists within the Proposal site. This habitat is also common along the secondary floodplains of the

Murrumbidgee catchment in the region where irrigation flow frequently inundates natural depressions. The impact of the Proposal would not significantly impact upon the wetland vegetation community in the region or local area.

During construction, impacts may occur on the water quality of Sandy Creek floodplain and on aquatic vegetation, from increased sedimentation and from disturbance of the irrigation channels. The area of Juncus sp. that would remain between the realigned highway and the open water areas of the wetland would provide a substantial buffer to pollutants, noise and predators. *Juncus sp.* would regenerate rapidly following disturbance. Weed invasion within this regularly inundated wetland would be minor.

Impacts on flora are expected to be short term. Flora are likely to be effected by:

- Sedimentation of the irrigation channel, creek and wetland from runoff, which may result in decreased light penetration through the water column essential for aquatic plant growth.
- Removal of aquatic vegetation and emergent vegetation.
- These impacts would be minimised by appropriate mitigation measures detailed below.

Proposed Safeguards

Flora controls would be undertaken in accordance with the specifications set out in **Section 6.9** of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would also be required as part of the Proposal:

- A Sediment and Erosion Control Plan would be implemented to reduce the likelihood of increased turbidity and sedimentation.
- The embankment would be sufficiently stabilised with sterile annual grasses and endemic native species to help reduce the risk of erosion and sedimentation.
- Any imported fill used would need to be free of weed propagules.
- Impacted wetland and River Red Gum woodland would be rehabilitated and replanted using propagated ephemeral, terrestrial and aquatic species from the local area.
- The extent of clearing and disturbance to native vegetation would be kept to a minimum within the road reserve so that impact on flora and fauna is restricted.
- In response to the removal of native vegetation and disturbance of topsoil, a revegetation program would be undertaken.

River Red Gum woodland

- Tree planting at a ratio of ten trees to every one removed would be undertaken to compensate for the loss of River Red Gum and Grey Box. Equal numbers of shrubs to trees would be planted.
- Shrub planting would include Sweet Bursaria (*Bursaria spinosa*), Dwarf Cherry (*Exocarpus strictus*), Willow Wattle (*Acacia salicina*), Eumong (*Acacia stenophylla*) and Silver Wattle (*Acacia dealbata*).
- Ground cover would include Plains Grass (*Austrostipa aristoglumis*), Warrego Summer Grass (*Paspalidium jubiflorum*), Wallaby Grass (*Austrodanthonia caespitosa*) and Sedge (*Carex appressa*).
- Plant species suitable for the revegetation program are listed in Appendix C (Table 7).

Wetland community

- If open water areas in close proximity to the Proposal Site (50 metres) are disturbed, they would be vegetated using emergent and floating aquatic species.
- If open water areas in close proximity to the Proposal Site (50 metres) are disturbed, they would be vegetated using emergent and floating aquatic species.

- The aquatic plants to be included in the revegetation plan would include Ribbed Spike-Rush (*Eleocharis plana*), Tall Spike-Rush (*Eleocharis sphacelata*), *Pondweed (Potamogeton tricarinatus*) and Water Ribbons (*Triglochin procerum*). These species would be planted slightly under the water line, and if available, seed and rhizomes would be spread back up the bank to full bank height.
- Ground covers would include Tussock Grass (*Poa labillardieri*) and Sedge (*Carex appressa*).
- If the irrigation channels are disturbed, they would be rehabilitated immediately to minimise erosion.
- Plant species suitable for the revegetation program are listed in Appendix C (Table 7).

Grazing

- If possible, and following negotiation with the land holder, revegetation areas would be excluded from grazing until the trees and shrubs are well established. The management of grazing within the floodplain habitat would encourage the establishment of native grasses and suppress weed species.
- Grazing impact would be monitored during the period when the animals have access to the replanting area. This would enable the program to assess whether grazing intensity is too high or too low, and to move stock before vegetation degradation becomes a problem.

Monitoring

- Revegetated areas would be monitored every two months for the first six months, and then every 6 months for two years. Monitoring would assess establishment success, weed abundance and grazing impacts.
- If revegetation works are deemed to be unsatisfactory, remedial action would be taken to ensure that revegetation works are successfully implemented.

9.1.2 Fauna

Survey Methodology

A preliminary survey of the site was conducted to identify different habitat types and suitable locations for traps and other survey points. A number of methods were used to identify resident fauna on the Proposal site. A survey was undertaken to assess the presence of nocturnal and arboreal mammals, microchiropteran bats, amphibians and reptiles.

The assessment of aquatic habitat was undertaken in accordance with the NSW Fisheries *Aquatic Habitat Management and Fish Conservation Guidelines - Minimum Information Requirements for Aquatic Environmental Assessment 1999*. The assessment included descriptions of aquatic and ephemeral habitat availability, lists of finfish and macroinvertebrate species present or likely to be present. The assessment of species presence included sampling macroinvertebrate communities within the Proposal Site and within a control site. No fish survey was undertaken, as it was not deemed necessary due to a lack of potential fish habitat.

Results

Avifauna was the most common fauna group observed, with 47 species recorded during the surveys. Ten mammal, three reptile, two fish, five amphibian and seven bat species were also recorded.

Two threatened fauna species, the superb parrot (*Polytelis swainsonii*) and grey-crowned babbler (*Pomatostomus temporalis*), were identified during the survey period. Common bird species observed during the survey included eastern rosella (*Platycercus eximius*), australian magpie (*Gymnorhina tibicen*), golden-headed cisticola (*Cisticola exilis*), galah (*Cacatua roseicapilla*) and purple swamphen (*Porphyrio porphyrio*).

Five frog species were recorded during the survey and included the eastern froglet (*Crinia parinsignifera*), eastern banjo frog (*Limnodynastes dumerili*), barking frog (*Limnodynastes fletcheri*), spotted grass frog (*Limnodynastes tasmaniensis*) and peron's tree frog (*Litoria peronii*). Three tree

reptiles were also identified: boulenger's skink (*Morethia boulengeri*), red-bellied black snake (*Pseudoechis porphyriacus*) and brown snake (*Pseudonja textelis*).

Mammals identified included swamp wallaby (*Wallabia bicolor*), eastern grey kangaroo (*Macropus giganteus*), common brushtail possum (*Trichosurus vulpecula*), rabbit (*Oryctolagus cuniculus*), feral cat (*Felis catus*) and fox (*Vulpes vulpes*).

Bat species (*Nyctophilus gouldi, Vespedelus regulus, Vespedelus vulturnus*) were captured in harp traps during the survey, and the white striped mastiff bat was heard calling above the canopy. bat calls recorded using ultrasonic bat detection methods identified a further four species of bat, the little pied bat (*Chalinolobus picatus*), which is a threatened species, *Chalinolobus gouldii, Mormopterus sp.* and the inland broad-nosed bat (*Scotorepens balstoni*).

Carp (*Cyprinus carpio*) and mosquito fish (*Gambusia affinis*) were observed during surveys. Three threatened species of fish are listed for the region encompassing the Proposal site: silver perch (*Bidyanus bidyanus*), trout cod (*Maccullochella macquariensis*) and murray hardyhead (*Craterocephalus fluviatilis*). The murray hardyhead (*Craterocephalus fluviatilis*) occurs in slow flowing rivers and creeks as well as billabongs. This species could potentially occur in the Proposal site, inhabiting the wetland, associated irrigation channels and Sandy Creek. Silver perch and trout cod are unlikely to occur within Sandy Creek given the lack of specific habitat and the stream's low velocity.

Macroinvertebrate sampling was undertaken within the ephemeral wetland and riparian zone of the eastern irrigation channel. Sampling identified 26 macroinvertebrate taxa from both sites. The irrigation channel samples contained a greater number of taxa than the wetland samples (with 21 and 15 taxa respectively). The irrigation channel contained 13 taxa not observed in the wetland and four species were unique to the wetland.

The irrigation channel samples were dominated by two families of water bug (Notonectidae, Corixidae), damselfly nymphe (Coenagrionidae) and midge larvae (Chironimdae). The wetland habitat was dominated by a genus of aquatic snail (Physa sp.), midge larvae (Chironimdae) and beetle larvae (Dytiscidae 2).

Threatened Fauna

The species recorded in the area that are listed as threatened under the *NSW Threatened Species Conservation Act, 1995* (TSC Act), *Fisheries Management Act, 1994* (FM Act) and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are presented in Appendix C.

Thirty terrestrial fauna and 3 fish species are listed as threatened with a range extending over the Proposal site. Of these species, seven terrestrial fauna (southern bell frog, grey-crowned babbler, superb parrot, australasian bittern, freckled duck, blue-billed duck and painted snipe) and one fish species (Murray Hardyhead) may occur in the immediate vicinity of the Proposal.

The eight part test was applied to the threatened species, southern bell frog, grey-crowned babbler, superb parrot, australasian bittern, freckled duck, blue-billed duck, painted snipe and murray hardyhead (Appendix C). The assessment indicated that the Proposal would not impact significantly upon these species listed by the TSC Act 1995, and that a Species Impact Statement (SIS) is not required.

Threatened Populations and Ecological Communities

The Riverina population of glossy-black cockatoo (*Calyptorhynchus lathami*) and Wagga Wagga population of squirrel glider (*Petaurus norfolcensis*) are the only threatened population within the immediate region surrounding Narrandera, but occur near Griffith and at Wagga Wagga, respectively. Therefore these threatened populations were not addressed in the eight part tests.

Impacts

The superb parrot was observed within the Proposal Site. The southern bell frog and murray hardyhead may occur within the Proposal site. All three species are listed under the EPBC Act.

The impact of the Proposal upon these species was assessed using the EPBC Act Guidelines and indicated that there would be no significant impact on this species.

The main impact upon fauna would result from the removal of approximately 0.2 hectares of River Red Gum woodland and would impact on 4.2 hectares of ephemeral wetland. Similar fauna habitat extends well beyond the boundary of the Proposal Site and the removal of these areas of terrestrial and ephemeral aquatic habitat is unlikely to cause a significant impact.

Up to a maximum of 52 River Red Gum trees would be removed. These trees do not contain hollows and are of low structural diversity and thus provide limited refuge, nesting and roosting habitat for native fauna. Two hollow bearing and one standing dead tree (stag) would also be removed. The loss of this number of trees to native fauna in the region would be insignificant.

Superb parrots have high nest fidelity, and commonly utilise hollows in mature River Red Gums during their breeding season (September – December). The survey was conducted during the breeding season, and found that no Superb Parrots were utilising trees within the Proposal Site.

Despite a number of hollow bearing trees and an area of approximately 4 hectares of wetland habitat being impacted by the Proposal, it is not expected to have a significant impact the non-threatened fauna in the local area. Fauna such as bats, arboreal mammals and other birds who may utilise this habitat for nesting and foraging, would be able to utilise similar habitat present within the Proposal site.

The wetland provides refuge, foraging and nesting habitat for a number of species within the Proposal site and is connected to open water areas to the north of the Proposal site. During the construction period of the Proposal it is envisaged that native fauna would move from the impacted areas to those unaffected by the Proposal in the northern section of the Proposal site. The Proposal is not expected to create a barrier to natural fish movements.

Impacts on fauna are expected to be short term. Fauna are likely to be effected by:

- Sedimentation of the irrigation channel, creek and wetland from runoff may fill holes that provide fish habitat.
- Removal of aquatic vegetation and emergent vegetation that provide habitat for aquatic fauna.

These impacts would be minimised by appropriate mitigation measures detailed below.

Proposed Safeguards

Fauna controls would be undertaken in accordance with the specifications set out in **Section 6.10** (p.20) of RTA's Environmental Protection (Management Plan) - QA Specification, G36. In addition, stringent pollution control measures would be undertaken to maintain the quality of habitat on site.

- The Proposed works would be conducted outside of the fauna breeding season (August – January) to limit potential impacts on bats, arboreal mammals and birds.
- A Sediment and Erosion Control Plan would be implemented to reduce the likelihood of increased turbidity and sedimentation.
- Removal of hollow bearing trees would occur during the period January to May to avoid the breeding season of bats, birds or arboreal fauna and the cooler months when some species may be in torpor.
- Felled River Red Gum trees would also be used to create terrestrial fauna habitat around the Proposal Site. Felled trees would be cut into short lengths and placed approximately 5m from bases of existing trees, fences and road table drains.
- Prior to lopping, hollow limbs would be checked by a qualified ecologist for the presence of fauna. It is possible that the initial disturbance by chain saws and other lopping equipment would cause these species to move on.
- Stockpiles of spoil or construction materials would be stored at least 50 metres from

waterways, as per NSW Fisheries requirements.

- The Proposal would not create a barrier to natural fish movements. If barriers are used, approval would be required from NSW Fisheries.

9.2 Indigenous Heritage

The RTA Aboriginal Programs Coordinator (APC) for the South Western Region, Paul House was informed about the project via telephone conversation and email.

NPWS Aboriginal Heritage Information Management System

A search of the NSW NPWS Aboriginal Heritage Information Management System was undertaken to determine the occurrence of known Aboriginal sites within 5km of the Proposal site (Easting: 465194, Northing: 6138413).

No known Aboriginal sites were recorded within the search area. The Wiradjuri Branch of the NSW Aboriginal Land Council met with RTA on-site on 9 August 2002. The Wiradjuri Branch has requested that the RTA notify the Narrandera LALC prior to any excavation works commencing.

If the Proposal area is found to contain an Aboriginal site or suspected archaeological item, works would cease immediately and NPWS, the Regional Environmental Adviser and the Local Aboriginal Land Council would be alerted to the find for further assessment.

Correspondence provided by NPWS is included in Appendix F *Correspondence and Database Searches* of this REF.

Native Title Claims Search

A search of the National Native Title Tribunal Claims database revealed no claims in the Narrandera Local Government Area.

Aboriginal Land Claims

Aboriginal Land Claims are a property issue. The RTA Property Division would manage any issues regarding Aboriginal Land Claims. A search of the Department of Aboriginal Affairs, Aboriginal Land Claims Register is therefore not required as part of the assessment process.

Impacts

Due to the disturbed nature of the Proposal site, indigenous sites are not expected to be encountered during the works. The Proposal area, particularly beyond the Sandy Creek floodplain has been disturbed by agricultural activities. The floodplain has been subject to regular inundation from irrigation flows. Drainage channels have also been excavated within the floodplain and Proposal area.

Proposed Safeguards

Indigenous Heritage Controls would be managed in accordance with the specifications set out in Section 6.14 (p.22) of RTA's Environmental Protection (Management Plan) - QA Specification G36.

- RTA would notify the Narrandera LALC (02 6959 1823) prior to any excavation works commencing, so that a LALC representative can be present to ensure that if any culturally significant material is unearthed during the works, that appropriate action is taken.

9.3 Non-indigenous Heritage

Existing Situation

A desktop review into Non-Indigenous cultural heritage has been carried out for the Proposal. As part of the investigation searches were undertaken on a number of databases to assess the cultural heritage of the Proposal area. No recorded sites were found to exist within the Proposal site on the NSW Heritage Office State Heritage Register or Inventory, Australian Heritage Commission Register of the National Estate, RTA's s.170 Heritage and Conservation Register, or Narrandera Shire Council LEP Heritage Listings. (Refer to Appendix F for further details). No items of heritage significance were observed during field investigations.

Proposed Safeguards

Non-Indigenous Heritage Controls would be managed in accordance with the specifications set out in Section 6.15 (p.23) of RTA's Environmental Protection (Management Plan) - QA Specification G36.

9.4 Noise and Vibration

Existing Situation

Existing noise levels within the Proposal area are dominated by light and heavy traffic noise generated from the Sturt Highway. There are no sensitive noise sites located nearby the Proposal. The nearest rural dwelling is located approximately 400 metres south-west of the south end of the Proposal.

Construction Noise

The RTA adopts the construction noise control criteria of the NSW EPA. The guidelines establish background noise at +10dBA for periods of between 4 and 26 weeks. Short-term noise is more likely to be accepted when the works are part of necessary safety works such as those being undertaken for this Proposal. Where daytime goals are likely to be exceeded, a performance approach would be followed that allows the implementation of best management practice in reducing construction noise levels towards the goals. Current ambient noise levels are moderate at this location as a result of moderate traffic volumes using the Sturt Highway, particularly during peak times.

Construction noise would be generated by standard road construction earthmoving activities including bulldozers, scrapers, excavators, front-end loaders, vibratory rollers, graders and haul trucks, and standard pavement construction activities and service vehicles.

Close consultation with the affected community is essential where it is expected that construction works would exceed EPA criteria, with consultation protocols (RTA Community Involvement Practice Notes and Resource Manual, 1998) being followed. Noisy activities would be scheduled to occur in the daytime or early evening if possible to avoid undue disturbance to residents. No blasting would be undertaken during the works.

Operational Noise

Using the criteria set out in the EPA's *Environmental Criteria for Road Traffic Noise,* 1999, the Proposal is an upgrade. Noise amelioration would not be required on the basis that the works would not generate new traffic. The road alignment would be moved further away from nearby rural properties, reducing current noise exposure to the residents.

Proposed Safeguards

Controls associated with Noise Control and Vibration would be undertaken in accordance with the specifications set out in Sections 6.7 and 6.8 (pp.17 and 18) of RTA's Environmental Protection (Management Plan) – QA Specification G36.

- Procedures outlined in Practice Note vii of the *RTA Environmental Noise Management Manual 2001 – Roadworks outside normal working hours,* would be followed for all works undertaken outside of normal working hours.

9.5 Landforms, Geology & Soils

Existing Situation

The Proposal is located within the Sandy Creek freshwater floodplain. Sandy Creek flows into the Murrumbidgee River. Soils within the Proposal area consist of sandy clay beyond the floodplain, with these soils being generally hard and dry below 200mm. Soils within the floodplain are silty clay up to a depth of 400mm, and sandy clay at depths of 400mm-1100mm. Soils within the floodplain are very soft, and firmer toward a depth of 1.5m (see Appendix G). Topography is generally flat. The Proposal crosses over the Sandy Creek freshwater floodplain. Topsoils have been disturbed in the past by agricultural practices. Two irrigation channels have been constructed within the floodplain. These irrigation channels connect to the

Sandy Creek low-flow channel. The Sandy Creek low-flow channel has been modified by channel works in the vicinity of the Proposal.

The potential for the presence of Potential Acid Sulfate Soils (PASS) was anticipated and investigated via a search of the DLWC PASS database. The search found no potential acid sulfate soils present.

Impacts

Excavation works would be limited to the two ends of the Proposal beyond the floodplain and at the two irrigation channels to install drainage culverts. Due to the nature and location of the works there is a relatively low risk of soil erosion and sedimentation of topsoil and excavated materials into Sandy Creek. No hard rock excavation is anticipated.

The Proposal would create a barrier across the Sandy Creek floodplain, and would be parallel to the main Sandy Creek channel which would not be bisected. To provide for water movement and fish passage, two (1.2m diameter) pipes would be installed at each of the irrigation channels, and two (1.2m diameter) pipes at the northern end of the Proposal area. Measures outlined below would minimise these impacts.

Proposed Safeguards

Soil Management Controls would be undertaken in accordance with the specifications set out in **Section 6.5** Soil & Water Management (p.14) of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site-specific controls would be undertaken to minimise potential impacts.

- Regular maintenance and checking of the controls would be undertaken (at least every week and after a major rainfall event) and records kept. Sediment would be cleared from behind barriers on a regular basis.
- Site rehabilitation of disturbed areas would be undertaken progressively.

9.6 Contaminated Land

Existing Situation

Small amounts of contaminants may be present within the Proposal site. Contaminants could include hydrocarbons from roadworks, fuel/oil leaks and spills from highway vehicle road runoff and/or agricultural activities. Agricultural activities also contribute chemicals from irrigation applications and sheep dips. Narrandera Council were requested to comment on site contamination, but no response was received.

Impacts

The Proposal has a very limited potential to expose contaminated land as minimal earthworks would be required to complete the project. The Proposal has the potential to create contaminated land through the spillage of fuels and other chemicals used during construction. This risk is minimal as the amount of fuels and chemicals used for the works would be relatively low.

Proposed Safeguards

Controls associated with contaminated land would be undertaken in accordance with the specifications set out in **Sections 6.5, 6.13 & 6.16** of RTA's Environmental Protection (Management Plan) - QA Specification G36.

9.7 Climate

Existing Situation

Climatic data was obtained from the nearest meteorological station at Narrandera. The climate of the area is warm in summer and mild to cool in winter. Average summer maximums are around 23°C with highest maximums at 45°C. Average winter maximums are around 10°C with winter minimums at minus 5°C. The wettest months occur from April to October. October has the highest average monthly rainfall with 45.5mm. The driest months

are in November, December, February and March. February has the lowest average rainfall with 30.8mm (Bureau of Meteorology, 2002).

Potential Impact

It is considered that the proposed works would not have an impact upon climate either within the local area or on a global scale.

Proposed Safeguards

Issues relevant to construction associated with climate have been covered in the sections on Hydrology and Water Quality and Landforms, Geology and Soils (**Sections 9.1** and **9.4**).

9.8 Hydrology ,Water Quality and Drainage

Existing Situation

The Proposal would cross the Sandy Creek freshwater floodplain. The floodplain is approximately 365m wide (from creek bank to bank) where the new road would cross the floodplain. Sandy Creek flows into the Murrumbidgee River (see Appendix A - air photo).

The Murrumbidgee River quality is good at sites downstream of the Proposal (NSW SoE 2000). Water in the irrigation channels and Sandy Creek was noted to be turbid during a field inspection in July 2002. Agricultural activities occur on either side of Sandy Creek. These activities contribute sediment, nutrients, and organic matter loads to the creek.

The Sandy Creek floodplain varies in width from 200m to 300m within the Proposal site. The Sandy Creek low-flow channel and both irrigation channels are all less than 15m in width. The Sturt Highway has standard earth guttering on both sides in the vicinity of the Proposal. At 3 to 4km downstream of the Proposal at Painters Bridge there is a barrage that causes water in Sandy Creek to back up to the Sandy Creek floodplain.

During floods, flow overtops Sandy Creek banks and spreads onto the adjacent floodplain. The overflow from the creek to the floodplain is estimated to be a less than 1 in 1 year average recurrence interval (ARI). Overflow from the creek is also influenced by irrigation activity on Old Man Creek located upstream of Sandy Creek. The average rise in water level for Murrumbidgee River floods at Narrandera between 1974 to 1995 is 20mm/hour. It is expected that a similar rate of rise in water level would be observed at Sandy Creek. Observed duration of flooding is approximately 3 to 5 days. The flow velocity on the floodplain is slow (see Appendix H).

Potential Impact

The main potential impacts on water quality from road construction works are likely to be through sediment laden waters entering Sandy Creek, and pollutants from fuel and hydraulic fluid leaks, spills, pavement material and general litter. Spills during the refuelling of plant and equipment have the potential to cause localised contamination of waterways. Impacts associated with the introduction of new drainage works would also include potential pollution, erosion and sedimentation of waterways.

Erosion could also occur where surfaces are exposed due to vegetation removal and excavation works. Impacts would also be minimised through the implementation of the following safeguards.

The proposed realignment of the highway would increase the flood level by 0.02m and flow velocity by 0.11m/sec. These increases are only marginal. A slow rate of water rise and fall in water level is predicted at the site. Provision of six 1.2m diameter pipes for the new alignment would provide for flow interaction between the north-east and south-west sections of the Sandy Creek floodplain. It is predicted that there would only be a small head water difference at any stage of flooding between these two sections of the floodplain.

Water would be pumped from irrigation channels within the Sandy Creek floodplain. The Proposal would extract a total of up to 100,000ML of water (6ML/day x 60 days). Prior to undertaking water extraction, affected landowners would be consulted. Approval to extract water from the irrigation channels would be required from the Sandy Creek Water Users

Association. If water is extracted from the Murrumbidgee River, approval from DLWC would be required.

Construction of a temporary dam may be required at the two irrigation channels to enable dewatering of the work sites and installation of drainage culverts. The base of the irrigation culverts would be positioned to provide for water flow when Sandy Creek water levels are low. Prior to undertaking these works, DLWC and affected landowners would be consulted.

Road runoff has the potential to cause a decline in water quality due to discharges of fuel, oil and rubber from the road surface during rainfall events.

Proposed Safeguards

Hydrology and water quality controls would be undertaken in accordance with the specifications set out in **Section 6.5** (p.14) of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would be required as part of the Proposal:

- An Erosion and Sedimentation Control Plan (ESCP) would be developed for the site and incorporated into the Contractors Environmental Management Plan (CEMP). The ESCP would incorporate specifications outlined in the *NSW Erosion and Sediment Control Handbook No.2* and be reviewed by the Regional Environmental Adviser prior to the commencement of works.
- If any activities likely to cause pollution of nearby waterways are to be undertaken, a licence would be obtained for the works under the POEO Act.
- Any waterway rehabilitation works proposed would be discussed with both NSW Fisheries and relevant Rivercare officers from DLWC.
- To provide temporary protection to creek beds and banks, geotextile material would be installed where there is contact between unconsolidated fill embankments and water. Creek bed and bank stabilisation works would be completed immediately after completion of road works.
- The roadworks would be designed and constructed to minimise disturbance to the existing waterways.
- The base of the irrigation culverts would be positioned to provide for water flow when Sandy Creek water levels are low.
- Approval to extract water from the irrigation channels would be required from the Sandy Creek Water Users Association. Approval to extract water from the Murrumbidgee River would be required from DLWC at Leeton. Affected landowners would also be consulted to address any irrigation requirements they may have.
- Prior to construction temporary dams (if required) at the two irrigation channels, DLWC would be consulted regarding any approvals required. Affected landowners would also be consulted to address any irrigation requirements they may have.

9.9 Air Quality

Existing Situation

Presently there is little data on air quality for the area. Pollutants could include vehicle exhaust (transport and agriculture), topsoil disturbance and fertiliser/herbicide/pesticide` spray drift. There is no commercial industry located near the Proposal area. It can therefore be assumed that air quality at the Proposal site is fair to good.

Potential Impact

The Proposal is not likely to have any long-term impacts on the air quality of the area, as the Proposal is not expected to lead to any significant increase in traffic. However there is the potential for minimal short-term air pollution during construction due to dust generated from exposed surfaces, vehicle movements and construction activities, including cut and filling and

earthworks. The effect on local residents is likely to be negligible, as the nearest house is located approximately 400m SW from the proposed works.

Proposed Safeguards

Air quality controls would be undertaken in accordance with the specifications set out in **Section 6.6** (p.16) of the RTA's Environmental Protection (Management Plan) - QA Specification G36.

9.10 Socio-economic Considerations

Existing Situation

The 2km section of the Sturt Highway at Sandigo has substandard reverse curves which has resulted in an increase in the accident rate, especially for heavy vehicles.

There are two farms located within the Proposal area (M. Quilter and W. Anderson). Agricultural pastures and crops are present on both sides of the Sandy Creek floodplain. Small pump equipment is present at the SW ends of the two irrigation channels. A tree plantation area is located beyond the Proposal area. Irrigation channels are present within the Proposal site. The Sandigo town is located approximately 5km east of the Proposal site, and consists of tennis courts, rest area and a hall.

Impacts

The Proposal would provide safe travel conditions, especially for heavy vehicles at the existing Sandigo bends site. It is not anticipated that there would be any adverse socio-economic impacts as a result of the proposed road realignment at this location. The construction process has been planned to minimise disruptions to traffic during construction. Traffic would be maintained throughout construction by utilising the existing highway until the new section of road has been constructed. Traffic management measures would be implemented to manage traffic during connections of the new roadworks with the existing Sturt Highway.

The Proposal would have no impact on improved agricultural land, and minor impacts on unimproved grazing land. Stock would be able to access existing grazing land, except for land consumed by the new length of road. Existing access to rural residences would be maintained. The functioning of the irrigation channels would be maintained during construction and operation of the Proposal.

Proposed Safeguards

Traffic management would be undertaken in accordance with the specifications set out in **Section 6.4** "Access and Traffic Management" of the RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would be required as part of the Proposal:

- The functioning of the irrigation channels would be maintained during construction and operation of the Proposal.

9.11 Visual Impact, Landscape, and Urban Design

Existing Situation

The site of the Proposal has flat topography and is within an area typical of rural visual amenity. Sandy Creek is generally oriented in a north-south direction. Agricultural pastures and crops are present on both sides of the Sandy Creek floodplain. The Sturt Highway is parallel to Sandy Creek at the Proposal site.

Remnant river red gums are present within the Sandy Creek riparian zone. Wetland vegetation is present within the Sandy Creek floodplain, and native trees and shrubs are present adjacent to the irrigation channels.

No heritage buildings are located in the vicinity of the Proposal. The nearest residence is located 400m south-west of the Proposal.

Impacts

During construction and operation the visual quality of the area would be subject to minor adverse impacts. A small area of vegetation would be removed at the north and south ends of the works to make room for the new roadway. Construction of the road across the floodplain would modify the appearance of the floodplain. The floodplain would be bisected by the road (see Appendix A). Within the floodplain, the road would be 365m in length, 23m in width (maximum), and 2.6m in height (maximum). The road foundation would consist of a rock layer (500mm), clay (1350mm), and fill (300mm). The clay and fill batter slopes would be topsoiled and grassed. It is anticipated the above issues would be minimised through the implementation of the safeguards outlined below.

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- Vegetation removal would be minimised, and mature trees would be retained where possible.
- Endemic native grasses would be used to vegetate batter slopes.
- All areas affected or exposed during works would be extensively revegetated and landscaped after the completion of construction works.

9.12 Waste Management and Minimisation

The RTA adopts the Resource Management Hierarchy principles embodied in the *Waste Avoidance & Resource Recovery Act 2001* (WARR Act). The Resource Management Hierarchy principles of the WARR Act are as follows:

1. Avoid unnecessary resource consumption as a priority;
2. Avoidance is followed by resource recovery (including reuse of materials, reprocessing, recycling, and energy recovery); and,
3. Disposal is undertaken as a last resort.

The minimisation of surplus material would be a feature of the works. Waste materials would be limited to the removal of asphalt, excavated soil, workers refuse, and miscellaneous minor construction waste. These materials would be stockpiled at the compound sites prior to re-use, recycling or disposal. Proposed mitigation measures and adherence to Waste Mitigation legislation would minimise these impacts. Excavated soil would be utilised for fill as appropriate.

During operation, the Proposal has the potential to generate rubbish which may be thrown from motor vehicles along the new road route. Rubbish would be deposited within the floodplain and/or on agricultural land. Mitigation measures would be implemented to address this issue.

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- Any surplus soil material generated by the Proposal would be reused as part of the landscaping works. Any waste material unable to be reused by the Proposal would be taken to an appropriately licensed landfill.
- Regular rubbish collection would be undertaken by RTA along the new section of road, and rubbish taken to an appropriately licensed landfill.

9.13 Cumulative Environmental Effects

The Proposal is likely to result in:

- Changes in stream morphology within the Sandy Creek floodplain as a result of road construction within the floodplain.
- Potential for spread of exotic terrestrial and aquatic plant species.
- Reduction in operational noise impacts on nearby residents.
- Adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora.

9.14 Principles of Ecologically Sustainable Development

The *National Strategy for Ecologically Sustainable Development* (NSESD) has been formulated to ensure ESD is accounted for in Proposals. There are three core objectives:

- To enhance individuals and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- To provide for equity within and between generations; and
- To protect biological diversity and maintain essential ecological processes and life-support systems.

These objectives are complemented with a number of guiding principles, which are considered in **Table 9.14** in terms of the Proposal.

Table 9.14. Principles of ESD applied to the Proposal

Principle	Consideration for Proposal
Precautionary Principle	Mitigation measures have been proposed which would minimise the impacts of the Proposal. None of the studies undertaken identified any serious or irreversible damage.
Intergenerational Equity	The Proposal would improve the level of supporting infrastructure required for a Classified Road and improve the safety and efficiency of the transport corridor. At the same time, the Proposal considers and minimises impacts on the local environment.
Conservation of Biological Diversity & Ecological Integrity	Mitigation measures have been included in this REF to ensure the Proposal would not compromise biological diversity or ecological integrity.
Improved Valuation and Pricing of Environmental Resources	The integrity of the local environment is recognised as a valuable resource to the area in terms of its water resources for aquatic communities. To ensure that these resources remain, the Proposal addresses issues relevant to water quality and ecological integrity. Mitigation measures outlined in this REF (Section 10.2) have been provided to ensure the value of these environmental resources is maintained.

9.15 Matters of National Environmental Significance

The RTA is obliged under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) (Commonwealth), as part of its EIA processes, to consider a set of listed matters of National Environmental Significance (NES matters). These matters include:

- World Heritage Properties;
- Listed Migratory Species;
- Listed Threatened Species and Communities;
- Nuclear Actions;
- Wetlands of International Importance; and
- Commonwealth Marine Environment.

Details of the biodiversity assessment undertaken for this Proposal are presented in Section 9.1. The factors which need to be taken into account when considering the environmental impact of an activity on NES matters are listed and considered in Section 11.2 – EPBC Checklist.

The EPBC database search revealed the following data utilising a 5km buffer:

Threatened Ecological Communities:

0 found

Threatened Species:

13 species

Migratory Species:

5 species

Marine Protected Species:

5 species

World Heritage Areas:

none found

Ramsar Sites:

Within catchment of Ginini Flats Subalpine Bog Complex (Proposal site is located approximately 200km west of this Ramsar site).

Commonwealth Areas:

none found

Conservation Reserves:

none found

Regional Forest Agreements (RFA):

none found

9.16 Operational Hazards and Risks

Operational hazards and risks could include the following:

- spills resulting from motor vehicles accidents.
- fire caused by disposal of cigarette butts, and motor vehicles accidents.

These incidents could impact on water quality, flora, fauna and agricultural land. In the event of an incident, emergency services (ie. Rural Fire Service) would respond and attend to the incident. Mitigation measures would be implemented to address such occurrences.

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- The new section of road would have a guardrail installed across floodplain to prevent vehicles leaving the road and impacting on the floodplain.

10 Implementation Stage

10.1 Safeguards Process

Environmental safeguards outlined in this document would be incorporated into the detailed design phase of the project and as part of its construction and operation. These safeguards would reduce any potential adverse impact arising from the proposed works on the surrounding environment. All of the safeguards described throughout this REF and the Assessment Report would be incorporated into the Project Environmental Management Plan (PEMP).

The PEMP would identify the requirements for compliance with relevant legislation, requirements for ensuring implementation of the environmental safeguards and development of self-assessment and auditing schedules.

10.2 Summary of Proposed Safeguards

In order that the potential impacts of the Proposal are minimised, a number of environmental safeguards have been identified as being appropriate to the works. Measures to mitigate or prevent impacts would be implemented prior to construction, during construction and following construction.

10.2.1 General

The RTA Roadside Environmental Manual and Strategic Plan would be adhered to at all times.

10.2.2 Flora, Fauna and Aquatics

Flora - Proposed Safeguards

Flora controls would be undertaken in accordance with the specifications set out in **Section 6.9** of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would also be required as part of the Proposal:

- A Sediment and Erosion Control Plan would be implemented to reduce the likelihood of increased turbidity and sedimentation.
- The embankment would be sufficiently stabilised with sterile annual grasses and endemic native species to help reduce the risk of erosion and sedimentation.
- Any imported fill used would need to be free of weed propagules.
- Impacted wetland and River Red Gum woodland would be rehabilitated and replanted using propagated ephemeral, terrestrial and aquatic species from the local area.
- The extent of clearing and disturbance to native vegetation would be kept to a minimum within the road reserve so that impact on flora and fauna is restricted.
- In response to the removal of native vegetation and disturbance of topsoil, a revegetation program would be undertaken.

River Red Gum woodland

- Tree planting at a ratio of ten trees to every one removed would be undertaken to compensate for the loss of River Red Gum and Grey Box. Equal numbers of shrubs to trees would be planted.
- Shrub planting would include Sweet Bursaria (*Bursaria spinosa*), Dwarf Cherry (*Exocarpus strictus*), Willow Wattle (*Acacia salicina*), Eumong (*Acacia stenophylla*) and Silver Wattle (*Acacia dealbata*).
- Ground cover would include Plains Grass (*Austrostipa aristoglumis*), Warrego Summer

Grass (*Paspalidium jubiflorum*), Wallaby Grass (*Austrodanthonia caespitosa*) and Sedge (*Carex appressa*).

- Plant species suitable for the revegetation program are listed in Appendix C (Table 7).

Wetland community

- If open water areas in close proximity to the Proposal Site (50 metres) are disturbed, they would be vegetated using emergent and floating aquatic species.
- The aquatic plants to be included in the revegetation plan would include Ribbed Spike-Rush (*Eleocharis plana*), Tall Spike-Rush (*Eleocharis sphacelata*), *Pondweed (Potamogeton tricarinatus*) and Water Ribbons (*Triglochin procerum*). These species would be planted slightly under the water line, and if available, seed and rhizomes would be spread back up the bank to full bank height.
- Ground covers would include Tussock Grass (*Poa labillardieri*) and Sedge (*Carex appressa*).
- If the irrigation channels are disturbed, they would be rehabilitated immediately to minimise erosion.
- Plant species suitable for the revegetation program are listed in Appendix C (Table 7).

Grazing

- If possible, and following negotiation with the land holder, revegetation areas would be excluded from grazing until the trees and shrubs are well established. The management of grazing within the floodplain habitat would encourage the establishment of native grasses and suppress weed species.
- Grazing impact would be monitored during the period when the animals have access to the replanting area. This would enable the program to assess whether grazing intensity is too high or too low, and to move stock before vegetation degradation becomes a problem.

Monitoring

- Revegetated areas would be monitored every two months for the first six months, and then every 6 months for two years. Monitoring would assess establishment success, weed abundance and grazing impacts.
- If revegetation works are deemed to be unsatisfactory, remedial action would be taken to ensure that revegetation works are successfully implemented.

Fauna - Proposed Safeguards

- Fauna controls would be undertaken in accordance with the specifications set out in **Section 6.10** (p.20) of RTA's Environmental Protection (Management Plan) - QA Specification, G36. In addition, stringent pollution control measures would be undertaken to maintain the quality of habitat on site.
- The Proposed works would be conducted outside of the fauna breeding season (August – January) to limit potential impacts on bats, arboreal mammals and birds.
- A Sediment and Erosion Control Plan would be implemented to reduce the likelihood of increased turbidity and sedimentation.
- Removal of hollow bearing trees would occur during the period January to May to avoid the breeding season of bats, birds or arboreal fauna and the cooler months when some species may be in torpor.
- Felled River Red Gum trees would also be used to create terrestrial fauna habitat around the Proposal Site. Felled trees would be cut into short lengths and placed approximately 5m from bases of existing trees, fences and road table drains.
- Prior to lopping, hollow limbs would be checked by a qualified ecologist for the

presence of fauna. It is possible that the initial disturbance by chain saws and other lopping equipment would cause these species to move on.

- Stockpiles of spoil or construction materials would be stored at least 50 metres from waterways, as per NSW Fisheries requirements.
- The Proposal would not create a barrier to natural fish movements. If barriers are used, approval would be required from NSW Fisheries.

10.2.3 Indigenous Heritage

Proposed Safeguards

- Indigenous Heritage Controls would be managed in accordance with the specifications set out in Section 6.14 (p.22) of RTA's Environmental Protection (Management Plan) - QA Specification G36.
- RTA would notify the Narrandera LALC (02 6959 1823) prior to any excavation works commencing, so that a LALC representative can be present to ensure that if any culturally significant material is unearthed during the works, that appropriate action is taken.

10.2.4 Non-Indigenous Heritage

Proposed Safeguards

- Non-Indigenous Heritage Controls would be managed in accordance with the specifications set out in Section 6.15 (p.23) of RTA's Environmental Protection (Management Plan) - QA Specification G36.

10.2.5 Noise and Vibration

Proposed Safeguards

- Controls associated with Noise Control and Vibration would be undertaken in accordance with the specifications set out in Sections 6.7 and 6.8 (pp.17 and 18) of RTA's Environmental Protection (Management Plan) – QA Specification G36.
- Procedures outlined in Practice Note vii of the *RTA Environmental Noise Management Manual 2001 – Roadworks outside normal working hours,* would be followed for all works undertaken outside of normal working hours.

10.2.6 Landforms, Geology & Soils

Proposed Safeguards

- Soil Management Controls would be undertaken in accordance with the specifications set out in **Section 6.5** Soil & Water Management (p.14) of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site-specific controls would be undertaken to minimise potential impacts.
- Regular maintenance and checking of the controls would be undertaken (at least every week and after a major rainfall event) and records kept. Sediment would be cleared from behind barriers on a regular basis.
- Site rehabilitation of disturbed areas would be undertaken progressively.

10.2.7 Contaminated Land

Proposed Safeguards

Controls associated with contaminated land would be undertaken in accordance with the specifications set out in **Sections 6.5, 6.13 & 6.16** of RTA's Environmental Protection (Management Plan) - QA Specification G36.

10.2.8 Climate

Proposed Safeguards

Issues relevant to construction associated with climate have been covered in the sections on Hydrology and Water Quality and Landforms, Geology and Soils (**Sections 9.1** and **9.4**).

10.2.9 Hydrology ,Water Quality and Drainage

Proposed Safeguards

Hydrology and water quality controls would be undertaken in accordance with the specifications set out in **Section 6.5** (p.14) of RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would be required as part of the Proposal:

- An Erosion and Sedimentation Control Plan (ESCP) would be developed for the site and incorporated into the Contractors Environmental Management Plan (CEMP). The ESCP would incorporate specifications outlined in the *NSW Erosion and Sediment Control Handbook No.2* and be reviewed by the Regional Environmental Adviser prior to the commencement of works.
- If any activities likely to cause pollution of nearby waterways are to be undertaken, a licence would be obtained for the works under the POEO Act.
- Any waterway rehabilitation works proposed would be discussed with both NSW Fisheries and relevant Rivercare officers from DLWC.
- To provide temporary protection to creek beds and banks, geotextile material would be installed where there is contact between unconsolidated fill embankments and water. Creek bed and bank stabilisation works would be completed immediately after completion of road works.
- The roadworks would be designed and constructed to minimise disturbance to the existing waterways.
- The base of the irrigation culverts would be positioned to provide for water flow when Sandy Creek water levels are low.
- Approval to extract water from the irrigation channels would be required from the Sandy Creek Water Users Association. Approval to extract water from the Murrumbidgee River would be required from DLWC at Leeton. Affected landowners would also be consulted to address any irrigation requirements they may have.
- Prior to construction temporary dams (if required) at the two irrigation channels, DLWC would be consulted regarding any approvals required. Affected landowners would also be consulted to address any irrigation requirements they may have.

10.2.10 Air Quality

Proposed Safeguards

Air quality controls would be undertaken in accordance with the specifications set out in **Section 6.6** (p.16) of the RTA's Environmental Protection (Management Plan) - QA Specification G36.

10.2.11 Socio-economic Considerations

Proposed Safeguards

Traffic management would be undertaken in accordance with the specifications set out in **Section 6.4** "Access and Traffic Management" of the RTA's Environmental Protection (Management Plan) - QA Specification G36. In addition, the following site specific mitigative measures would be required as part of the Proposal:

- The functioning of the irrigation channels would be maintained during construction and operation of the Proposal.

10.2.12 Visual Impact, Landscape, and Urban Design

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- Vegetation removal would be minimised, and mature trees would be retained where possible.
- Endemic native grasses would be used to vegetate batter slopes.

All areas affected or exposed during works would be extensively revegetated and landscaped after the completion of construction works.

10.2.13 Waste Management and Minimisation

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- Any surplus soil material generated by the Proposal would be reused as part of the landscaping works. Any waste material unable to be reused by the Proposal would be taken to an appropriately licensed landfill.
- Regular rubbish collection would be undertaken by RTA along the new section of road, and rubbish taken to an appropriately licensed landfill.

10.2.14 Fire Control

Fire control would be undertaken in accordance with Section 6.11 "Fire Precautions" of the RTA's QA Specification G36.

10.2.15 Operational Hazards and Risks

Proposed Safeguards

Measures recommended to minimise the potential impacts are:

- The new section of road would have a guardrail installed across floodplain to prevent vehicles leaving the road and impacting on the floodplain.

10.3 Licences, Approvals and Permits

At the time of writing, no further approvals or licences have been identified for the Proposal to proceed.

10.4 Summary of Beneficial Effects

The works would have a number of beneficial effects and would:

- Improve safety for motorists via realigning Sturt Highway
- Reduce ongoing maintenance costs.

10.5 Summary of Adverse Effects

The works would result in some short-term adverse effects, which would include:

- Minor traffic delays during construction.
- Changes in stream morphology within the Sandy Creek floodplain as a result of road construction within the floodplain.
- Potential for spread of exotic terrestrial and aquatic plant species.
- Adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora.

11 Checklists

11.1 Clause 228(2) Checklist

The factors which need to be taken into account when considering the environmental impact of an activity are listed in Clause 228(2) of the Environmental Planning and Assessment Regulation, 2000. Those factors are listed and considered below:

Table 11.1: Clause 228 Checklist (NSW Legislation)

FACTOR		IMPACTS
a)	**Any environmental impact on a community?**	
	Short term negative impacts include the disruption to vehicular traffic for periods during construction and visual impact of the works during construction. However, these would be minimised through the implementation of controls and measures detailed in Section 10 of this document.	Short term –ve Long term +ve
	In the long term, the Proposal would benefit the community by providing a safe travel route.	
b)	**Any transformation of a locality?**	
	The Proposal would transform the locality in a positive manner by allowing for improved access and transport. The Proposal would also adversely impact on the floodplain by constructing a road across it.	Long term +ve and –ve
c)	**Any environmental impact on the ecosystems of the locality?**	
	Works would be minimal in extent with minimal risks to ecosystems. All risks associated with the Proposal would be mitigated against.	Short term –ve Long term –ve
	There would have long term environmental impacts on the ecosystems of the locality.	
	The Proposal would cause changes in stream morphology within the Sandy Creek floodplain, and have adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora.	
	The Proposal would have potential impact on aquatic ecosystems in the form of pollutants or sediments entering waterways. However, this impact would be reduced to a minimum by ensuring mitigation measures would be implemented as outlined in Section 10.	
d)	**Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality?**	
	There would be a short term reduction of the aesthetic quality of the locality as a result of machinery, stockpile sites etc. There would be a long term reduction in aesthetic quality, scientific and environmental quality as a result of this Proposal.	Short term –ve Long term –ve
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?

The Proposal site is not registered on any heritage registers. There would be no negative impacts on any items of historical significance. The Proposal would have negative impacts on visual amenity during construction and operation, and scientific values would be reduced due to impacts on the floodplain.

Short term –ve

Long term –ve

f) **Any impact on the habitat of any protected or endangered fauna?**

The Proposal would have adverse impacts on aquatic habitat, including a barrier to fauna movement. No significant impact on the habitat of any protected or endangered fauna is anticipated as a result of the proposed works.

Long term –ve

g) **Any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air?**

The Proposal would have adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora. The Proposal would not endanger any species of animal, plant or other form of life living on land, in the water or in the air.

Long term –ve

h) **Any long-term effects on the environment?**

The Proposal would have long term negative effects on the environment. The Proposal would cause changes in stream morphology within the Sandy Creek floodplain, and have adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora.

Long term –ve

i) **Any degradation of the quality of the environment?**

There would be short term potential impacts on the environment as a result of the proposed works, including traffic delays. These impacts would be minimised through the implementation of safeguards outlined in Section 10 of this REF.

Nil to Minor Short term –ve

Long term –ve

The Proposal would degrade the quality of the environment. The Proposal would cause changes in stream morphology within the Sandy Creek floodplain, and have adverse impacts on aquatic habitat, including a barrier to fauna movement and loss of flora.

j) **Any risk to the safety of the environment?**

The Proposal would not cause any risk to the safety of the environment in the long term. There would be some disruption and a short term risk for motorist and worker safety during construction as the works would be undertaken in trafficked conditions. This disruption would be minimised through the implementation of a traffic management plan and mitigation measures as outlined in Section 10.

Short term –ve,

Long term nil.

There would be no risk to the safety of the environment due to the mitigation measures to be introduced as part of the CEMP to ensure no chemical or other spills occur in the waterways. Hazardous materials would not be stored at the site.

k) **Any reduction in the range of beneficial uses of the environment?**

	Although there would be some reduction in access during construction, the Proposal would not result in a restriction in the beneficial uses of the environment in the long term.	Nil.
l)	**Any pollution of the environment?**	
	Water pollution through sedimentation, spillage and emissions from the works site has the potential to occur. However, the risk is low and any effect would be minimised through the implementation of safeguards outlined in Section 10 of this REF.	Nil to Minor Short term –ve Long term minor -ve
m)	**Any environmental problems associated with the disposal of waste?**	
	Waste would be generated as a result of the Proposal. All waste would be disposed of in accordance with relevant legislation and guidelines detailed in Section 8 of this REF.	Nil
n)	**Any increased demands on resources, natural or otherwise which are, or are likely to become, in short supply?**	
	The Proposal would extract a total of up to 100,000ML of water. Impacts would be minimised through the implementation of safeguards outlined in Section 10 of this REF.	Short term –ve, Long term nil.
o)	**Any cumulative environmental effect with other existing or likely future activities?**	
	RTA activities within NSW involve standard jobs that have the potential to have cumulative effects, however safeguards such as reuse, recycling and substitution would be implemented to reduce any cumulative impacts. No future projects are currently planned for the region which would lead to cumulative effects.	Nil.

11.2 EPBC Checklist

The factors which need to be taken into account when considering the environmental impact of an activity on matters of National Environmental Significance (NES) are listed and considered below:

Table 11.2: EPBC Act 1999 Matters of NES Checklist

	FACTOR	IMPACTS
a.	**Any Environmental Impact on a World Heritage Property?**	Nil
	The Proposal is not located within and would not have an impact on a World Heritage Property.	
b.	**Any Environmental Impact on Wetlands of International Importance?**	Nil
	The Proposal would not have any impact on RAMSAR wetlands.	
c.	**Any Environmental Impact on Commonwealth Listed Threatened Species and Ecological Communities?**	Nil
	Potential impacts of the Proposal on Commonwealth listed species and ecological communities have been investigated. No impacts would occur as a result of the Proposal.	
d.	**Any Environmental Impact on Commonwealth Listed Migratory Species?**	Nil
	Potential impacts of the Proposal on Commonwealth listed migratory species have been investigated. No impacts would occur as a result of the Proposal.	
e.	**Does Any Part of the Proposal Involve a Nuclear Action?**	Nil
	No part of the Proposal involves a nuclear action.	
f.	**Any Environmental Impact on a Commonwealth Marine Area?**	Nil
	There would be no impact on Commonwealth Marine Areas.	
g.	**Any Impact on Commonwealth Land?**	Nil
	The Proposal would not be located on or near Commonwealth Land.	

12 Certification

This Review of Environmental Factors provides a true and fair review of the activity in relation to its likely effects on the environment. It addresses to the fullest extent possible all matters affecting or likely to affect the environment as a result of the proposed activity.

Peter Ryan
Environmental Officer, Environmental Technology
Date: 17 December 2002

I have examined this Review of Environmental Factors and the certification and accept the Review of Environmental Factors on behalf of the RTA.

Wayne Walgers
RTA Project Services, South Western Region
Date:_____

13 References

EPA (2000) *NSW SoE, Report for Narrandera Council, River Health Assessed by Macroinvertebrate Assessment.* NSW EPA.

CSU (2002) *Flora and Fauna Assessment Realignment of Sturt Highway at Sandigo.* Charles Sturt University, Johnstone Centre - Research in Natural Resources and Society.

NSW Fisheries (1999). *NSW Fisheries Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures.* Guidelines published by NSW Fisheries;

RTA (2001a). *Environmental Impact Assessment Policy, Guidelines, Procedures.* NSW RTA, Sydney;

RTA (2001b). *RTA Environmental Noise Management Manual.* NSW RTA, Sydney;

RTA (2002a) *Environmental Overview for the Re-alignment of Sandigo Bends, SH 14 Sturt Highway.*

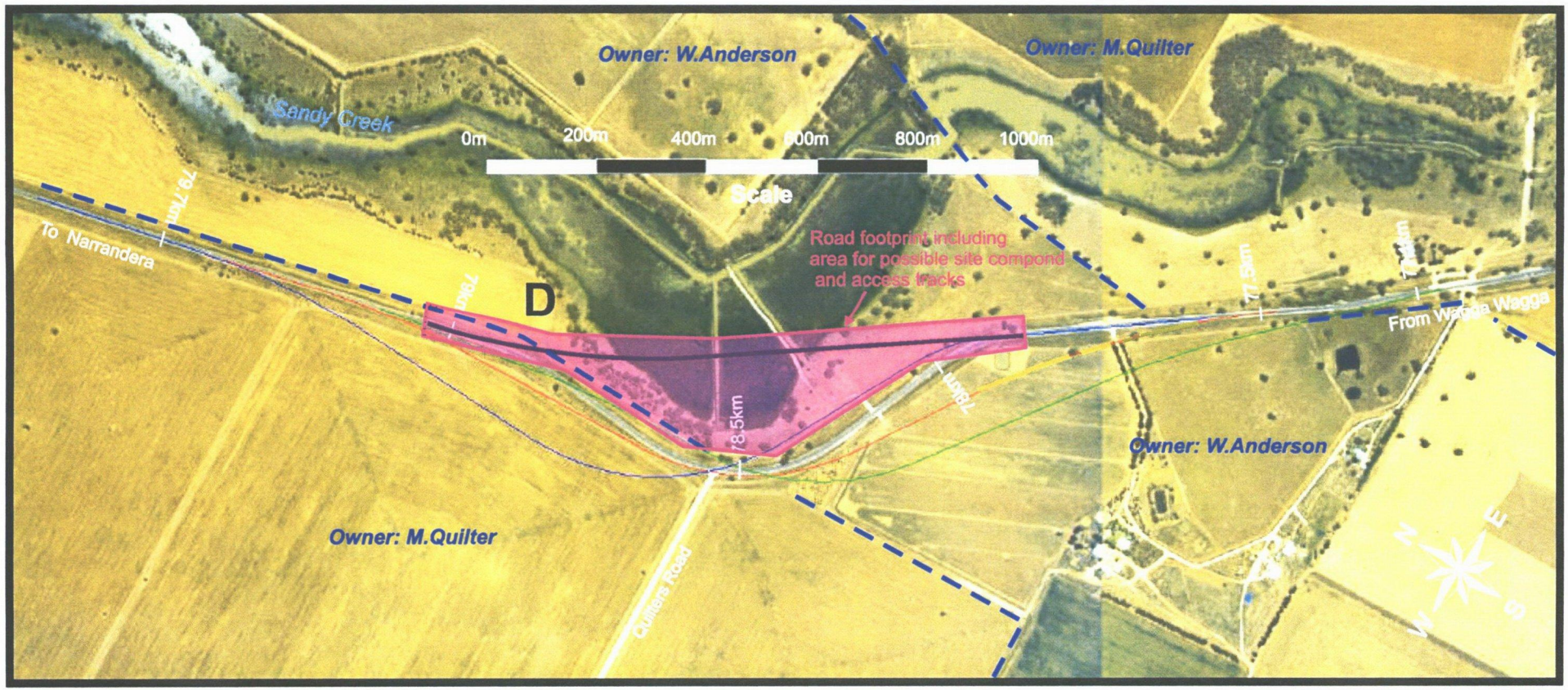
RTA (2002b). *Hydrology Assessment.* RTA Operations Directorate, Bridge Section.

RTA (2002c). *Traffic Volume Data for the South Western Region.* NSW Roads and Traffic Authority, Sydney, NSW;

RTA (2002d) *Geotechnical Assessment.* South Western Region. Project Development, Wagga Wagga NSW.

Appendix A

Site Air Photo



LOCALITY PLAN

Appendix B

Photographs

Southern irrigation channel

Northern irrigation channel

View to SE from north end of proposal

Sandy Creek floodplain, view to NE

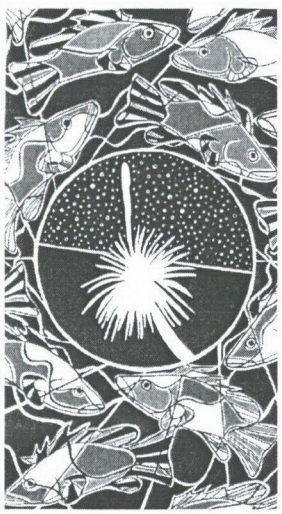
Appendix C

Flora and Fauna Report

JOHNSTONE CENTRE
RESEARCH IN NATURAL RESOURCES & SOCIETY
Environmental Consulting
Report No. 41

Flora and Fauna Assessment
Realignment of Sturt Highway at Sandigo

NSW Roads and Traffic Authority (RTA)



Lachlan J. Sutherland

Bruce J.D. Mullins

Wagga Wagga - November 2002

Summary

The proposed realignment of the Sturt Highway at Sandigo will traverse a natural floodplain depression and two irrigation channels. These aquatic habitats are inundated by water from Sandy Creek to the immediate north of the Proposal Site. An area of River Red Gum woodland also occurs at the transition of the floodplain depression and the surrounding plains on the southern edge of the Sandy Creek floodplain. The Proposal site is approximately 1.36 kilometres in length and will be around 25 metres wide. The Proposal will remove an area of approximately 0.2 hectares of River Red Gum woodland, one hectare of ephemeral wetland and approximately 3.2 hectares of mixed grassland as well as isolate a section of 3.2 hectares of ephemeral wetland from interconnected areas.

An on site survey was undertaken on the 21st and 24th of October and the 5th and 6th of November 2002. The Proposal Site traverses three distinct vegetation communities: mixed grassland, River Red Gum woodland and ephemeral wetland. The mixed grassland that occurs on site is of low conservation value. The vegetation community occurs throughout the region and is derived from the clearance of Grey Box and River Red Gum woodland.

Two stands of River Red Gum woodland occur within the study area but are of low conservation value for the region. The low conservation woodland is widely distributed in the region and locally. The ephemeral wetland that occurs in the Proposal Site is filled annually by irrigation flows within Sandy Creek. The wetland is a natural feature but has greater frequency of inundation by irrigation supplies and is of moderate conservation value for the region as it supports a diverse range of fauna. The wetland has a diverse array of habitats that include numerous open water areas. Impact assessment of these habitats concluded that the Proposal will not have a significant impact.

The location of the Proposal warranted consideration of Commonwealth and New South Wales legislation, given the threatened species likely to occur in the area. Two threatened species, the Superb Parrot and Grey-crowned Babbler were observed during the survey period. An assessment of the impact of the Proposal on threatened species, populations and ecological communities was undertaken and determined that a significant impact is not likely.

The aquatic habitat assessment was conducted in accordance to NSW Fisheries policy for aquatic habitat assessment. The assessment identified aquatic habitats that occurred within the study area, listed potential native fish species and populations and sampled aquatic macroinvertebrates within and outside of the Proposal Site. The assessment indicated that the Proposal may have minor impacts upon the habitat and threatened and common aquatic species in the study area. Adherence to appropriate mitigation measures is recommended and will minimise any potential impacts upon aquatic habitat within the Proposal Site.

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1.0 Introduction

1.1 Proposal

New South Wales Roads and Traffic Authority (RTA) proposes to realign the Sturt Highway approximately 77 to 79 kilometres west of Wagga Wagga. The Proposal would improve the existing reverse curve alignment to National Highway standard. The new road would be constructed within a floodplain and would cross over two irrigation channels. The proposed construction methods would comprise:

- Laying Geotextile material across the floodplain (25m width x 1.36 km length)
- Placing rock layer and fill / road-base material on top of Geotextile material
- The two irrigation channels would be excavated and culverts (1.5m x 23m length) with headwalls installed, including backfilling.

A Review of Environmental Factors (REF) is required as part of the Proposal to fulfil the requirements of Section 111 (Part V) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and to take into account all matters affecting or likely to affect the environment as a result of the Proposal.

Johnstone Centre – Environmental Consulting, Charles Sturt University has been contracted to conduct a flora, fauna and aquatic habitat assessment of the Proposal Site that will be included in a REF being prepared by the RTA.

1.2 Scope of the Work

Objectives:

- To identify the effects of the project on threatened and protected flora, fauna and fish species, populations and ecological communities and their habitats.
- To determine if a Species Impact Statement is required under section 5a of the EP&A Act.
- To determine if the Proposal needs to be referred to the Minister for Environment according to *EPBC* Act.

Key Issues/Activities:

- Research existing information on protected and threatened flora, fauna and fish species, populations and ecological communities and their habitats in the vicinity of the Proposal.
- Review all relevant reports and databases covering the area.
- Identify on suitable maps and/or aerial photographs, locations where threatened species, populations or ecological communities are known to exist.
- Undertake a field survey to identify the presence and extent of species, populations and ecological communities in the vicinity of the proposed route.
- Prepare maps and photographs and a description of the flora, fauna and fish species, populations and ecological communities and their habitats.

- Assess the type and degree of impacts of the Proposal on the flora, fauna and fish species and communities of the route.
- Propose ameliorative measures and management advice to reduce the extent of impacts.

Plate 1: Scattered River Red Gum (*Eucalyptus camaldulensis*) woodland on the north western end of the study area.

1.3 Report

This report documents the findings of a desktop and field survey conducted during 21st and 24th of October and 5th and 6th November 2002. The document details the species, populations and communities of aquatic and terrestrial flora and fauna occurring along and in the vicinity of the Proposal Site and provides an assessment of existing habitat. The potential impacts of the proposed development upon threatened species is reviewed, and ameliorate measures, designed to minimise the impact of the Proposal, are provided in Section 6.

2.0 Site Description

2.1 Location

The study area is located on the south west floodplain of Sandy Creek at Sandigo approximately 78 kilometres west of Wagga Wagga and 23 kilometres south east of Narrandera in south western New South Wales (Figure 1). The proposed realignment will direct the Sturt Highway through a floodplain depression and two irrigation channels. The RTA's proposed construction will comprise laying a 25 metre wide layer of Geotextile material. For the purposes of this document the Proposal Site constitutes an area 1.36 kilometres in length and up to 300 metres wide (Pink shaded polygon, Appendix 4). However, vegetation removal will be restricted to a 25 metre wide section, 1.36 kilometres in length along the Proposed realignment.

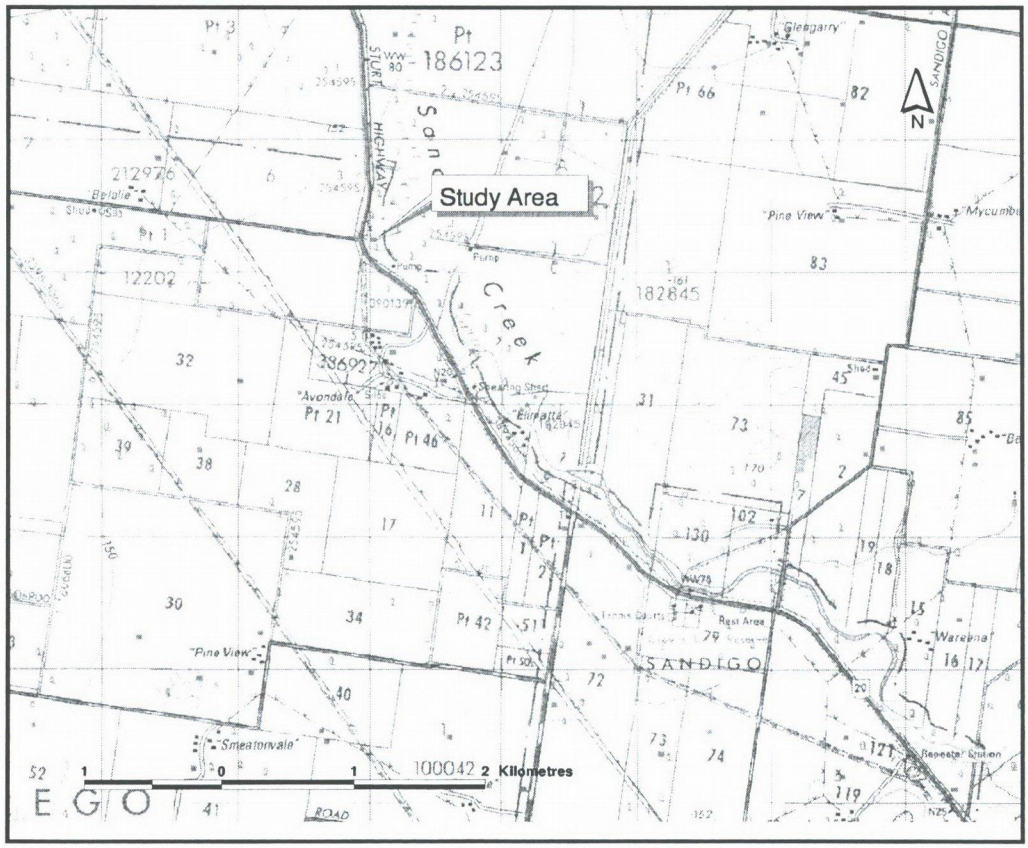


Figure 1: Location of the study area between approximately 78 kilometres west of Wagga Wagga in south western New South Wales.

2.2 Climate

The surrounding area is classified as semi-arid with a mean annual rainfall of 446 millimetres (mm). Rainfall is relatively uniform throughout the year, but is heaviest in October (Table 1).

Table 1: Mean monthly rainfall (mm) recorded at Narrandera Airport (074148).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
36.8	30.8	31.4	38.0	44.2	35.9	38.1	40.8	38.3	45.5	31.8	34.7	446.2

(Source: Bureau of Meteorology, 2002)

January and February are the two hottest months with maximum averages of 31.1 °C and 31.2 °C, respectively. In August the average minimum temperature drops to 3.5 °C and frosts occur between May and September (Table 2).

Table 2: Mean monthly maximum and minimum temperatures recorded at Narrandera Airport (074148).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	31.1	31.2	28.1	22.5	18.2	14.2	13.9	15.7	18.9	22.5	26.9	29.7
Min	15.3	14.9	13.6	9.5	5.8	4.2	3.8	3.5	5.4	8.0	11.2	14.3

(Source: Bureau of Meteorology, 2002)

In the months leading up to the survey, rainfall was well below average and thus the region has been under drought conditions since July 2002. The region surrounding Narrandera had a rainfall decile of one (very much below average) for the three months leading up to the survey, where 4-7 is average and 10 is very much above average (Bureau of Meteorology 2002).

Day and night time temperatures for the surveys undertaken during October were above average with no rainfall and slight wind (Table 3). Conditions during the November surveys were close to average with clear skies and low wind.

Table 3: Weather conditions experienced during the October - November 2002 survey.

Day/Date	Day temp °C	Night temp °C	Rainfall (mm)	Cloud Cover	Wind
Monday 21/10/02	31	15	zero	clear	zero - low
Wednesday 23/10/02	29	21	zero	overcast	zero- low
Tuesday 5/11/02	24	15	zero	clear	low
Wednesday 6/11/02	25	12	zero	clear	low

2.3 Topography

The proposed realignment crosses the south west floodplain of Sandy Creek and adjacent plains. The south east corner of the Proposal Site commences on the transition between plains / secondary floodplain and continues to traverse floodplain depression to the north until terminating at the plains / secondary floodplain transition in the north west corner of the Proposal Site.

Aspect varies slightly at the transition between plains / secondary floodplain at each end of the Proposal Site but aspect is negligible throughout the floodplain depression. Change in

elevation of approximately two to three metres occurs from plain to floodplain depression. The study area is approximately 130 metres AHD (Australian Height Datum).

2.4 Surface Water & Flow Regime

Sandy Creek is the major surface water feature surrounding the Proposal Site. Two irrigation channels connected to Sandy Creek also bisect the Proposal Site. Discharge within Sandy Creek is minor and flows occur in an east-west direction. The system is a tributary of the Murrumbidgee to the north west. Sandy Creek is used for the delivery of water for irrigation and generally flows during October through March.

The secondary floodplain occurring over the majority of the Proposal Site is annually inundated by water breaching levee banks on Sandy Creek. The floodplain depression contains standing waters that vary between ten and forty centimetres deep. During the survey, the proposed route was damp, but not inundated.

2.5 Adjacent Land Use

The Proposal Site is privately owned and is currently used for sheep and cattle grazing enterprises. Property to the south of the Sturt Highway is used for a mixture of dry land and irrigated cropping. Land use to the north of Sandy Creek is a mixture of grazing and dry land cropping.

2.6 Previous Surveys

This assessment was unable to identify any previously conducted surveys in the study area.

3.0 Flora, Fauna and Aquatic Habitat Survey

An on site survey was undertaken on the 21st and 24th of October and the 5th and 6th of November 2002. During the survey, the site and its immediate surrounds were surveyed for aquatic and terrestrial flora and fauna and an assessment of aquatic habitat was conducted. The survey was undertaken during the optimal survey period, however below average rainfall and drought conditions may have limited the comprehensiveness of the survey given poor plant growth and resource conditions outside of the floodplain depression.

To compensate for the limitations associated with the timing and duration of the survey data from the NSW National Parks and Wildlife Service database and NSW Fisheries database were obtained. A total of 22 person hours were utilised for this survey.

3.1 Flora Survey Methods

A flora survey was conducted along the proposed route encompassing the variety of vegetation types and landform features that occurred. A reconnaissance of the site was conducted that identified unusual features along the route and assisted in selecting the most appropriate survey method.

The Proposal Site contains three vegetation communities: Grey Box woodland, River Red Gum woodland and ephemeral wetland. The Grey Box woodland was associated with plains land formation but this community has been all but totally cleared and replaced with mixed grassland. Mixed grassland is a combination of introduced and native species, which in some places may be dominated by natives and in others by introduced species. The River Red Gum woodland was associated with the floodplain depression and three stands were identified (Appendix 4). The remainder of this community had been cleared and replaced with mixed grassland. For the purposes of this document the Grey Box community and the segments of River Red Gum woodland that had been cleared were grouped as mixed grassland.

The ephemeral wetland is an artificial feature, which has developed following the use of Sandy Creek as an irrigation channel. It should be noted that this floodplain depression would be inundated more irregularly under natural flow conditions in Sandy Creek.

Line transects of the proposed route were deemed the most appropriate method for the flora survey. The entire length of the site was traversed to ensure a comprehensive coverage. Plants were either identified on site or collected for later identification.

A census of hollow bearing trees and stags (standing dead trees) was conducted within the Proposal Site. These trees are potential habitat for nesting and roosting native fauna and the results are designed to gauge the impact of the proposed activity upon fauna habitat. The census recorded tree species, diameter at breast height (m), presence of hollows, presence of fauna and location.

Conservation status of the vegetation occurring within the Proposal Site was evaluated using the CAR method, based on the Comprehensiveness, Adequacy and Representativeness of the conservation of the particular vegetation community. This evaluation considers the conservation of vegetation communities at a regional scale. Rapid

vegetation assessment technique was used to determine the condition of the vegetation along the proposed route. The assessment technique utilised the *Save the Bush Toolkit* (Goldney, 1997), and considered the remnant rather than areas in isolation.

3.2 Fauna Survey Methods

A reconnaissance of the site was conducted to identify different habitat types and suitable locations for traps and other survey points. A number of methods were used to identify resident fauna on the study site.

3.2.1 Nocturnal and arboreal mammals

Spotlight searches were conducted at night to locate arboreal and nocturnal mammals. Searches lasted for approximately two hours and were conducted in both the eastern and north western sections of the River Red Gum woodland. The presence of large mammals was also noted by recording the presence of scats, tracks and other signs. Incidental sightings were also recorded.

3.2.2 Microchiropteran Bats

Bat surveys were conducted using a combination of trapping and ultra-sonic detection methods (Anabat II – Titley Electronics). Four harp traps were erected in preselected flyways before dusk on the 5th November and cleared of bats the following morning prior to sunrise (Plate 2). Three sites were utilised in this survey: one located on a River Red Gum woodland trail, two located within naturally occurring vegetation corridors (River Red Gum woodland, Appendix 4). The traps were checked late in the evening and again before dawn to allow time for captured bats to be released under the cover of darkness.

Electronic detection was undertaken using an Anabat II detector to record bat echolocation calls. The Anabat detector was connected to a Delay Switch (Titley Electronics) to record bat activity throughout the night and was located on the northern levee of Sandy Creek with the microphone aimed out onto the creek. Generally, microchiropteran species drink at the commencement of foraging and thus recording echolocation calls at this site provided the opportunity to survey a wide variety of species that may occur in the study area.

Bats captured in the harp traps were identified (Parnaby, 1992; Churchill, 1998), measured and released.

3.2.3 Birds

Bird censuses were undertaken in the early morning of the 21st of October and 6th of November and during the late afternoon of the 24th of October and 5th of November. Each census covered a one hectare area for a twenty minute duration. During this time all species that were observed, heard or evidenced by other signs (eg scats) were noted. Notes about the weather conditions and general site information were also recorded. Bird census were undertaken in River Red Gum woodland and wetland vegetation communities (see Appendix 4 for locations).

Spotlight searches were conducted to locate nocturnal birds in conjunction with searches for nocturnal mammals (see Section 3.2.1). Incidental sightings were also recorded.

3.2.4 Amphibians

Surveys for amphibians were conducted around and within the wetland vegetation community. Searches took place in the evening when frog chorusing was loudest. Frog species heard incidentally during the survey period were also identified and recorded. Call play back was undertaken on the 24th of October and 5th of November in both the eastern and northern sections of the wetland. Call play back concentrated on the Southern Bell Frog (*Litoria raniformis*), a threatened species, but also included other common species. The call was played for a period of five minutes followed by a five minute listening period. Call play back was undertaken at six individual sites within the Proposal Site and associated study area.

3.2.5 Reptiles

The reptile survey included searching through leaf litter, under fallen timber and debris, and under bark on trees. Searches were undertaken in early to mid afternoon when reptile activity was expected to be high. Incidental sightings were also noted.

3.2.6 Aquatic Invertebrates

Aquatic macroinvertebrates were sampled in the eastern irrigation channel and in the wetland vegetation community (see Appendix 4 for location). Four sweep net samples were taken from the littoral zone of the irrigation channel and four from littoral sections of the wetland. These sweeps covered an area of two square metres. The contents of each sweep were rinsed into white sorting trays and for a period of twenty minutes all macroinvertebrates were picked out using pipettes and / or soft jaw tweezers and placed in sample jars containing 70 percent ethanol. The remaining contents were washed back into the area where the sample was taken. Vertebrate fauna identified in sweep samples were immediately removed and released at the point of capture. Macroinvertebrates were identified to the highest level possible using coarse diagnostic means (raw data, Appendix 8). Sample dissections or other more labour intensive means of identification were not used nor deemed necessary.

3.3 Aquatic Habitat Assessment

The assessment of aquatic habitat was in accordance with the NSW Fisheries Aquatic Habitat Management and Fish Conservation Guidelines - *Minimum Information Requirements for Aquatic Environmental Assessment 1999*. The assessment included descriptions of aquatic and ephemeral habitat availability, lists of finfish and macroinvertebrate species present or likely to be present (including threatened species) and predicted impacts of the Proposal upon aquatic habitat. The assessment of species presence included sampling macroinvertebrate communities within the Proposal Site and within a control site.

To determine if any differences in macroinvertebrate communities existed between the wetland within the Proposal Site and the channel areas outside the Proposal Site, visual inspections of the data were undertaken (Appendix 8).

Investigations of the presence of a fishery or recreational users as well as the presence of other activities that may have cumulative impacts upon the aquatic habitat if the proposed activity is conducted. Mitigation measures were also investigated.

3.4 Threatened Species Legislation

The impact of the proposed development upon threatened species, populations and ecological communities of aquatic and terrestrial flora and fauna were assessed using relevant Commonwealth and New South Wales Environmental Legislation (Appendix 3). State Environmental Planning Policy (SEPP) No.44 – Koala Habitat Protection was also addressed. The results of these assessments are presented in Section 4.4.

4.0 Results

4.1 Flora

A total of 73 species were identified during the flora surveys conducted at Sandigo in south western New South Wales (Appendix 1). A total of two native trees and six native sub shrub species were identified within the Proposal Site.

4.1.1 Vegetation Structure and Communities

Three vegetation communities were identified on the Proposal Site: mixed grassland, River Red Gum woodland and ephemeral wetland. Consequently transects were conducted within each community and recorded the following results.

Mixed grassland

A total of 39 flora species were identified within the mixed grassland community occurring within the Proposal Site. Mixed grassland in the Proposal Site is derived from cleared woodland and contains a mix of introduced and native ground cover species, which in some places may be dominated by natives and in others by introduced species. The species recorded included two native tree species, Grey Box (*Eucalyptus microcarpa*) and River Red Gum (*Eucalyptus camaldulensis*) and six native sub shrubs including Berry Saltbush (*Atriplex semibaccata*), Climbing Saltbush (*Einadia nutans*), Black Cottonbush (*Maireana decalvans*) and Black Roly-poly (*Sclerolaeana muricata*) (Plate 2).

Plate 2: Mixed grassland at the transition between plains and secondary floodplain. Note River Red Gum in foreground and Grey Box in background. Photo point located on centre line of realignment looking east toward the Sturt Highway. Red point denotes start of Proposal site.

The canopy cover was less than one percent with only a small number of scattered Grey Box and River Red Gum present. The community contained one mid-stratum layer comprised of the six native sub shrub species listed above. The ground covers were composed of a number of species including White Top (*Austrodanthonia caespitosa*), Plains Grass (*Austrostipa aristiglumis*), Rough Spear-grass (*Austrostipa scabra* ssp. *falcata*), Wild Oat (*Avena fatua*) and Great Brome (*Bromus diandrus*). The dominant species of ground covers varied over the site, being weighted toward introduced species near the existing road pavement and tending toward native species as distance from the highway increased. Overall 45 percent of the species identified in this vegetation community were introduced. Approximately 3.2 hectares of mixed grassland occurs within the clearance zone of the Proposal Site.

River Red Gum Woodland

A total of 35 species were identified in the River Red Gum woodland occurring within the Proposal Site, including one native tree species River Red Gum, one native epiphytic species Box Mistletoe (*Amyema miquelii*) and two native sub shrubs: Berry Saltbush (*Atriplex semibaccata*) and Black Roly-poly (*Sclerolaeana muricata*).

River Red Gum was the dominant canopy species and within the three stands identified averaged approximately 20 percent cover (Appendix 4). The community contained a sparse mid-stratum layer of Berry Saltbush and Black Roly-poly. The ground was covered in low to moderate amounts of leaf litter and a patchy mosaic of ground covers including White Top, Tufted Burr-daisy (*Calotis scapigera*), Paterson's Curse (*Echium plantagineum*) and Rigid Panic (*Homopholis proluta*). Overall 43 percent of the species identified in the River Red Gum woodland community were introduced.

A census of hollow bearing trees along the Proposed Site identified only three hollow bearing trees (1 Grey Box, 1 River Red Gum, 1 Stag) within 15 metres of the proposed realignment centre line. A further 52 young River Red Gum trees not containing hollows occurred within this area. For the purposes of this document these 55 trees occur within the Proposal Site and may need to be removed by the Proposal. Approximately 0.2 hectares of River Red Gum occurs within the Proposal Site. The provisions of the Native Vegetation Conservation Act 1997 do not apply to the Proposal given that the area of clearance is below the two hectare minimum threshold.

Ephemeral Wetland

A total of 30 species were identified in the ephemeral wetland occurring within the Proposal Site, 36 percent of species being introduced. River Red Gum was the only canopy species recorded and only occurred as isolated trees. The River Red Gum woodland described above was located on the outer perimeter of the wetland.

The wetland community was dominated by a Common Rush tentatively identified as *Juncus sarophorus*, particularly in sections of the wetland that undergo minor inundation. A specimen is currently being identified at the Melbourne Herbarium The wetland contained a number of open water areas the perimeter of which contained a mixture of Common Rush (*Juncus sarophorus*), Buttercup (*Ranunculus undosus*) and Ribbed Spike-Rush (*Eleocharis plana*) with a transition to Tall Spike-Rush (*Eleocharis sphacelata*) as water depth increased.

A number of emergent species were identified in the open water areas: Broad-leaved Cumbungi (*Typha orientalis*), Milfoil (*Myriophyllum* sp.), Ribbon Weed (*Triglochin procerum*), Wavy Marshwort (*Nymphoides crenata*) and Floating Pondweed (*Potamogeton tricarinatus*). The two irrigation channels that bisect the Proposal area are approximately two metres deep and the littoral zones are dominated by Tall Spike-Rush and intermixed with a combination of emergent species identified in the wetland. Approximately 1.1 hectares of wetland occurs within the Proposal Site and a further 2.5 hectares of wetland will be fragmented from the current depression by the realignment.

Plate 3: Ephemeral wetland within the Proposal site, photo point located on centre line of the realignment looking to the north west. Realignment follows a smooth curve from the photo point toward the River Red Gum in the right background.

4.1.2 Weeds

No weeds proclaimed noxious in Narrandera Control Area were identified within the study area.

4.1.3 Conservation Status of Vegetation

The Proposal Site traverses three distinct vegetation communities: mixed grassland, River Red Gum woodland and ephemeral wetland. The mixed grassland that occurs on site is of low conservation value. The vegetation community occurs throughout the region and is derived from the clearance of Grey Box and River Red Gum woodland. The rapid assessment was not undertaken given that it is designed for communities with tree and shrub cover.

The two stands of River Red Gum woodland are of low conservation value for the region given their lack of interconnection, low number of hollow bearing trees and degraded understorey. The low conservation woodland is widely distributed along the Murrumbidgee River and secondary floodplains, including Sandy Creek. The majority of River Red Gum woodland within the floodplain of Sandy Creek but outside of the study area resembles these two stands.

The rapid assessment determined that the vegetation community is highly disturbed. Features of the two approach sites that contributed to this outcome include evidence of rabbits, evidence of grazing and clearing, presence of weeds, vehicle tracks, lack of canopy species regrowth and the presence of carnivorous feral animals.

The ephemeral wetland that occurs in the Proposal Site is filled annually by irrigation flows within Sandy Creek. The regular wetting has created a wetland dominated by native aquatic species. The wetland is a natural feature but has been regularly inundated by irrigation supplies and is of moderate conservation value for the region as it supports a diverse range of fauna. The wetland has a number of different inundation depths and a mosaic of habitats, including approximately eight hectares of dense *Juncus sarophorus*. to 1.5 metres in height and numerous open water areas containing several emergent species.

4.2 Fauna

Avifauna was the most common fauna group observed with 47 species recorded during the surveys. Ten mammal, three reptile, two fish and four amphibian species were also recorded. The species list compiled during the survey is located in Appendix 2.

Two threatened fauna species, Superb Parrot (*Polytelis swainsonii*) and Grey-crowned Babbler (*Pomatostomus temporalis*), were identified during the survey period.

Common bird species observed during the survey included Eastern Rosella (*Platycercus eximius*), Australian Magpie (*Gymnorhina tibicen*), Golden-headed Cisticola (*Cisticola exilis*), Galah (*Cacatua roseicapilla*) and Purple Swamphen (*Porphyrio porphyrio).* The number of bird species observed during each 20 minute census ranged between 11 and 17, with an average of 13 species per census.

Four frog species were recorded during the survey and included the Eastern Froglet (*Crinia parinsignifera*), Barking Frog (*Limnodynastes fletcheri*), Spotted Grass Frog (*Limnodynastes tasmaniensis*) and Peron's Tree Frog (*Litoria peronii*). These were found within and adjacent to irrigation canals and in inundated wetland areas. With the exception of irrigation canals, frog were not found along the proposed route. Three reptiles were also identified: Boulenger's Skink (*Morethia boulengeri*), Red-bellied Black Snake (*Pseudoechis porphyriacus*) and Brown Snake (*Pseudonja textelis*).

A total of five bats, consisting of three species were captured in harp traps during the survey, and the White Striped Mastiff Bat was heard calling above the canopy (Table 4). A total of three passes were recorded in one night during Anabat surveys. Analysis of these passes revealed very low quality recordings making identifications impossible.

Table 4: Bat species captured during Harp trapping surveys, within River Red Gum woodland at Sandigo.

Species	Trap 1	Trap 2	Trap 3	Trap 4
Nyctophilus gouldi	-	-	-	2
Vespedelus regulus	-	-	1	1
Vespedelus vulturnus	-	-	-	1
Total Number of Bats Captured	0	0	1	4

4.3 Aquatic Habitat Assessment

The ephemeral wetland and riparian areas of Sandy Creek including two irrigation channels that bisect the Proposal Site were surveyed for aquatic habitat (Plate 4). A number of habitats were identified (Appendix 4). Table 5 provides a summary of the assessment.

Table 5: Summary of the aquatic habitat assessment conducted at Sandy Creek and associated floodplains, Sandigo. The assessment included approximately 200 metres of riparian habitat on Sandy Creek, approximately 200 metres of riparian habitat within the irrigation channels and two hectares of wetland habitat.

Site	Sandy Creek Riparian	Irrigation Channel Riparian	Ephemeral Wetland
Flow	Slow	Standing	Standing
Vegetation			
Cover abundance	40-50%	50%	90-100%
Emergent vegetation	Yes	Yes	Yes
Regeneration (*E. camaldulensis*)	Minor	Nil	Minor
Dominant species	*Eleocharis sphacelata, Eleocharis plana*	*Eleocharis sphacelata, Eleocharis plana*	*Juncus sarophorus, Eleocharis sphacelata, Ranunculus undosus*
Percent canopy cover	20 - 30%	<1	0
Exposed roots	No	No	No
Woody debris (<20cm in diameter)	Yes	No	Yes
Woody debris (>20cm in diameter)	No	No	No
Erosion	Minor	Nil	Minor
Recreational / livestock disturbance	Minor	Minor	Minor
Barriers to fish	No, earthen bridge	No	No

Site	Sandy Creek Riparian	Irrigation Channel Riparian	Ephemeral Wetland
movement	with good flow through		
Presence of Gravel Beds	No	No	No
Substrate	Heavy clay	Fine-coarse sand	Heavy clay

A list of aquatic vertebrate species, recorded during surveys below Yanco Weir approximately 70 river kilometres downstream, was obtained from NSW Fisheries (Table 6). A total of 18 species are recorded for the region, including the threatened Trout Cod (*Maccullochella macquariensis*) and Murray Hardyhead (*Craterocephalus fluviatilis*), and Fisheries Research Officers suggest that Silver Perch (*Bidyanus bidyanus*) is also likely to occur in the region. Although these species are likely to occur in the Murrumbidgee River a discussion of the relationships between the habitat observed within the study area and the species present is provided in Section 5.3. The potential impact of the Proposal upon these relationships is also discussed in this section.

Table 6: Aquatic species recorded within the Murrumbidgee below Yanco Weir, approximately 70 river kilometres downstream of the Proposal Site. The list also includes fish species that are likely to be found in the area, but were not captured during the surveys. Source, Narrandera Fisheries. Highlighted species are listed as threatened.

Scientific name	Common name	Habitat preference	FMA	EPBC
Bidyanus bidyanus	Silver Perch	Fast flowing waters, particularly around rapids, barrages and weirs.	V	
Carassius auratus *	Goldfish	Still and sluggish waters.		
Craterocephalus fluviatilis	Murray hardyhead	Slow flowing waters, swamps, billabongs, in and around submerged aquatic plants over gravel.	E	V
Craterocephalus stercusmuscarum	Non specked hardyhead	Usually schools in still or gently flowing water over sand, gravel or mud, as well as amongst marginal weeds		
Cyprinus carpio *	Carp	Still and gently flowing waters, especially where aquatic vegetation is prolific.		
Gadopsis marmoratus	River blackfish	Frequents diverse stream types from clear, fast flowing mountain streams to more sluggish, lowland rivers; prefers streams with abundant cover, such as snags and boulders.		

Scientific name	Common name	Habitat preference	FMA	EPBC
Gambusia holbrooki	Gambusia	Abundant in warm and gently flowing or still waters, mostly occurring around the margins and along the edges of aquatic vegetation beds.		
Hypseleotris species	Carp gudgeons	Lower reaches of streams and rivers in slow flowing and still waters around vegetation. Feeds upon small aquatic invertebrates and weeds.		
Maccullochella macquariensis	Trout Cod	Two distinct habitat types: Murray and Murrumbidgee River with various substrates and abundant in-stream cover of snags and woody debris; and Seven Creeks, a narrow stream of rock, gravel and sand substrates, and pools interspersed with rapids and cascades.	E	E
Maccullochella peelii	Murray Cod	Found in small, clear, rocky streams in upper western slopes to turbid slow-flowing rivers and creeks of the western plains. Resides in or near deep holes and prefers habitats containing cover such as rocks, fallen trees, stumps, clay banks or over-hanging vegetation.		
Macquaria ambigua	Golden perch	Warm, turbid, slow-flowing inland rivers. Also floodplain lakes and anabranches.		
Melanotaenia fluviatilis	Murray rainbowfish	Includes rivers, creeks, drains, billabongs, ponds and reservoirs, generally within marginal areas of these ecosystems.		

Scientific name	Common name	Habitat preference	FMA	EPBC
Nematalosa erebi	Bony herring	Found in most of the main flowing and some standing waters of western New South Wales, including billabongs, particularly occupying turbid waters.		
Perca fluviatilis *	Redfin Perch	Occurs mainly in still and slow-flowing waters, especially around prolific growths of aquatic vegetation.		
Philypnodon grandiceps	Flat-head gudgeon	Prefers quiet waters, particularly in lakes and dams, usually on weedy or mud bottoms.		
Philypnodon sp.1	Dwarf flat-headed Gudgeon	Tends to prefer relatively calm waters and lives over mud or rocks in weedy areas. Regularly occurs with *P. grandiceps*.		
Retropinna semoni	Australian Smelt	Occur in still and gently flowing waters of south eastern Australia.		
Tandanus tandanus	Freshwater catfish	Usually habitat is near the bottoms of lakes and slow-flowing rivers. The species is a carnivorous bottom-feeder and have limited habitat movements.		

Note: Habitat information was sourced from McDowall, 1996
FMA = Fisheries Management Act 1994
EPBC = Environment Protection and Biodiversity Conservation Act 1999
V = vulnerable species
E = endangered species
* = introduced species

Plate 4: Aquatic habitat typical of that identified in the ephemeral wetland within the Proposal Site. Note the *Juncus sarophorus* and *Eleocharis sphacelata*.

Macroinvertebrate sampling was undertaken within the ephemeral wetland and within the riparian zone of the eastern irrigation channel bisecting the Proposal Site (Appendix 4). Macroinvertebrates were identified to Family, with a number of taxon identified to Genus and one to species (Appendix 7). Given the variety of levels the macroinvertebrates are referred to as taxon.

Overall 26 macroinvertebrate taxa were identified from both sites. The irrigation channel samples contained a greater number of taxa than the wetland samples with 21 and 15 taxa, respectively. The irrigation channel contained 13 taxa not observed in the wetland and concurrently four species were unique to the wetland.

The irrigation channel samples were dominated by two families of water bug (Notonectidae, Corixidae), damselfly nymphe (Coenagrionidae) and midge larvae (Chironimdae). The wetland habitat was dominated by a genus of aquatic snail (*Physa* sp.), midge larvae (Chironimdae) and beetle larvae (Dytiscidae 2).

The wetland within the Proposal Site and the section of Sandy Creek is currently used for agricultural purposes. Cattle are grazed within the wetland and riparian areas surrounding Sandy Creek. Commercial and recreational fisheries do not appear to occur within the immediate vicinity of the Proposal Site.

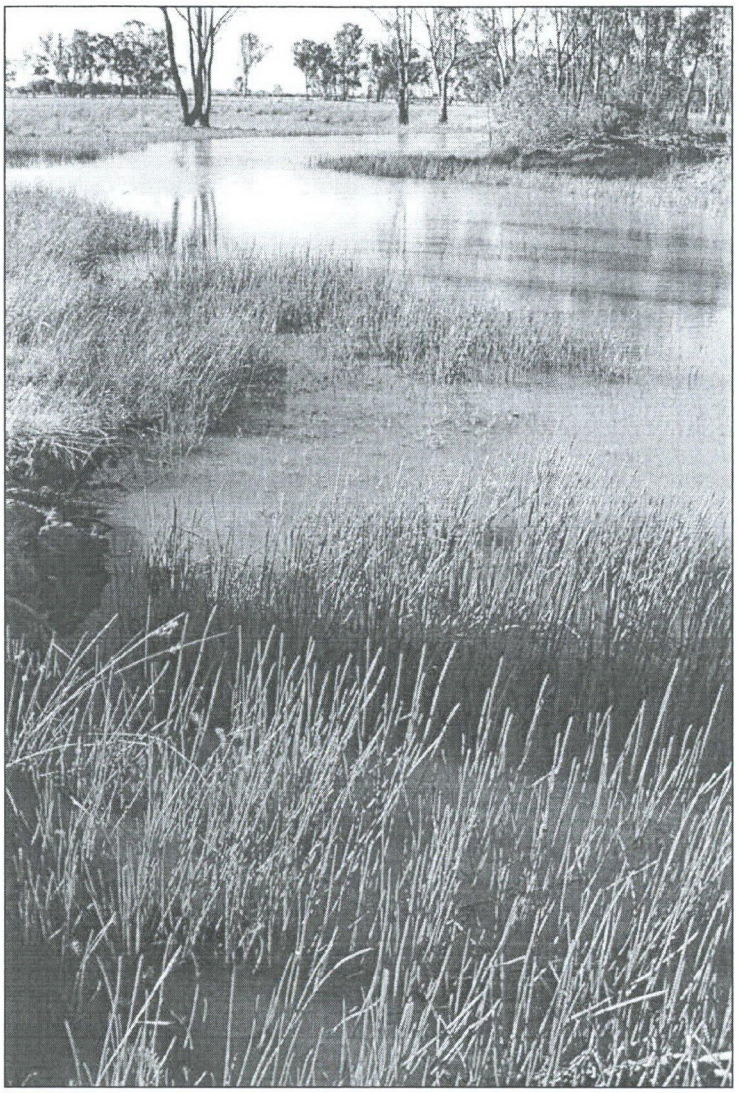


Plate 5: Aquatic habitat observed within Sandy Creek and two irrigation channels within the Proposal Site. These water bodies contained dense littoral beds of Tall Spike-Rush and a number of other emergent species such as Milfoil.

Three threatened species of fish are listed for the region encompassing the Proposal Site: Silver Perch (*Bidyanus bidyanus*), Trout Cod (*Maccullochella macquariensis*) and Murray Hardyhead (*Craterocephalus fluviatilis*). These records are from NSW Fisheries surveys in the Murrumbidgee River approximately 60 river kilometres from the site. Silver Perch and Trout Cod inhabit fast flowing rivers and creeks and utilise snags and barriers for habitat and are unlikely to occur within Sandy Creek given the lack of specific habitat and the streams low velocity. The Murray Hardyhead occurs in slow flowing rivers and creeks as well as billabongs. This species could potentially occur in the study area, inhabiting the wetland, associated irrigation channels and Sandy Creek.

4.4 Threatened Species Legislation

The species recorded in the area that are listed as threatened under the NSW *Threatened Species Conservation Act, 1995* (TSC Act), *Fisheries Management Act*, 1994 (FM Act)

and Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) are presented in Appendix 1 and 2. While there are several species (four flora, 30 fauna) listed that have a range that extends over the study area, only three species have been recorded within five kilometre radius of the Proposal Site: Superb Parrot (*Polytelis swainsonii*), Brolga (*Grus rubicundus*) and Western Starwort (*Callitriche cyclocarpa*). Fisheries surveys have not been conducted within the same proximity to the Proposal Site, however three threatened species (Silver Perch, Trout Cod and Murray Hardyhead) have been recorded within the region, approximately 70 river kilometres downstream of the study area.

4.4.1 Threatened Species Conservation Act & Fisheries Management Act

Species

Four flora species, 30 terrestrial fauna and three fish species are listed as threatened with a range extending over the study area. Of these species one threatened aquatic flora species (Western Starwort), seven terrestrial fauna (Southern Bell Frog, Grey-crowned Babbler, Superb Parrot, Australasian Bittern, Freckled Duck, Blue-billed Duck and Painted Snipe) and one fish species (Murray Hardyhead) may possibly occur in the immediate vicinity of the Proposal.

Surveys identified both Superb Parrot and Grey-crowned Babblers within the Proposal Site. Surveys did not identify any nesting Superb Parrots within the study area. A family of eight Grey-crowned Babblers was observed on a number of occasions within and surrounding the Proposal Site but no nests were identified.

The eight part test was applied to the Western Starwort, Southern Bell Frog, Grey-crowned Babbler, Superb Parrot, Australasian Bittern, Freckled Duck, Blue-billed Duck, Painted Snipe and Murray Hardyhead (Appendix 5). The assessment indicated that the Proposal, while reducing the potential area of inundation, should not significantly impact these species and that a Species Impact Statement (SIS) is not required. The Proposal will remove three hollow bearing trees and up to 52 River Red Gum trees without hollows. The loss of this magnitude will be insignificant in respect to the distribution of River Red Gum woodland in the region. Surveys indicated that Superb Parrots did not utilise these three hollow bearing trees as nesting sites.

However, the assessment identified that the new alignment may impact upon the movement of Grey-crowned Babblers between known habitat in the study area. Although this fragmentation of habitat may impact the family of Babblers identified during the survey considerable areas of interconnected habitat of similar quality exists to the north of the study area. Given this it is expected that the Proposal will not significantly affect the movement of Babblers within their home range.

Threatening Populations and Ecological Communities

There are no Threatened Populations or Ecological Communities listed for the Narrandera map sheet. The Riverina Population of Glossy-Black Cockatoo (*Calyptorhynchus lathami)* and Wagga Wagga Population of Squirrel Glider (*Petaurus norfolcensis*) are the only threatened population within the immediate region surrounding Narrandera, but occur near Griffith and at Wagga Wagga, respectively. Therefore these threatened populations were not addressed in the eight part tests.

Threatened Species Recovery Plans

Recovery Plans for the threatened species assessed in this document have not been finalised, and only one species recovery plan, the Southern Bell Frog, is in draft.

Threat Abatement Plans

There are currently thirteen key threatening processes listed under NPWS legislation and four listed under NSW Fisheries legislation. The Proposal will result in a small area of native River Red Gum woodland and ephemeral wetland being removed. Although this disturbance will be minor, the removal of native vegetation is the only key threatening process that the Proposal will produce.

There has only been one threat abatement plan finalised by NPWS for the European Fox. The Proposal will not result in changes to the ability of foxes or increases in fox numbers in the study area and therefore no threat abatement plans will be discussed.

4.4.2 State Environmental Protection Policy 44 – Koala Habitat Protection.

Step 1.

The provisions of SEPP 44 apply to the proposed development site, and the Proposal Site is potential koala (*Phascolarctos cinereus*) habitat. Narrandera local government area is listed in Schedule 1 of the policy. The study area contains River Red Gum (*Eucalyptus camaldulensis*) woodland, and it is the intention of the developer to remove approximately 0.2 hectares of this habitat.

Step 2.

Core Koala Habitat is defined in SEPP 44 (clause 4) as 'an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young), and recent sightings of and historical records of a koala population.

The River Red Gum woodland located within and around the Proposal Site is not core koala habitat. Surveys of the area did not observe resident populations of koalas and no recent sightings or historical records exist within the area. The only sightings of koala in the region occur within Narrandera State Forest where a population has been relocated.

4.4.3 Environment Protection and Biodiversity Conservation Act

Species

Superb Parrot (*Polytelis swainsonii*) was observed within the Proposal Site. Investigations suggested that this species, as well as the Southern Bell Frog (*Litoria raniformis*) and Murray Hardyhead (*Craterocephalus fluviatilis*) listed under the EPBC Act, may occur within the study area.

The impact of the Proposal upon the Superb Parrot was assessed using the EPBC Act Guidelines and indicated that there will not be a significant impact (Appendix 6). No nesting birds were observed during the survey, a period when movements and visibility of Superb Parrots between foraging areas and nest trees is high.

The Southern Bell Frog was also assessed and indicated that this species is unlikely to be adversely affected by the Proposal, if it occurs. Call play back and census of frog chorusing for this species was undertaken and did not identify this species in the study area. Further, areas of more suitable habitat, for example those areas of the wetland that contain open water, occur approximately 100 metres north of the Proposal Site and should not be impacted by the Proposal.

The Murray Hardyhead was once common in slow flowing streams, swamps and billabongs of southern New South Wales. This species has habitat preferences for submerged aquatic plants over gravel and given these preferences the Proposal Site constitutes potential habitat for the species although it lacks gravel substrate. The assessment has indicated that although the species may be present the Proposal is unlikely to pose a significant impact to the species.

International Agreements

The assessment indicated that the proposed activity will not significantly impact upon migratory species listed under the JAMBA and CAMBA agreements, given the lack of suitable habitat for these species within and around the Proposal Site (Appendix 6). Further, the absence of RAMSAR listed wetlands within the region means that this aspect of the matters of NES is not applicable to the RTA's Proposal.

5.0 Discussion

5.1 Impact of Proposal on Vegetation

The flora survey identified three vegetation communities: mixed grassland, River Red Gum woodland and ephemeral wetland. The mixed grassland that occurs on site is of low conservation value. The vegetation community occurs throughout the region and is derived from the clearance of Grey Box and River Red Gum woodland. This community contains one hollow bearing Grey Box and a mix of native and introduced species, being dominated by introduced species close to the current highway and dominated by native species as distance from the highway increased. The removal of approximately 3.2 hectares of mixed grassland will not have a significant impact upon vegetation within the local area or region given the magnitude of the clearance and the derived nature of the community.

The two stands of River Red Gum woodland are of low conservation value for the region given their fragmentation from surrounding woodland, low number of hollow bearing trees and degraded understorey. The low conservation woodland is widely distributed along the Murrumbidgee River and secondary floodplains, and the majority of woodland within the floodplain of Sandy Creek resembles these two stands. Approximately 0.2 hectares of River Red Gum woodland will be removed by the Proposal and consists of one hollow bearing tree, one stag and up to 52 trees without hollows. This loss of woodland to the region and local area is minor and will not significantly impact this community in the region and local area.

The ephemeral wetland that occurs in the Proposal Site is a natural depression but is filled regularly by irrigation flows within Sandy Creek. The regular wetting has created a wetland dominated by native aquatic species. The Proposal will result in the removal of approximately one hectare of this wetland community and the further isolation of 3.2 hectares of wetland that will be separated from the irrigation flows in Sandy Creek. Therefore a total of 4.2 hectares of wetland community will be impacted by the Proposal.

A further 16 hectares of interconnected wetland occurs to the north of the Proposal Site, and contains more diverse habitat than what exists within the study area. This habitat is also common along the secondary floodplains of the Murrumbidgee catchment in the region where irrigation flow frequently inundates natural depressions. The loss of this magnitude will not significantly impact upon the wetland vegetation community in the region or local area.

The Proposal can benefit the surrounding wetland and River Red Gum woodland through strategic weed management and revegetation programs. The wetland community is dominated by Juncus sp. and weed invasion within this regularly inundated wetland should be minor. Further revegetation within this community should not be warranted given that the growth and recovery of *Juncus sarophorus* in the depression should be rapid. However revegetation in disturbance areas should be undertaken to minimise erosion potential.

Revegetation of the River Red Gum woodland using native tree, shrub and ground cover species would enhance the habitat within the area. Weed and grazing management after the establishment of these plants will further enhance the areas habitat potential.

5.2 Impact of the Proposal on Fauna

The most significant possible impact upon fauna results from the removal of approximately 0.2 hectares of River Red Gum woodland and impacts on 4.2 hectares of ephemeral wetland. Similar fauna habitat extends well beyond the boundary of the Proposal Site and the removal of these areas of terrestrial and ephemeral aquatic habitat is unlikely to cause a permanent significant effect.

Up to 52 River Red Gum trees will be impacted as a result of the Proposal. These trees do not contain hollows and are of low structural diversity and thus provide limited refuge, nesting and roosting habitat for native fauna. Two hollow bearing and one standing dead tree (stag) will also be removed by the Proposal. Although the surrounding woodland and mixed grassland communities contain limited numbers of hollow bearing trees, the loss of this number of trees to native fauna in the region will be insignificant.

Superb Parrots have high nest fidelity, and commonly utilise hollows in mature River Red Gums during their breeding season (September – December). Given the season in which the survey was conducted, the habitat assessment was able to determine that no Superb Parrots were utilising trees within the Proposal Site. Target surveys of potential Superb Parrot nest sites are not necessary.

The wetland in the Proposal Site provides refuge, foraging and nesting habitat for a number of species within the study area and is connected to open water areas to the north of the study area. Although the habitat within the Proposal Site is utilised by native fauna more extensive areas of similar value habitat exists on the northern side of the realignment. During the construction period of the Proposal it is envisaged that native fauna will move from the impacted areas to those unaffected by the Proposal in the northern section of the study area.

Despite a number of hollow bearing trees and an area of approximately 4 hectares of wetland habitat being impacted by the Proposal, it is not expected to have a significant effect the non-threatened fauna in the local area. Fauna such as bats, arboreal mammals and other birds who may utilise this habitat for nesting and foraging, should be able to utilise similar habitat in the study area. However, the proposed works should be conducted outside of the breeding season (August – January) to limit potential impacts.

5.3 Impact on Aquatic Habitat

The aquatic habitat within the Proposal Site consists of ephemeral wetland and two irrigation channels. The wetland community occurs within a natural secondary floodplain depression but is more frequently inundated at present than it would naturally given the overflow from irrigation supplies from Sandy Creek. The habitat within the wetland community is dominated by *Juncus sarophorus* particularly in sections of the wetland that undergo minor inundation. The wetland also contains a number of open water areas to 50 centimetres in depth, the perimeter of which contained a mixture of Rush, Buttercup (*Ranunculus undosus*) and Ribbed Spike-Rush (*Eleocharis plana*) with a transition to Tall Spike-Rush (*Eleocharis sphacelata*) as water depth increased. The open water areas of the wetland are standing but are not stagnant.

The irrigation channels are approximately two metres deep and contain littoral zones dominated by Tall Spike-Rush and Ribbed Spike-Rush and open water areas containing a similar suite of species to the open water areas of the wetland. The water flow within these channels is negligible. Pumping stations are located at the southern ends of these channels, which feed water to channels on the southern side of the Sturt Highway.

The aquatic habitat provided in the Proposal Site is limited by the absence of coarse woody debris or snags. The channel and wetland habitats do, however, contain high structural diversity of emergent aquatic plants. These plants provide a mixture of floating, submerged and emergent habitat for aquatic fauna. However, given the magnitude of the Proposal and the location of the open water areas within the wetland it is expected that no significant changes to this aquatic habitat will occur. The area of *Juncus sarophorus* that will remain between the realigned highway and the open water areas of the wetland should provide a substantial buffer to pollutants, noise and predators.

Impact on wetland and Sandy Creek fauna

Macroinvertebrate sampling identified that substantial differences occur between communities within the wetland as apposed to those in the irrigation channel. This difference is suspected to be a function of habitat variability between sites. Although no fish surveys were conducted a number of native species may occur within Sandy Creek and perhaps the irrigation channel and wetland areas of the Proposal Site. This possibility is due to the slow to still flowing hydrology and the presence of diverse aquatic vegetation structures. The impact of the Proposal upon the threatened Murray Hardyhead was assessed using *TSC* Act and *EPBC* Act. The assessments indicated that although the species may occur in the habitat on site, no significant impact upon this species will occur.

A number of species including the threatened Trout Cod and Silver Perch are unlikely to occur within the habitat in the study area given flow conditions and lack of submerged coarse woody debris. Given the magnitude of the proposed works and adherence to recommended mitigation measures it is not thought that these species would be adversely impacted by the Proposal.

The Proposal does not include a barrier to natural fish movements and no other Proposals within the area have been identified and thus cumulative impacts are not expected. The lack of instream structural habitat within Sandy Creek and the irrigation channels reduces the value of this section of creek for native fish and macroinvertebrate species (Treadwell 1999).

Overall, the impacts on the aquatic habitat are likely to be short term, provided that a number of mitigation measures are adopted during the construction of the realignment. Following construction the highway is not likely to effect fish or aquatic habitat, although some increases in pollutants from the road surface during rain events may occur.

Fish and aquatic habitats are likely to be effected by:

- Sedimentation of the irrigation channel, creek and wetland from runoff, which may result in decreased light penetration through the water column essential for aquatic plant growth and sediment may fill holes that provide fish habitat,
- Removal of aquatic vegetation and emergent vegetation that provide habitat for aquatic fauna,

- Minor increases in oil and pollutant run off from the road surface during rainfall events.

Some of these potential impacts are an unavoidable part of constructing a new road way through wetland depressions and their impact should be low and of little significance. There will be no removal of large woody debris and riparian vegetation should not be significantly affected, limiting significant and long term impacts. Further, the rehabilitation of both riparian and instream aquatic habitat will help to ensure the maintenance of a healthy instream environment. A number of mitigation measures are recommended and should be adhered to during and following the development (Section 6).

5.4 Summary of Threatened Species Review

5.4.1 NSW Threatened Species Conservation Act and Fisheries Management Act

The eight part test has been applied to threatened species listed under NSW legislation known or likely to occur on site. Despite the limitations associated with a brief survey period, the review has indicated that the Proposal is not likely to have a significant impact on threatened species known or likely to occur in the area. No threatened populations or ecological communities will be impacted by the Proposal.

Similar habitat to that occurring within the Proposal Site exists throughout the region. As mentioned above a number of threatened species utilise River Red Gum woodland and ephemeral wetlands with dense and moderately high ground covers of similar conservation value. However, there are no records for any of these species within the study area and, further, the Proposal is of a small scale and will only remove a minor area in respect to the regional distribution of similar habitat. Therefore, it is extremely unlikely that the woodland and wetland constitutes critical habitat for these species.

Threats to threatened fish populations are minor, but would be further minimised by adhering to a series of mitigation measures. This includes appropriate sediment and erosion control and strategic revegetation programs.

State Environment Protection Policy 44 – Koala Habitat Protection

The assessment of core koala habitat was undertaken upon the River Red Gum woodland that occurs in the study area. The assessment indicated that the site is unlikely to support the species, and it was not considered to be core koala habitat. No further provisions of SEPP 44 apply to the Proposal.

5.4.2 Commonwealth Environment Protection and Biodiversity Conservation Act

Species

The Superb Parrot is listed as vulnerable under Commonwealth legislation and endangered under NSW legislation. Eight birds were observed flying over the study area but no nests or roosting sites were observed in trees along the proposed realignment during the survey. The survey was conducted during a peak activity period for nesting Superb Parrots a period when nest sites can be readily identified. The fact that no nests were identified during the

survey suggests that the species does not utilise the area for nesting and therefore the possibility of a significant impact is extremely low.

The Southern Bell Frog has been recorded in the region in a number of localities. This species was once common but has undergone considerable decrease in distribution. Call play back and census of frog chorusing was undertaken in a number of survey locations within the Proposal Site and the surrounding study area on two nights and failed to record the species. Survey conditions were good on both nights as evidenced by strong chorusing of other common species. Although no Southern Bell Frogs were identified the Proposal is of a magnitude and nature that it will have only a minor impact on amphibian species in the wetland community. Given this and the apparent absence of Southern Bell Frogs in the Proposal Site the assessment has indicated that a significant impact is unlikely to occur.

Murray Hardyhead utilise slow flowing streams, swamps and billabongs and congregate in and around submerged aquatic plants over gravel substrate. This species may occur within the Proposal Site given the habitat present, although it is suspected that if they do occur it would be through fish stocking programs within the Murrumbidgee River approximately ten river kilometres downstream (NSW Fisheries pers comm 2002). The proposed works do not constitute any threatening processes to the Murray Hardyhead.

International Agreements

The assessment indicated that the proposed activity will not significantly impact upon migratory species listed under the JAMBA and CAMBA agreements, given the lack of suitable habitat for these species within and around the Proposal Site (Appendix 6). Further, the absence of RAMSAR listed wetlands within the region means that this aspect of the matters of NES is not applicable to the RTA's Proposal.

6.0 Mitigation Measures

The following mitigation measures are recommended to reduce the likely potential impacts of the Proposal on the terrestrial and aquatic environment and include:

1. Production and implementation of a Sediment and Erosion Control Plan to reduce the likelihood of increased turbidity and sedimentation as a result of the Proposal. Increased turbidity and sedimentation may reduce light penetration through the water column restricting aquatic plant growth and disruption to fish habitat.
2. The road embankment should be sufficiently stabilised with sterile annual grasses and endemic native species to help reduce the risk of erosion and sedimentation.
3. The wetland and River Red Gum woodland should be rehabilitated and replanted using propagated ephemeral, terrestrial and aquatic native species from the area.
4. Works should occur when the proposed route and areas to the south are not inundated. This will lessen any impact on water birds, frogs and other fauna utilising inundated areas.
5. Felled River Red Gum trees should also be used to create terrestrial fauna habitat around the Proposal Site.
6. Removal of hollow bearing trees should occur during the period January to May to avoid the breeding season of bats, birds or arboreal fauna and the cooler months when some species may be in torpor.
7. Prior to lopping, hollow limbs should be checked by a qualified ecologist for the presence of fauna. It is possible that the initial disturbance of chain saws and other lopping equipment should cause these species to move on.
8. The extent of clearing and disturbance to the native vegetation should be kept to a minimum so that impact on flora and fauna is restricted.
9. Revegetation program (Section 6.1).

6.1 Revegetation Management Program

In response to the removal of native vegetation and disturbance of topsoil during the proposed works the RTA should undertake a revegetation program. The following revegetation management plan includes advice on the magnitude and species to be used in the program, grazing regime and monitoring. The revegetation program should target the wetland community and River Red Gum woodland.

6.1.1 Revegetation

Wetland Community

The ephemeral sections of the wetland are dominated by *Juncus sarophorus* and it is suspected that this species will regenerate rapidly following the disturbance. Open water areas in close proximity to the Proposal Site (50 metres) could be vegetated using a number of emergent and floating aquatic species if these areas are disturbed. Further, it may be necessary to rehabilitate the irrigation channel to minimise erosion. The aquatic plants to be included in the revegetation plan could include Ribbed Spike-Rush (*Eleocharis plana*), Tall Spike-Rush (*Eleocharis sphacelata*), Pondweed (*Potamogeton tricarinatus*) and Water Ribbons (*Triglochin procerum*). These species should be planted slightly under the water line, and if available, seed and rhizomes should be spread back up the bank to bank full height. Ground covers could include Tussock Grass (*Poa*

labillardieri), and Sedge (*Carex appressa*). The management of grazing within the riparian area will encourage the establishment of native grasses and suppress weed species.

River Red Gum Woodland

Tree planting at a ratio of ten trees to every one removed should be undertaken to compensate for the loss of River Red Gum and Grey Box. If possible, the revegetated area should be excluded from grazing until the trees and shrubs are well established.

Shrub planting should include the following species: Sweet Bursaria (*Bursaria spinosa*), Dwarf Cherry (*Exocarpus strictus*), Willow Wattle (*Acacia salicina*), Eumong (*Acacia stenophylla*) and Silver Wattle (*Acacia dealbata*). Equal numbers of shrubs to trees should be planted.

Ground covers include Plains Grass (*Austrostipa aristiglumis*), Warrego Summer Grass (*Paspalidium jubiflorum*), Wallaby Grass (*Austrodanthonia caespitosa*) and Sedge (*Carex appressa*). The management of grazing within the floodplain habitat will encourage the establishment of these native grasses and suppress weed species.

6.1.2 Grazing Regime

Grazing should be restricted or prevented altogether during plant establishment and when plants are starting their annual growth. Heavy grazing during this time can substantially weaken plantings and natural revegetation. Grazing should occur when plants are dormant, such as in winter, when there will be less impact upon plants as well as promoting plant vigour and seed and root production. Vegetation should also be spelled around the time of flowering and seed production in order to allow for continual replacement and maintenance of good vegetation cover.

Grazing impact will need to be monitored during the period when the animals have access to the replanting area. This will enable the program to assess whether grazing intensity is too high or too low, and to move stock before vegetation degradation becomes a problem.

6.1.3 Monitoring

Revegetated areas will need to be monitored every two months for the first six months and then every 6 months for two years. Monitoring should assess establishment success, weed abundance and grazing impacts.

Plant species suitable for the revegetation program are listed in Table 7.

Table 7: Suitable species for the revegetation program.

Trees	Shrubs	Ground covers	Aquatic/wetland Plants
Eucalyptus camaldulensis	*Bursaria spinosa*	*Austrostipa aristiglumis*	*Eleocharis plana*
Eucalyptus microcarpa	*Acacia dealbata*	*Austrodanthonia caespitosa*	*Eleocharis sphacelata*
Casuarina cunninghamiana	*Exocarpus strictus*	*Paspalidium jubiflorum*	*Phragmites australis*
	Acacia salicina	*Carex appressa*	*Potamogeton tricarinatus*
	Acacia stenophylla		*Triglochin procerum*

7.0 References

ANZECC (2000) Australian & New Zealand guidelines for fresh and marine water quality Vol 1, Chapter 3 section 3.3 pp 5-11, the guidelines, ANZECC & Agriculture and Resource Management Council of Australia & New Zealand. Canberra.

Ayers, D., Nash, S. and Baggert, K. (1996) *Threatened Species of Western New South Wales.* NSW National Parks and Wildlife Service, Hurstville, Sydney.

Barker, J., Grigg, G.C. and Tyler, M. (1995). *A Guide to Australian Frogs.* Surrey Beatty & Sons, Chipping Norton.

Bureau of Meteorology (2002) *Climate averages* (online). Http://www.bom.gov.au [Accessed November 2002].

Churchill, S. (1998) *Australian Bats.* New Holland Publishers, Australia.

Cogger, H.G. (1994) *Reptiles and Amphibians of Australia.* Reed Books, Chatswood.

Costermans, L. (1991) *Native Trees and Shrubs of South-Eastern Australia.* Weldon Publishing, Sydney.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. and Leigh, J.H. (1992) *Plants of Western New South Wales.* Inkata Press, Melbourne.

Douglas, J.W., Gooley, G.J., and Ingram, B.A. (1994). *Trout Cod,* Maccullochella macquariensis *(Cuvier)(Pisces: Pericicthyidae), Resource Handbook and Research and recovery plan.* Department of Conservation and Natural Resources. Work and Turner Pty Ltd, Victoria.

DUAP. (1995) *State Environmental Planning Policy number 44 – Koala Habitat Protection.* Circular no. B35. Department of Urban Affairs and Planning, Sydney.

Eardley, K.A. (1999) *A Foundation for Conservation in the Riverina Bioregion.* Unpublished Report, NSW National Parks and Wildlife Service.

Goldney, D.C. (1997) *Save the Bush Toolkit.* Environmental Studies Unit, Charles Sturt University, Bathurst and Orange Agricultural College, Orange.

Harden, G. J. (1990-93) *Flora of New South Wales.* **Volumes 1-4.** New South Wales University Press, Kensington, New South Wales.

Kent, K., Earl, G., Mullins, B., Lunt, I. and Webster, R. (2002) *Native Vegetation Guide for the Riverina: notes for land managers on its management and revegetation.* Johnstone Centre, Charles Sturt University.

Lamp, C. and Collet, F. (1989) *Field Guide to Weeds in Australia.* Inkata Press, Melbourne.

McDowall, R. *Freshwater Fishes of South-eastern Australia.* Reed Books, Syndey.

NSW Agriculture (2002). *Noxious Weeds in New South Wales* (online). http://www.agric.nsw.gov.au/noxweed/ [Accessed November 2002].

NSW Fisheries Service (1999). Policy & Guidelines - Aquatic Habitat Management and Fish Conservation 1999. *Minimum Information Requirements for Aquatic Environmental Assessment.* NSW Fisheries Service, Sydney.

NSW National Parks and Wildlife Service (1997a). *New South Wales legislation administered by us* (online). Http://www.npws.nsw.gov.au/about/legislat.htm [Accessed November 2002].

NSW National Parks and Wildlife Service (1997b). *Threatened Species Conservation* (online). http://www.npws.nsw.gov.au/wildlife/threaten.htm [Accessed November 2002].

NSW National Parks and Wildlife Service (2002) *Wildlife Atlas* (online). http://www.npws.nsw.gov.au [Accessed November 2001]

Readers Digest (1986) *Complete Book of Australian Birds.* Readers Digest Services Pty Ltd, Sydney.

Romanowski, N. (1998) *Aquatic and wetland plants: A field guide for non-tropical Australia.* UNSW Press, Sydney.

Simpson, K. and Day, N. (1993) *Field Guide to the Birds of Australia.* Viking, Penguin Books, Australia, Pty Ltd.

Strahan, R. (1983) (ed.) *Complete Book of Australian Mammals,* The Australian Museum. Angus & Robertson.

Treadwell, S. (1999) 'Managing snags and large woody debris' in S. Lovett and P. Price (eds), *Riparian Land Management Technical Guidelines, Volume two: On-ground Management Tools and Techniques*, Land and Water Resources and Development Corporation, Canberra, pp. 15-22.

Appendix 1

Flora Species List

The table below includes data from the NPWS Wildlife Atlas, EPBC database and CSU survey. The table provides species lists and indicates the conservation status of threatened species (highlighted) as they are described under New South Wales and Commonwealth Environmental Legislation. The following codes are included in the table:

NPWS = NSW National Parks and Wildlife Service Atlas database records for map 7929.
CSU WET= Transect results recorded from ephemeral wetland conducted by CSU in October 2002.
CSU OG = Transect results recorded from open grassland conducted by CSU in October 2002.
CSU RRG = Transect results recorded from River Red Gum woodland conducted by CSU in October 2002.
TSC = NSW Threatened Species Conservation Act 1995.
EPBC = Commonwealth Environment Protection and Biodiversity Conservation Act 1999.
V = vulnerable species, E = endangered species.

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Adiantaceae							
Cheilanthes austrotenufolia	Rock Fern	✓					
Cheilanthes sieberi spp *sieberi*		✓					
Aizoaceae							
Glinus lotoides		✓					
Zaleya galericulata		✓					
Alismataceae							
Alisma plantago-aquatica	Water Plantain	✓					
Damasonium minus	Starfruit	✓					
Amaranthaceae							
Alternanthera denticulata	Lesser Joyweed	✓					
Alternanthera nana	Hairy Joyweed	✓					
Amaranthus macrocarpus	Dwarf Amaranth	✓					
Ptilotus gaudichaudii		✓					
Ptilotus seminudus	Rabbit Tails	✓					
Ptilotus spathulatus f. spathulatus	Pussy Tails	✓					
Amaryllidaceae							
Calostemma purpureum	Garland Lily	✓					
Anacardiaceae							
Schinus areira #	Pepper Tree	✓					
Anthericaceae							
Arthropodium minus	Small Vanilla-lily	✓					
Dichopogon fimbriatus	Nodding Chocolate Lily	✓					
Dichopogon strictus	Chocolate Lily	✓					
Laxmannia compacta		✓					
Thysanotus baueri		✓					
Tricoryne elatior	Yellow Autumn-lily	✓					
Apiaceae							
Daucus glochidiatus	Austral Carrot	✓					
Eryngium ovinum	Blue Devil	✓					
Eryngium plantagineum	Long Eryngium	✓					
Hydrocotyle callicarpa	Tiny Pennywort	✓					
Hydrocotyle laxiflora	Stinking Pennywort	✓					
Platysace lanceolata		✓					
Trachymene cyanopetala	Purple Parsnip	✓					
Apocynaceae							
Parsonia eucalyptophylla	Gargaloo	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Asparagaceae							
Myrsiphyllum asparagoides	Florist's Smilax	✓					
Asphodelaceae							
Bulbine bulbosa	Bulbine Lily	✓					
Bulbine semibarbata	Wild Onion	✓					
Aspleniaceae							
Pleurosorus rutifolius		✓					
Asteraceae							
Actinobole uliginosum	Flannel Cudweed	✓					
Arctotheca calendula #	Cape Weed	✓		✓			
Aster subulatus	Aster-weed	✓					
Brachyscome basaltica var. *gracilis*	Woodland Swamp-daisy	✓					
Brachyscome ciliaris	Variable Daisy	✓					
Brachyscome diversifolia		✓					
Brachyscome goniocarpa	Dwarf Daisy	✓					
Brachyscome gracilis		✓					
Brachyscome lineariloba	Hard-headed Daisy	✓					
Brachyscome perpusilla var. *tenella*	Tiny Daisy	✓					
Bracteantha bracteata	Golden Everlasting	✓					
Bracteantha viscosa	Sticky Everlasting	✓					
Calocephalus sonderi	Pale Beauty-heads	✓					
Calotis anthemoides	Cut-leaved burr-daisy	✓					
Calotis cuneifolia	Purple Burr-daisy	✓					
Calotis hispidula	Bogan Flea	✓			✓		
Calotis lappulacea	Yellow Burr-daisy	✓					
Calotis scabiosifolia	Rough Burr-daisy	✓					
Calotis scapigera	Tufted Burr-daisy	✓			✓		
Carduus pycnocephalus #	Slender Thistle	✓					
Carduus tenuiflorus	Winged Thistle	✓					
Carthamus lanatus #	Saffron Thistle	✓					
Cassinia laevis	Cough Bush	✓					
Centaurea melitensis #	Maltese Cockspur	✓					
Centipeda cunninghamii	Common Sneezeweed	✓	✓				
Chondrilla juncea	Skeleton Weed	✓					
Chrysocephalum apiculatum	Common Everlasting	✓					
Chrysocephalum semipapposum	Clustered Everlasting	✓					
Cirsium vulgare #	Spear Thistle	✓	✓	✓	✓		
Conyza bonariensis #	Flaxleaf Fleabane	✓					
Conyza sumatrensis #		✓					
Cotula australis	Common Cotula	✓		✓			
Cotula bipinnata	Ferny Cotula	✓					
Cotula coronopifolia	Water Buttons	✓					
Cymbonotus preissianus		✓					
Dittrichia graveolens	Stinkweed	✓					
Eclipta platyglossa	Yellow Twin-heads	✓					
Eriochlamys behrii	Woolly Mantle	✓					
Euchiton gymnocephalus	Creeping Cudweed	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Euchiton involucratus	Star Cudweed	✓					
Euchiton sphaericus	Annual Cudweed	✓					
Gamochaeta spicata		✓					
Hedypnois rhagadioloides ssp *cretica*	Cretan Weed	✓					
Hyalosperma demissum		✓					
Hyalosperma semisterile	Orange Sunray	✓					
Hypochoeris glabra	Smooth Cat's-ear	✓					
Hypochoeris radicata #	Flatweed	✓					
Isoetopsis graminifolia	Grass Cushion	✓					
Ixiolaena leptolepis	Narrow Plover-daisy						
Lactuca saligna	Willow-leaved Lettuce						
Lactuca serriola #	Prickly Lettuce	✓		✓			
Leontodon taraxacoides ssp. *Taraxacoides*	Hairy Hawkbit	✓					
Leptorhynchos panaetioides	Woolly Buttons	✓					
Leptorhynchos tetrachaetus	Beauty Buttons	✓					
Leucochrysum molle	Hoary Sunray	✓					
Millotia myosotidifolia	Broad-leaved Millotia	✓					
Minuria denticulata		✓					
Minuria leptophylla	Minnie Daisy	✓					
Myriocephalus rhizocephalus	Woolly-heads	✓					
Olearia pimeleoides		✓					
Olearia ramulosa		✓					
Olearia tenuifolia		✓					
Podolepis arachnoidea	Cluster copper-wire Daisy	✓					
Pseudognaphalium luteo-album	Jersey Cudweed	✓					
Rhodanthe corymbiflora	Paper Sunray	✓					
Rhodanthe diffusa		✓					
Rhodanthe laevis	Smooth Sunray	✓					
Rhodanthe polygalifolia	Brilliant Sunray	✓					
Rhodanthe pygmaea	Pigmy Sunray	✓					
Senecio quadridentatus	Cotton Fireweed	✓					
Solenogyne bellioides		✓					
Solenogyne dominii		✓					
Solenogyne stolonifera	Jo-jo	✓					
Solvia stolonifera	Carpet Burrweed	✓					
Sonchus asper #	Rough Sow-thistle	✓	✓		✓		
Sonchus oleraceus #	Common Sow-thistle	✓	✓		✓		
Stuartina hamata	Prickly Cudweed	✓					
Stuartina muelleri	Spoon Cudweed	✓					
Tagetes minuta	Stinking Roger	✓					
Taraxacum officinale #	Dandelion	✓			✓		
Tragopogon porrofolius	Salsify	✓					
Triptilodiscus pygmaeus	Common Sunray	✓					
Vittadinia cuneata	Fuzzy New Holland Daisy	✓					
Vittadinia dissecta	Dissected New Holland Daisy	✓					
Vittadinia gracilis	Woolly New Holland Daisy	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Vittadinia sp.				✓	✓		
Xanthium occidentale	Noogoora Burr	✓					
Xanthium spinosum #	Bathurst Burr	✓					
Azollaceae							
Azolla filiculoides	Pacific Azolla	✓					
Bignoniaceae							
Pandorea pandorana	Wonga Wonga Vine	✓					
Boraginaceae							
Cynoglossum suaveolens		✓					
Echium plantagineum #	Paterson's Curse	✓	✓	✓	✓		
Heliotropium europaeum	Common Heliotrope	✓					
Myosotis discolor	Forget-me-not	✓					
Brassicaceae							
Brassica rapa ssp *syvestris*	Turnip	✓					
Brassica tournefortii	Mediterranean Turnip	✓					
Capsella bursa-pastoris #	Shepherd's Purse	✓					
Harmsiodoxa blennodioides		✓					
Lepidium africanum	Common Peppercress	✓					
Lepidium aschersonii	Spiny Peppercress	✓					
Lepidium pseudohyssopifolium	Peppercress	✓		✓			
Rorippa laciniata		✓					
Rorippa nasturtium aquaticum	Watercress	✓					
Rorippa palustris	Yellow Marsh-cress	✓					
Sisymbrium irio	London Rocket	✓					
Sisymbrium orientale #	Hedge Mustard	✓					
Cactaceae							
Opuntia stricta		✓					
Callitrichaceae							
Callitriche cyclocarpa		✓					
Callitriche sonderi	Matted Water-starwort	✓					
Campanulaceae							
Wahlenbergia communis	Tufted Bluebell	✓					
Wahlenbergia fluminalis	River Bluebell	✓					
Wahlenbergia gracilenta	Annual Bluebell	✓					
Wahlenbergia gracilis	Sprawling Bluebell	✓					
Wahlenbergia luteola		✓					
Wahlenbergia stricta	Tall Bluebell	✓					
Caprifoliaceae							
Lonicera japonica	Japanese Honeysuckle	✓					
Caryophyllaceae							
Cerastium balearicum	Lesser Mouse-ear Chickweed	✓					
Cerastium glomeratum #	Mouse-eared Chickweed	✓					
Paronychia brasiliana	Chilean Whitlow Wort	✓					
Petrorhagia velutina		✓					
Sagina apetala	Common Pearlwort	✓					
Sagina gallica		✓					
Spergularia rubra	Red Sand-spurrey	✓					
Stellaria angustifolia	Swamp Starwort	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Stellaria media	Common Chickweed	✓					
Casuarinaceae							
Allocasuarina luehmannii	Buloke	✓					
Allocasuarina verticillata	Drooping Sheoak	✓					
Casuarina cunninghamiana	River Sheoak	✓					
Centrolepidaceae							
Centrolepis strigosa ssp strigosa		✓					
Chenopodiaceae							
Atriplex limbata		✓					
Atriplex semibaccata	Berry Saltbush	✓		✓	✓		
Atriplex spinibractea		✓					
Atriplex suberecta	Sprawling Saltbush	✓					
Chenopodium album	Fat Hen	✓					
Chenopodium ambrosioides	Mexican Tea	✓					
Chenopodium desertorum	Frosted Goosefoot	✓					
Chenopodium melanocarpum	Black Crumbweed	✓					
Chenopodium nitrariaceum	Nitre Goosefoot	✓					
Chenopodium pumilio	Clammy Goosefoot	✓					
Einadia hastata	Berry Saltbush	✓					
Einadia nutans	Climbing Saltbush	✓		✓			
Enchylaena tomentosa	Ruby Saltbush	✓					
Maireana brevifolia	Short-leaf Bluebush	✓					
Maireana decalvans	Black Cotton-bush			✓			
Maireana enchylaenoides	Wingless Bluebush	✓		✓			
Maireana humillima		✓					
Maireana microphylla		✓					
Maireana pentagona	Hairy Bluebush	✓					
Rhagodia spinescens	Hedge Saltbush	✓					
Salsola kali				✓			
Salsola tragus		✓					
Sclerolaena birchii	Galvanised Burr	✓					
Sclerolaena muricata	Black Roly-poly			✓	✓		
Clusiaceae							
Hypercium gramineum	Small St John's Wort	✓					
Hypercium perforatum	St. John's Wort	✓					
Colchicaceae							
Wurmbea dioica ssp *dioica*	Early Nancy	✓					
Convonvulaceae							
Convolvulus arvensis		✓					
Convolvulus erubescens	Pink Bindweed	✓		✓	✓		
Cressa australis		✓					
Dichondra sp.A		✓					
Crassulaceae							
Crassula colorata	Dense Crassula	✓					
Crassula decumbens var. *decumbens*	Spreading Crassula	✓					
Crassula helmsii	Swamp Stonecrop	✓					
Crassula peduncularis	Purple Crassula	✓					
Crassula sieberiana	Sieber Crassula	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Crassula sp.				✓			
Cucurbitaceae							
Citrullus lanatus var *lanatus*	Wild Melon	✓					
Cucumis myriocarpus ssp. *Leptodermis* #	Paddy Melon	✓					
Cupressaceae							
Callitris endlicheri	Black Cypress Pine	✓					
Callitris glaucophyllus	White Cypress Pine	✓					
Cyperaceae							
Bolboschoenus medianus		✓					
Carex appressa		✓					
Carex bichenoviana		✓					
Carex inversa	Knob Sedge	✓					
Carex tereticaulis		✓					
Cyperus difformis	Variable Flat-sedge	✓					
Cyperus eragrostis #	Drain Flat-sedge	✓		✓			
Cyperus exaltatus		✓					
Cyperus gymnocaulos		✓					
Eleocharis acuta	Common Spike-sedge	✓					
Eleocharis plana		✓	✓				
Eleocharis sphacelata	Tall Spike Rush	✓	✓				
Isolepis congrua		✓					
Isolepis hookeriana		✓					
Isolepis marginata	Little Club-sedge	✓					
Lepidosperma laterale		✓					
Schoenus apogon	Fluke Bogrush	✓					
Dilleniaceae							
Hibbertia obtusifolia		✓					
Hibbertia riparia		✓					
Droseraceae							
Drosera auriculata		✓					
Drosera glanduligera	Pimpernel Sundew	✓					
Drosera peltata		✓					
Elatinaceae							
Elatine gratioloides	Waterwort	✓					
Epacridaceae							
Astroloma humifusum	Native Cranberry	✓					
Melichrus urceolatus	Urn Heath	✓					
Euphorbiaceae							
Beyeria viscosa		✓					
Chamaesyce drummondii	Flat Spurge	✓					
Euphorbia depauperata		✓					
Euphorbia drummondii	Caustic weed	✓			✓		
Euphorbia helioscopia		✓					
Euphorbia peplus	Petty Spurge	✓					
Phyllanthus hirtellus		✓					
Poranthera microphylla	Small Poranthera	✓					
Fabaceae (Caesalpinioideae)							

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Cassia eremophila var eremophila		✓					
Senna artemisioides		✓					
Fabaceae (Faboideae)							
Chamaecytisus palmensis #	Tree Lucerne	✓					
Daviesia ilicifolia	Gorse Bitter Pea	✓					
Dillwynia sericea		✓					
Eutaxia microphylla		✓					
Glycine canescens		✓					
Glycine clandestina		✓					
Glycine tabacina		✓					
Glycyrrhiza acanthocarpa	Southern Liquorice	✓					
Indigofera australis		✓					
Lupinus angustifolius	Narrow-leaved Lupin	✓					
Medicago luteus	Yellow Lupin	✓					
Medicago minima #	Woolly Burr Medic	✓					
Medicago polymorpha #	Burr Medic	✓					
Medicago praecox #			✓				
Medicago sativa #	Lucerne	✓					
Medicago truncatula #	Barrel Medic	✓	✓		✓		
Melilotus albus	Bokhara	✓					
Mirbelia pungens		✓					
Pultenaea largiflorens		✓					
Swainsona oroboides	Variable Swainson-pea	✓					
Swainsona procumbens	Broughton Pea	✓					
Trifolium angustifolium #	Narrow-leaf Clover	✓		✓			
Trifolium arvense #	Hare's-foot Clover	✓					
Trifolium campestre #	Hop Clover	✓					
Trifolium dubium #	Yellow-suckling Clover	✓					
Trifolium glomeratum #	Clustered Clover	✓					
Trifolium pratense #	Red Clover	✓					
Trifolium repens #	White Clover	✓					
Trifolium resupinatum	Shaftal Clover	✓					
Trifolium sp.			✓				
Trifolium striatum #	Knotted Clover	✓					
Trifolium subterraneum #	Subterraneam Clover	✓					
Trifolium tomentosum #	Woolly Clover	✓					
Vicia sativa #	Common Vetch	✓					
Fabaceae (Mimosoideae)							
Acacia acinacea	Gold-dust Wattle	✓					
Acacia brachybotrya	Grey Mulga	✓					
Acacia buxifolia	Box-leaved Wattle	✓					
Acacia deanei	Green Wattle	✓					
Acacia decora	Western Golden Wattle	✓					
Acacia doratoxylon	Currawang	✓					
Acacia hakeoides	Hakea Wattle	✓					
Acacia implexa	Hickory Wattle	✓					
Acacia montanta	Mallee Wattle	✓					
Acacia oswaldii	Miljee	✓					
Acacia paradoxa	Kangaroo Thorn	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Acacia pendula	Boree	✓					
Acacia pycnantha	Golden Wattle	✓					
Acacia salicina	Cooba	✓					
Acacia stenophylla	River Cooba	✓					
Fumariaceae							
Fumaria bastardii	Bastards Fumitory	✓					
Fumaria capreolata	Climbing Fumitory	✓					
Fumaria densiflora	Narrow-leaved Fumitory	✓					
Gentianaceae							
Centaurium erythraea	Common Centaurium	✓					
Centaurium spicatum	Spike Centaurium	✓					
Centaurium tenuiflorum		✓					
Centaurium quadrangularis		✓					
Cicendia quadrangularis		✓					
Sebaea ovata	Yellow Centaury	✓					
Geraniaceae							
Erodium botrys #	Long Storksbill	✓					
Erodium cicutarium #	Common Heron's-bill	✓					
Erodium crinitum	Blue Heron's-bill	✓					
Erodium moschatum #	Musky Crowfoot	✓					
Geranium molle	Cranesbill Geranium	✓					
Geranium retrorsum	Cut-leaf Cranesbill	✓					
Geranium solanderi	Native Geranium	✓					
Goodeniaceae							
Dampiera lanceolata		✓					
Goodenia cycloptera		✓					
Goodenia fascicularis	Silky Goodenia	✓			✓		
Goodenia glabra		✓					
Goodenia heteromera	Spreading Goodenia	✓					
Goodenia pinnatifida	Cut-leaf Goodenia	✓					
Goodenia pusilliflora	Small-flower Goodenia	✓					
Velleia paradoxa		✓					
Haloragaceae							
Gonocarpus elatus		✓					
Haloragis aspera	Rough Raspwort	✓					
Haloragis heterophylla	Variable Raspwort	✓					
Myriophyllum propinquum		✓					
Myriophyllum sp.			✓				
Myriophyllum verrucosum	Red Water-milfoil	✓					
Hydrocharitaceae							
Elodea canadensis	Elodea	✓					
Hypoxidaceae							
Hypoxis glabella var *glabella*	Tiny Star	✓					
Iridaceae							
Moraea setifolia	Thread Iris	✓					
Romulea rosea var *australis*	Onion Grass	✓					
Juncaceae							
Juncus amabilis		✓					
Juncus aridicola	Tussock Rush	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Juncus articulatus		✓					
Juncus bufonius	Toad Rush	✓					
Juncus capitatus		✓					
Juncus flavidus		✓					
Juncus holoschoenus		✓					
Juncus homalocaulis		✓					
Juncus ingens		✓					
Juncus radula		✓					
Juncus remotiflorus		✓					
Juncus sarophorus		✓	✓				
Juncus subglaucus		✓					
Juncus subsecundus	Finger Rush	✓					
Juncus spp.					✓		
Juncus usitatus		✓					
Luzula densiflora		✓					
Luzula flaccida		✓					
Luzula meridionalis		✓					
Juncaginaceae							
Triglochin procerum		✓	✓				
Lamiaceae							
Ajuga australis	Austral Bugle	✓					
Lamium amplexicaule	Dead Nettle	✓					
Marrubium vulgare #	Horehound	✓					
Mentha australis	River Mint	✓					
Mentha pulegium	Pennyroyal	✓					
Mentha satureioides	Native Pennyroyal	✓					
Prostanthera nivea	Snowy Mint-bush	✓					
Prostanthera ovalifolia		✓					
Salvia verbenaca	Wild Sage	✓					
Scutellaria humilis	Dwarf Skullcap	✓					
Stachys arvensis	Stagger Weed	✓					
Teucrium racemosum	Grey Germander	✓					
Lemnaceae							
Lemna disperma		✓					
Spirodela punctata		✓					
Linaceae							
Linum marginale	Native Flax	✓					
Lobeliaceae							
Isotoma axillaris	Showy Isotome	✓					
Pratia concolor	Poison Pratia	✓	✓	✓	✓		
Loganiaceae							
Mitrasacme paradoxa		✓					
Lomandraceae							
Lomandra effusa	Scented Mat-rush	✓					
Lomandra filiformis	Wattle Mat-rush	✓					
Lomandra leucocephala	Woolly Mat-rush	✓					
Lomandra longifolia	Spiny-headed Mat-rush	✓					
Lomandra multiflora	Many-flowered Mat-rush	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Lomandra patens		✓					
Loranthaceae							
Amyema miquelii	Box Mistletoe	✓			✓		
Amyema quandang		✓					
Lysiana exocarpi		✓					
Lythraceae							
Ammannia multiflora	Jerry-jerry						
Lythrum hyssopifolia	Small Loosestrife	✓		✓			
Malvaceae							
Abutilon halophilum	Plains Lantern-bush	✓					
Malva parviflora #	Small-flower Mallow	✓		✓	✓		
Modiola caroliniana	Red-flowered Mallow	✓					
Sida corrugata	Variable Sida	✓		✓	✓		
Sida cunninghamii		✓					
Sida trichopoda		✓			✓		
Marsileaceae							
Marsilea costulifera		✓					
Marsilea drummondii	Common Nardoo	✓	✓	✓			
Meliaceae							
Melia azedarach #	White Cedar	✓					
Menyanthaceae							
Nymphoides crenata	Wavy Marshwort	✓	✓				
Moraceae							
Maclura pomifera	Osage Orange	✓					
Myoporaceae							
Eremophila debilis	Amulla	✓					
Eremophila longifolia	Berrigan	✓					
Myrtaceae							
Calytrix tetragona		✓					
Eucalyptus blakelyi	Blakely's Red Gum	✓					
Eucalyptus camaldulensis	River Red-gum	✓	✓		✓		
Eucalyptus dealbata	Tumbledown Gum	✓					
Eucalyptus dwyeri	Dwyer's Red Gum	✓					
Eucalyptus largiflorens	Black Box	✓					
Eucalyptus melliodora	Yellow Box	✓					
Eucalyptus microcarpa	Western Grey Box	✓		✓			
Eucalyptus populnea	Bimble Box	✓					
Eucalyptus sideroxylon	Mugga Ironbark	✓					
Nitrariaceae							
Nitraria billardierei	Dillon Bush						
Nyctaginaceae							
Boerhavia dominii	Tarvine	✓					
Oleaceae							
Jasminium lineare	Desert Jasmine						
Olea europaea ssp. *europaea #*	Olive	✓					
Onagraceae							
Epilobium billardiereanum		✓					
Epilobium ciliatum		✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Epilobium spp.		✓					
Ludwigia peploides ssp. *montevidensis*	Clove-strip	✓					
Ophioglossaceae							
Ophioglossum lustanicum	Adder's Tongue	✓					
Orchidaceae							
Caladenia arenaria		✓				E1	
Caladenia carnea	Pink Fingers	✓					
Caladenia catenata	White Caladenia	✓					
Caladenia concinna	A Spider Orchid	✓					
Calochilus robertsonii	Purplish Beard Orchid	✓					
Cyanicula caerulea	Blue Caladenia	✓					
Diuris maculata	Spotted Doubletail	✓					
Glossodia major	Waxlip Orchid	✓					
Microtis unifolia	Common Onion Orchid	✓					
Pterostylis biseta		✓					
Pterostylis mutica	Midget Greenhood	✓					
Pterostylis nana	Dwarf Greenhood	✓					
Pterostylis revoluta		✓					
Thelymitra pauciflora	Slender Sun Orchid	✓					
Oxalidaceae							
Oxalis bowiei		✓					
Oxalis corniculata	Creeping Oxalis	✓					
Oxalis exilis		✓					
Oxalis perennans #	Grassland Wood-sorrel	✓		✓	✓		
Oxalis pes-caprae		✓					
Oxalis radicosa		✓					
Phormiaceae							
Dianella longifolia var *longifolia*	Pale Flax-lily	✓					
Dianella revoluta		✓					
Stypandra glauca	Nodding Blue Lily	✓					
Pittosporaceae							
Bursaria spinosa	Native Blackthorn	✓					
Pittosporum angustifolium		✓					
Plantaginaceae							
Plantago cunninghamii		✓					
Plantago debilis		✓					
Plantago lanceolata #	Ribwort	✓		✓			
Plantago turrifera		✓					
Plumbaginaceae							
Limonium sinuatum	Notch-leaf Sea-lavender						
Poaceae							
Agrostis avenacea var *avenacea*		✓	✓				
Aira caryophyllea	Silvery Hairgrass	✓					
Aira cupaniana		✓					
Aira elegantissima	Delicate Hairgrass	✓					
Alopecurus geniculatus	Marsh Fox-tail	✓					
Amphibromus macrorhinus		✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Amphibromus neesii		✓					
Amphibromus nervosus	Common Swamp Wallaby-grass	✓					
Aristida behriana	Brush Wire-grass	✓					
Aristida jerichoensis	Jericho Wire-grass	✓					
Aristida ramosa		✓					
Austrodanthonia auriculata	Lobed Wallaby-grass	✓					
Austrodanthonia caespitosa	Common Wallaby-grass	✓		✓	✓		
Austrodanthonia duttoniana		✓					
Austrodanthonia eriantha		✓					
Austrodanthonia pilosa	Smooth-flowered Wallaby-grass	✓					
Austrodanthonia racemosa		✓					
Austrodanthonia setacea	Bristly Wallaby-grass	✓			✓		
Austrodanthonia tenuior		✓					
Austrostipa aristoglumis	Plains Grass	✓		✓			
Austrostipa bigeniculata		✓					
Austrostipa blackii		✓					
Austrostipa densifolia		✓					
Austrostipa drummondii	Cottony Spear-grass	✓					
Austrostipa elegantissima	Feather Spear-grass	✓					
Austrostipa eremophila		✓					
Austrostipa mollis	Speargrass	✓					
Austrostipa nitida		✓					
Austrostipa platychaeta	Flat-awn Speargrass	✓					
Austrostipa scabra ssp. *falcata*	Rough Spear-grass	✓		✓	✓		
Austrostipa scabra ssp. *scabra*		✓					
Austrostipa setacea	Corkscrew Grass	✓					
Austrostipa stuposa		✓					
Austrostipa verticillata		✓					
Avena barbata	Bearded Oat	✓					
Avena fatua #	Wild Oat	✓		✓	✓		
Avena ludoviciana	Ludo Wild Oats	✓					
Avena sativa	Oat	✓					
Bothriochloa macra	Red-leg Grass	✓					
Briza maxima	Quaking Grass	✓					
Briza minor	Shivery Grass	✓					
Bromus alopecuros		✓					
Bromus brevis		✓					
Bromus diandrus #	Great Brome	✓		✓	✓		
Bromus hordeaceus #	Soft Brome	✓		✓	✓		
Bromus molliformis	Soft Brome	✓					
Bromus rubens #	Red Brome	✓					
Bromus sterilis	Sterile Brome	✓					
Cenchrus incertus		✓					
Chloris truncata	Windmill Grass	✓		✓	✓		
Cynodon dactylon	Couch	✓	✓	✓			
Dactyloctenium radulans	Button Grass	✓					
Dichelachne micrantha	Shorthair Plumegrass	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Digitaria divaricatissima	Umbrella-grass	✓					
Digitaria sanguinalis	Summer Grass	✓					
Diplachne fusca		✓					
Echinochloa crus-galli	Barnyard Grass	✓					
Ehrharta longiflora	Annual Veldtgrass	✓					
Elymus scaber		✓					
Enneapogon nigricans	Nigger-heads	✓					
Enteropogon acicularis	Spider Grass	✓		✓	✓		
Eragrostis australasica	Canegrass	✓					
Eragrostis brownii	Brown's Lovegrass	✓					
Eragrostis cilianensis	Stink Grass	✓					
Eragrostis elongata	Close-headed Love-grass	✓					
Eragrostis lacunaria		✓					
Eragrostis leptostachya	Paddock Lovegrass	✓					
Eragrostis parviflora	Weeping Love-grass	✓					
Eragrostis setifolia	Neverfail	✓					
Eriochloa crebra	Cup Grass	✓					
Eriochloa pseudoacrotricha	Early Spring Grass	✓					
Homopholis proluta	Rigid Panic	✓		✓	✓		
Hordeum hystrix	Mediterranean Barley Grass	✓					
Hordeum leporinum #	Barley Grass	✓	✓	✓	✓		
Hordeum marinum	Sea Barley Grass	✓					
Lamarckia aurea #	Golden-top	✓					
Lolium loliaceum #	Stiff Rye-grass	✓					
Lolium multiflorum	Italian Ryegrass	✓					
Lolium perenne #	Perennial Rye-grass	✓					
Lolium rigidum #	Wimmera Rye-grass	✓	✓	✓	✓		
Microlaena stipoides		✓					
Panicum decompositum	Native Millet	✓					
Panicum effusum	Hairy Panic	✓					
Panicum subxerophilum	Gilgai Grass	✓					
Parapholis incurva	Coast Barb-grass	✓					
Paspalidium constrictum		✓					
Paspalidium jubiflorum	Warrego Grass	✓					
Paspalum dilatatum #	Paspalum	✓	✓	✓			
Paspalum distichum	Water Couch	✓					
Pentaschistis airoides ssp. *airoides*	False Hair-grass	✓					
Phalaris aquatica #		✓		✓	✓		
Phalaris minor		✓					
Phalaris paradoxa	Paradoxical Canary-grass	✓					
Phleum pratense	Timothy	✓					
Phragmites australis	Common Reed	✓					
Poa annua	Winter Grass	✓					
Poa bulbosa	Bulbous Poa	✓					
Poa fordeana		✓					
Poa labillardieri	Tussock	✓					
Poa pratensis	Kentucky Bluegrass	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Poa sieberiana		✓					
Pseudoraphis spinescens		✓					
Rostraria cristata	Annual Cat's-tail	✓					
Setaria gracilis	Slender Pigeon Grass	✓					
Sporobolus caroli	Yakka Grass	✓					
Thyridolepis mitchelliana	Mulga Mitchell Grass	✓					
Vulpia bromoides	Squirrel-tail Fescue	✓					
Vulpia myuros	Rat's-tail Fescue	✓					
Vulpia sp.					✓		
Polygonaceae							
Acetosella vulgaris	Sorrel	✓					
Emex australis	Spiny Emex	✓					
Muehlenbeckia florulenta	Tangled Lignum	✓					
Muehlenbeckia horrida		✓					
Persicaria decipiens		✓	✓				
Persicaria hydropiper	Water Pepper	✓					
Persicaria lapathifolia	Pale Knotweed	✓					
Persicaria prostrata	Creeping Knotweed	✓					
Polygonum arenastrum #	Wireweed	✓					
Polygonum aviculare	Prostrate Knotweed	✓	✓				
Polygonum plebeium	Small Knotweed	✓					
Rumex brownii	Slender Dock	✓					
Rumex conglomeratus	Clustered Dock	✓					
Rumex crispus #	Curled Dock	✓	✓	✓			
Rumex crystallinus	Glistening Dock	✓					
Rumex dumosus	Wiry Dock	✓					
Rumex sp.			✓				
Rumex stenoglottis		✓					
Rumex tenax		✓					
Portulaceae							
Calandrinia eremaea	Small Purslane	✓					
Portulaca oleracea	Pigweed	✓					
Potamogetonaceae							
Potamogeton crispus	Curly Pondweed	✓					
Potamogeton tricarinatus	Floating Pondweed	✓	✓				
Primulaceae							
Anagallis arvensis	Pimpernel	✓					
Proteaceae							
Grevillea floribunda subsp. *floribunda*	Seven Dwarfs Grevillea	✓					
Grevillea robusta	Silky Oak	✓					
Hakea leucoptera ssp. *leucoptera*	Silver Needlewood	✓					
Ranunculaceae							
Ranunculus inundatus							
Ranunculus lappaceus	Common Buttercup	✓	✓				
Ranunculus muricatus	Sharp Buttercup	✓					
Ranunculus pachycarpus		✓					
Ranunculus pentandrus	Inland Buttercup	✓					
Ranunculus pumilio	Ferny Small-flower	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
	Buttercup						
Ranunculus sceleratus	Celery Buttercup	✓					
Ranunculus sessiliflorus		✓					
Ranunculus undosus		✓	✓				
Rhamnaceae							
Cryptandra amara		✓					
Rosaceae							
Acaena echinata		✓					
Aphanes australiana		✓					
Rosa rubiginosa #	Sweet Briar	✓					
Rubus ulmifolius #	Blackberry	✓					
Rubiaceae							
Asperula conferta	Common Woodruff	✓					
Galium aparine	Goosegrass	✓					
Galium gaudichaudii	Rough Bedstraw	✓					
Galium murale	Small Bedstraw	✓					
Rutaceae							
Geijera parviflora	Wilga						
Philotheca brevifolia		✓					
Philotheca difformis		✓					
Philotheca myoporoides		✓					
Philotheca myoporoides subsp. *acuta*		✓					
Salicaceae							
Salix babylonica #	Weeping Willow	✓					
Santalaceae							
Exocarpus cupressiformis	Native Cherry	✓					
Exocarpus strictus	Dwarf Cherry	✓					
Santalum acuminatum	Sweet Quandong	✓					
Sapindaceae							
Dodonaea altenuata	Narrow-leaf Hop-bush						
Dodonaea boroniifolia		✓					
Dodonaea viscosa ssp. *Angustissima*	Slender Hop-bush	✓					
Dodonaea viscosa ssp. *cuneata*	Wedge-leaf Hop-bush	✓					
Dodonaea viscosa ssp. *mucronata*		✓					
Dodonaea viscosa ssp. *spatulata*		✓					
Heterodendrum oleifolium	Rosewood						
Scrophulariaceae							
Glossostigma diandrum		✓					
Gratiola pedunculata							
Gratiola pumilo		✓					
Kickxia elatine ssp *crinita*	Twining Toadflax	✓					
Limosella australis	Austral Mudwort	✓					
Limosella curdieana	Large Mudwort	✓					
Mimulus gracilis	Slender Monkey-flower	✓					
Orobanche minor		✓					
Parentucellia latifolia	Red Bartsia	✓					
Verbascum virgatum	Twiggy Mullein	✓					

Family (bold) and Scientific Name	Common Name	NPWS	CSU WET	CSU OG	CSU RRG	TSC	EPBC
Solanaceae							
Datura stramonium	Common Thornapple	✓					
Lycium ferocissimum	African Box-thorn	✓					
Solanum esuriale	Quena	✓					
Solanum nigrum #	Black Nightshade	✓					
Solanum pseudocapsicum #	Madeira Winter Cherry	✓					
Solanum triflorum	Tree-flowered Nightshade	✓					
Stackhousiaceae							
Stackhousia monogyna	Creamy Stackhousia	✓					
Sterculiaceae							
Brachychiton populneus	Kurrajong	✓					
Thymelaeaceae							
Pimelea curviflora		✓					
Pimelea flava ssp. *dichotoma*		✓					
Pimelea glauca		✓					
Pimelea linifolia		✓					
Pimelea micrantha		✓					
Typhaceae							
Typha domingensis	Narrow-leaved Cumbungi	✓					
Typha orientalis	Broad-leaved Cumbungi	✓	✓				
Urticaceae							
Parietaria debilis	Native Pellitory	✓					
Urtica incisa	Stinging Nettle	✓					
Urtica urens	Small Nettle	✓					
Verbenaceae							
Phyla nodiflora #	Lippia	✓					
Verbena bonariensis #	Purpletop	✓					
Verbena officinalis	Common Verbena	✓					
Violaceae							
Hybanthus monopetalus	Slender Violet-bush	✓					
Viola betonicifolia		✓					
Zygophyllaceae							
Tribulus terrestris	Catshead	✓					

Appendix 2

Fauna Species List

The table below includes data from the NPWS Wildlife Atlas, EPBC database and JC-EC surveys. The table provides species lists and indicates the conservation status of threatened species (highlighted) as they are described under New South Wales and Commonwealth Environmental Legislation. The following codes are included in the table:

NPWS = NSW National Parks and Wildlife Service Atlas database records for map sheet 8228.
FS = NSW Fisheries Service Fishfiles database records for Murrumbidgee River @ Narrandera
JC-EC = surveys undertaken by Johnstone Centre – Environmental Consulting, October 2002.
TSC = Threatened Species Conservation Act Status
EPBC = Environmental Protection and Biodiversity Conservation Act Status
E = Endangered Species
V = Vulnerable Species

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
AMPHIBIANS						
Crinia signifera	Common Froglet					
Crinia parinsignifera	Plains Froglet	✓		✓		
Limnodynastes dumerilii	Pobblebonk	✓		✓		
Limnodynastes fletcheri	Barking Marsh Frog	✓		✓		
Limnodynastes interioris	Giant Banjo Frog	✓				
Limnodynastes tasmaniensis	Spotted Grass Frog	✓		✓		
Litoria peronii	Peron's Tree Frog	✓		✓		
Litoria raniformis	Southern Bell Frog	✓			E	V
Neobatrachus sudelli	Common Spadefoot Toad	✓				
Notoden bennetti	Holy Cross Frog	✓				
Pseudophryne bibronii	Bibron's Toadlet	✓				
Uperoleia rugosa	Wrinkled Toadlet	✓				
FISH						
Bidyanus bidyanus	Silver Perch		✓		V	
Cyprinus carpio	Carp		✓	✓		
Gambusia affinis	Mosquito Fish		✓	✓		
Maccullochella macquariensis	Trout Cod		✓		E	E
Maccullochella peelii	Murray Cod		✓			
Macquaria australasica	Macquarie Perch		✓		V	E
REPTILES						
Chelodina longicollis	Eastern Long-necked Tortoise	✓				
Christinus marmoratus	Marbled Gecko	✓				
Cryptoblepharus carnabyi	Carnaby's Wall Skink					
Ctenotus strauchii						
Delma inornata	Olive Legless Lizard					
Diplodactylus byrnei						
Diplodactylus intermedius	Southern Spiny-tailed Gecko					
Diplodactylus vittatus	Eastern Stone Gecko	✓				
Egernia striolata	Tree Skink					
Emydura macquarii	Murray Turtle					
Eremiascincus richardsonii	Broad-banded Sand Swimmer					
Gehyra variegata	Tree Delta					
Lampropholis guichenoti	Garden Skink					

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Lerista muelleri						
Lerista punctatovittata						
Morethia boulengeri	Boulenger's Skink	✓		✓		
Notechis scutatus	Eastern Tiger Snake					
Pogona barbata	Bearded Dragon	✓				
Pogona vitticeps	Central Bearded Dragon					
Pseudechis porphyriacus	Red-bellied Black Snake			✓		
Pseudonaja textilis	Eastern Brown Snake			✓		
Pygopus nigriceps	Hooded Scaly-foot					
Ramphotyphlops australis		✓				
Ramphotyphlops bituberculatus		✓				
Ramphotyphlops proximus						
Simoselaps australis	Eastern Shovel-nosed Snake	✓				
Suta spectabilis dwyeri		✓				
Suta suta	Curl Snake					
Tiliqua scincoides	Eastern Blue-tounged Lizard					
Trachydosaurus rugosus	Shingleback					
Underwoodisaurus milli	Thick-tailed Gecko	✓				
Varanus gouldii	Gould's Goanna					
Varanus varius	Tree Goanna	✓				
BIRDS						
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	✓				
Acanthiza apicalis	Inland Thornbill	✓				
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	✓				
Acanthiza lineata	Striated Thornbill					
Acanthiza nana	Yellow Thornbill	✓				
Acanthiza pusilla	Brown Thornbill	✓				
Acanthiza reguloides	Buff-rumped Thornbill	✓				
Acanthiza uropygialis	Chestnut-rumped Thornbill	✓				
Accipiter cirrhocephalus	Collared Sparrowhawk	✓				
Accipiter fasciatus	Brown Goshawk	✓				
Acrocephalus australis	Australian Reed-Warbler	✓				
Acrocephalus stentoreus	Clamorous Reed-Warbler			✓		
Actitus hypoleucos	Common Sandpiper					
Aegotheles cristatus	Australian Owlet-nightjar	✓				
Alcedo azurea	Azure Kingfisher					
Anas castanea	Chestnut Teal	✓				
Anas gracilis	Grey Teal	✓				
Anas platyrhynchos	Mallard	✓				
Anas rhynchotis	Australian Shoveler	✓				
Anas superciliosa	Pacific Black Duck	✓		✓		
Anhinga melanogaster	Darter	✓		✓		
Anseranas semipalmata	Magpie Goose				V	
Anthus novaeseelandiae	Richard's Pipit	✓				
Aphelocephala leucopsis	Southern Whiteface	✓				
Apus pacificus	Forked-tailed Swift	✓				

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Aquila audax	Wedge-tailed Eagle	✓				
Ardea alba	Great Egret	✓				
Ardea ibis	Cattle Egret					
Ardea intermedia	Intermediate Egret	✓		✓		
Ardea pacifica	White-necked Heron	✓		✓		
Ardeotis australis	Australian Bustard					
Arenaria interpres	Ruddy Turnstone					
Artamus cinereus	Black-faced Woodswallow	✓				
Artamus cyanopterus	Dusky Woodswallow	✓				
Artamus leucorhynchus	White-breasted Woodswallow	✓				
Artamus personatus	Masked Woodswallow					
Artamus superciliosus	White-browed Woodswallow	✓		✓		
Aythya australis	Hardhead	✓				
Barnardius zonarius barnardi	Mallee Ringneck	✓				
Biziura lobata	Musk Duck	✓				
Botaurus poiciloptilus	Australasian Bittern				V	
Burhinus grallarius	Bush Stone-curlew	✓			E	
Cacatua galerita	Sulphur-crested Cockatoo	✓		✓		
Cacatua leadbeateri	Major Mitchell's Cockatoo	✓			V	
Cacatua roseicapilla	Galah	✓		✓		
Cacatua sanguinea	Little Corella	✓		✓		
Cacatua tenuirostris	Long-billed Corella	✓				
Cacomantis flabelliformis	Fan-tailed Cuckoo	✓				
Calidris acuminata	Sharp-tailed Sandpiper					
Calidris canutus	Red Knot					
Calidris ferruginea	Curlew Sandpiper					
Calidris melanotos	Pectoral Sandpiper					
Calidris ruficollis	Red-necked Stint					
Calidris subminuta	Long-toed Stint					
Calamanthus pyrrhopygius	Chestnut-rumped Heathwren	✓				
Calyptorhynchus lathami	Glossy Black Cockatoo	✓			V	E
Cardeulis cardeulis	European Goldfinch	✓				
Certhionyx niger	Black Honeyeater	✓				
Charadrius australis	Inland Dotterel					
Charadrius bicinctus	Double-banded Plover					
Charadrius ruficapillus	Red-capped Plover	✓				
Chenonetta jubata	Australian Wood Duck	✓				
Cheramoeca leucosternus	White-backed Swallow	✓				
Chlidonias hybridus	Whiskered Tern	✓				
Chrysococcyx basalis	Horsfield's Bronze-cuckoo	✓				
Chrysococcyx lucidus	Shining Bronze Cuckoo	✓				
Chrysococcyx osculans	Black-eared Cuckoo	✓				
Cinclorhamphus cruralis	Brown Songlark	✓				
Cinclorhamphus mathewsi	Rufous Songlark	✓				
Circus approximans	Swamp Harrier	✓				
Circus assimilis	Spotted Harrier					
Cisticola exilis	Golden-headed Cisticola	✓		✓		
Cladorhynchus	Banded Stilt					

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
leucocephalus						
Climacteris picumnus subsp. *picumnus*	Brown Treecreeper (Arid zone subspecies)	✓		✓		
Climacteris picumnus subsp. *victoriae*	Brown Treecreeper (Eastern subspecies)					
Colluricincla harmonica	Grey Shrike-thrush	✓				
Columba livia	Rock Dove	✓				
Coracina maxima	Ground Cuckoo-shrike					
Coracina novaehollandiae	Black-faced Cuckoo-shrike	✓		✓		
Corcorax melanorhamphos	White-winged Chough	✓		✓		
Cormobates leucophaeus	White-throated Treecreeper	✓				
Corvus coronoides	Australian Raven	✓		✓		
Corvus mellori	Little Raven	✓				
Coturnix pectoralis	Stubble Quail	✓				
Coturnix ypsilphora	Brown Quail	✓				
Cracticus nigrogularis	Pied Butcherbird	✓		✓		
Cracticus torquatus	Grey Butcherbird	✓				
Cuculus pallidus	Pallid Cuckoo	✓				
Cygnus atratus	Black Swan	✓				
Dacelo novaeguineae	Laughing Kookaburra	✓		✓		
Daphoenositta chrysoptera	Varied Sittella	✓				
Dendrocygna arcuata	Wandering Whistling Duck					
Dendrocygna eytoni	Plumed Whistling Duck	✓				
Dicaeum hirundinaceum	Mistletoebird	✓				
Dromaius novaehollandiae	Emu	✓				
Egretta garzetta	Little Egret					
Egretta novaehollandiae	White-faced Heron	✓		✓		
Elanus axillaris	Black-shouldered Kite	✓				
Elseyornis melanops	Black-fronted Dotterel	✓				
Entomyzon cyanotis	Blue-faced Honeyeater	✓		✓		
Eopsaltria australis	Eastern Yellow Robin	✓				
Epthianura albifrons	White-fronted Chat	✓				
Epthianura aurifrons	Orange Chat	✓				
Epthianura tricolor	Crimson Chat	✓				
Erythogonys cinctus	Red-kneed Dotterel	✓				
Eurystomus orientalis	Dollarbird	✓				
Falco berigora	Brown Falcon	✓				
Falco cenchroides	Nankeen Kestrel	✓		✓		
Falco longipennis	Australian Hobby	✓				
Falco peregrinus	Peregrine Falcon	✓				
Falco subniger	Black Falcon					
Falcunculus frontatus	Crested Shrike-tit	✓				
Fulica atra	Eurasian Coot	✓				
Gallinago hardwickii	Latham's Snipe	✓				
Gallinula tenebrosa	Dusky Moorhen	✓		✓		
Gallinula ventralis	Black-tailed Native-hen	✓		✓		
Geopelia striata	Peaceful Dove	✓		✓		
Gerygone fusca	Western Gerygone	✓				
Gerygone olivacea	White-throated Gerygone	✓				

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Grallina cyanoleuca	Magpie-lark	✓		✓		
Grantiella picta	Painted Honeyeater				V	
Grus rubicunda	Brolga	✓			V	
Gymnorhina tibicen	Australian Magpie	✓		✓		
Haliaeetus leucogaster	White-bellied Sea-Eagle	✓				
Hieraaetus morphnoides	Little Eagle	✓				
Himantopus himantopus	Black-winged Stilt	✓				
Hirundapus caudacutus	White-throated Needletail	✓				
Hirundo ariel	Fairy Martin	✓		✓		
Hirundo neoxena	Welcome Swallow	✓		✓		
Hirundo nigricans	Tree Martin	✓				
Ixobrychus minutus	Little Bittern					
Lalage sueurii	White-winged Triller	✓				
Larus novaehollandiae	Silver Gull	✓				
Lichenostomus melanops	Yellow-tufted Honeyeater	✓				
Lichenostomus ornatus	Yellow-plumed Honeyeater	✓				
Lichenostomus penicillatus	White-plumed Honeyeater	✓		✓		
Lichenostomus virescens	Singing Honeyeater	✓				
Limosa lapponica	Bar-tailed Godwit					
Limosa limosa	Black-tailed Godwit				V	
Lophoictinia isura	Square-tailed Kite				V	
Malacorhynchus membranaceus	Pink-eared Duck	✓				
Manorina flavigula	Yellow-throated Miner	✓				
Manorina melanocephala	Noisy Miner	✓		✓		
Marulus cyaneus	Superb Fairy-wren					
Marulus lamberti	Variegated Fairy-wren	✓				
Marulus leucopterus	White-winged Fairy-wren	✓				
Marulus splendens	Splendid Fairy-wren	✓				
Megalurus gramineus	Little Grassbird	✓				
Melanodryas cucullata	Hooded Robin	✓				
Melithreptus brevirostris	Brown-headed Honeyeater	✓				
Melithreptus gularis gularis	Black-chinned Honeyeater	✓				
Melopsittacus undulatus	Budgerigar	✓				
Merops ornatus	Rainbow Bee-eater	✓				
Microeca fascinans	Jacky Winter	✓				
Milvus migrans	Black Kite	✓				
Milvus sphenurus	Whistling Kite	✓				
Mirafra javanica	Singing Bushlark					
Myiagra inquieta	Restless Flycatcher	✓				
Myiagra rubecula	Leaden Flycatcher					
Neochmia temporalis	Red-browed Finch					
Neophema chrysostoma	Blue-winged Parrot	✓				
Neophema pulchella	Turquoise Parrot	✓				
Ninox connivens	Barking Owl				V	
Ninox novaeseelandiae	Southern Boobook	✓		✓		
Northiella haematogaster	Blue Bonnet	✓				
Nycticorax caledonicus	Nankeen Night Heron	✓				
Nymphicus hollandicus	Cockatiel	✓		✓		

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Ocyphaps lophotes	Crested Pigeon	✓		✓		
Oriolus sagittatus	Olive-backed Oriole	✓				
Oxyura australis	Blue-billed Duck				V	
Pachycephala inornata	Gilbert's Whistler	✓				
Pachycephala pectoralis	Golden Whistler	✓				
Pachycephala rufiventris	Rufous Whistler	✓				
Pardalotus punctatus	Spotted Pardalote	✓				
Pardalotus punctatus xanthopyge	Yellow-rumped Pardalote	✓				
Pardalotus striatus	Striated Pardalote	✓		✓		
Passer domesticus	House Sparrow	✓				
Pedionomus torquatus	Plains Wanderer				E	V
Pelecanus conspicillatus	Australian Pelican	✓		✓		
Petroica goodenovii	Red-capped Robin	✓				
Petroica multicolor	Scarlet Robin	✓				
Petroica phoenicea	Flame Robin	✓				
Phalacrocorax carbo	Great Cormorant	✓				
Phalacrocorax melanoleucos	Little Pied Cormorant	✓				
Phalacrocorax sulcirostris	Little Black Cormorant	✓				
Phalacrocorax varius	Pied Cormorant	✓		✓		
Phaps chalcoptera	Common Bronzewing	✓				
Philemon citreogularis	Little Friarbird	✓				
Philemon corniculatus	Noisy Friarbird	✓				
Philomachus pugnax	Ruff					
Phipidura fuliginosa	Grey Fantail	✓				
Phipidura leucophrys	Willie Wagtail	✓		✓		
Phylidonyris albifrons	White-fronted Honeyeater	✓				
Platalea flavipes	Yellow-billed Spoonbill	✓				
Platalea regia	Royal Spoonbill	✓				
Platycercus elegans	Crimson Rosella	✓				
Platycercus elegans flaveolus	Yellow Rosella	✓		✓		
Platycercus eximius	Eastern Rosella	✓		✓		
Plectorhyncha lanceolata	Striped Honeyeater	✓				
Plegadis falcinellus	Glossy Ibis	✓				
Pluvialis dominica	Lesser Golden Plover					
Pluvialis fulva	Pacific Golden Plover					
Podargus strigoides	Tawny Frogmouth	✓		✓		
Podiceps cristatus	Great Crested Grebe	✓				
Poliocephalus poliocephalus	Hoary-headed Grebe	✓				
Polytelis anthopeplus	Regent Parrot				E	E
Polytelis swainsonii	Superb Parrot			✓		
Pomatostomus superciliosus	White-browed Babbler	✓				
Pomatostomus temporalis	Grey-crowned Babbler	✓		✓	V	
Porphyrio porphyrio	Purple Swamphen	✓		✓		
Porzana fluminea	Australian Spotless Crake	✓				
Porzana pusilla	Baillon's Crake	✓				
Porzana tabuensis	Spotless Crake	✓				
Psephotus haematonotus	Red-rumped Parrot	✓		✓		
Psephotus varius	Mulga Parrot	✓				
Pyrrholaemus brunneus	Redthroat				V	
Pyrrholaemus sagittatus	Speckled Warbler	✓				

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Rallus pectoralis	Lewin's Rail					
Recurvirostra novaehollandiae	Red Avocet	✓				
Rostratula benghalensis	Painted Snipe				V	
Smicrornis brevirostris	Weebill	✓				
Stagonopleura guttata	Diamond Firetail	✓			V	
Sterna nilotica	Gull-billed Tern					
Stictonetta naevosa	Freckled Duck				V	
Stiltia isabella	Australian Pratincole					
Strepera graculina	Pied Currawong	✓				
Struthidea cinerea	Apostlebird	✓				
Sturnus vulgaris	Common Starling	✓		✓		
Tachybaptus novaehollandiae	Australasian Grebe					
Tadorna tadornoides	Australian Shelduck	✓				
Taeniopygia bichenovii	Double-barred Finch	✓				
Taeniopygia guttata	Zebra Finch	✓				
Threskiornis molucca	Australian White Ibis	✓		✓		
Threskiornis spinicollis	Straw-necked Ibis	✓				
Todiramphus pyrrhopygia	Red-backed Kingfisher	✓				
Todiramphus sanctus	Sacred Kingfisher	✓				
Tringa glareola	Wood Sandpiper					
Tringa nebularia	Common Greenshank					
Tringa stagnatilis	Marsh Sandpiper					
Turdus merula	Common Blackbird	✓				
Turnix pyrrhothorax	Red-chested Button Quail					
Turnix varia	Painted-Button Quail	✓				
Turnix velox	Little Button-quail	✓				
Tyto alba	Barn Owl	✓		✓		
Tyto novaehollandiae	Masked Owl				V	
Vanellus miles	Masked Lapwing	✓		✓		
Vanellus tricolor	Banded Lapwing	✓				
Xanthomyza phrygia	Regent Honeyeater				E	E
Zosterops lateralis	Silvereye	✓				
MAMMALS						
Acrobates pygmaesus	Feathertail Glider	✓				
Canis familiaris	Dingo and Dog (feral)					
Capra bircus	Goat (feral)					
Chalinolobus gouldii	Gould's Wattled Bat					
Chalinolobus morio	Chocolate Wattled Bat	✓				
Chalinolobus picatus	Little Pied Bat				V	
Felis catus	Cat (feral)	✓				
Hydromys chrysogaster	Water Rat	✓		✓		
Lepus capensis	Brown Hare	✓				
Macropus fuliginosus	Western Grey Kangaroo					
Macropus giganteus	Eastern Grey Kangaroo	✓		✓		
Macrotis lagotis	Bilby	✓			E4	
Macropus rufus	Red Kangaroo					
Mormopterus planiceps	Little Mastiff-bat					
Mus musculus	House Mouse	✓				

Scientific Name	Common Name	NPWS	FS	JC-EC	TSC & FMA	EPBC
Nycticeius sp.	Unidentified Broad-nosed Bat					
Nyctinomus australis	White-striped Mastiff-bat	✓		✓		
Nyctophilus geoffroyi	Lesser Long-eared Bat	✓				
Nyctophilus gouldi	Gould's Long-eared Bat			✓		
Ornithorhynchus anatinus	Platypus	✓				
Oryctolagus cuniculus	Rabbit	✓		✓		
Ovis aries	Sheep (feral)	✓				
Phascolarctos cinereus	Koala	✓			V	
Pseudocheirus peregrinus	Common Ringtail Possum	✓				
Scotorepens balstoni	Inland Broad-nosed Bat	✓				
Sminthopsis crassicaudata	Fat-tailed Dunnart	✓				
Sus scrofa	Pig (feral)					
Tachyglossus aculeatus	Short-beaked Echidna	✓				
Trichosurus vulpecula	Common Brushtail Possum	✓		✓		
Vespadelus baverstocki	Inland Forest Bat				V	
Vespadelus darlingtoni	Large Forest Bat					
Vespadelus regulus	Southern Forest Bat			✓		
Vespadelus vulturnus	Little Forest Bat	✓		✓		
Vulpes vulpes	Fox	✓		✓		
Wallabia bicolor	Swamp Wallaby			✓		

Appendix 3

Relevent Legislation

NSW Legislation

Native Vegetation Conservation Act, 1997 (NVC Act)

One of the key initiatives of the Act is the development of Regional Vegetation Management Plans (RVMPs).

RVMPs are being developed by Regional Vegetation Committees and will provide a comprehensive strategy for managing native vegetation, based on regional needs.

A plan may:

- Identify areas where native vegetation can be cleared without application
- Identify areas where an application to clear will be necessary
- Allow clearing exemptions to be developed according to regional requirements
- Highlight areas where the condition of native vegetation should be improved
- Recommend areas that should be revegetated.

The region covered by an RVMP must be approved by the Minister for Land and Water Conservation and should include at least one local government area.

Threatened Species Conservation Act, 1995 (TSC Act)

The TSC Act contains provisions for conservation of threatened species, populations, ecological communities, critical habitat and listing of key threatening processes in New South Wales (NSW National Parks and Wildlife Service, 1997a).

One of the major features of the *Threatened Species Conservation Act* is the integration of the conservation of threatened species into development control processes under the Environmental Planning and Assessment Act 1979 (EP&A Act). The effect of a development or activity on threatened species must be considered by a consent or determining authority. Where there is likely to be a significant effect on threatened species, the preparation of a species impact statement is required. The consent or determining authority must seek the approval of the Director-General of National Parks and Wildlife, or in certain circumstances, consult with the Minister for the Environment (NSW National Parks and Wildlife Service, 1997b).

The eight-part test has been designed to determine whether a development or action is likely to cause a significant effect on threatened species, populations or ecological communities and if a species impact statement is required.

State Environmental Planning Policy No. 44 – Koala Habitat Protection (SEPP 44), 1995

The aim and strategy of the policy are:

Aim: To encourage the conservation and proper management of natural vegetation that provide habitat for koalas, to ensure permanent, free-living populations over their present range and to reverse the current trend in population decline (DUAP, 1995).

Strategy: To achieve its aim by ensuring that for any development application (DA) to which the policy applies, consent is not issued without investigation of the presence of core koala habitat.

To encourage the identification of areas of core koala habitat.

To encourage the inclusion of areas of core koala habitat in environment protection zones.

Fisheries Management Act, 1994 (FM Act)

The FM Act is very similar to the TSC Act in that it integrates the conservation of threatened species into development control processes under the EP&A Act. This legislation outlines the duties of NSW Fisheries and relates to freshwater and marine organisms and ecosystems. It provides for the protection, conservation and recovery of threatened species, and makes provision for the management of threats to threatened species, populations and ecological communities.

Fish Habitat Protection Plan No 1

Fish Habitat Protection Plans can be developed under Part 7 of the *Fisheries Management Act 1994* to protect any fish habitat "whether the habitat is critical for the survival of the species or required to maintain harvestable populations of fish". This plan deals with dredging and reclamation activities, fish passage requirements, the protection of mangroves, seagrasses and other marine vegetation and the importance of snags.

Minimum Information Requirements for Aquatic Environmental Assessment

These requirements are listed on page 50 of the *Aquatic Habitat and Fish Conservation Guidelines* developed by the NSW Fisheries Service.

National Parks and Wildlife Act, 1974

The National Parks and Wildlife Act, 1974 is the main legislation that defines the powers, duties and functions of the NSW National Parks and Wildlife Service relating to all areas reserved as national parks, historic sites, nature reserves, Aboriginal areas, state recreation areas and regional parks (NSW National Parks and Wildlife Service, 1997b). Under this legislation, all native fauna is protected and a permit is required to pick protected plant species identified in Schedule 13 of the Act.

Noxious Weeds Act, 1993

This Act provides for the identification, classification and control of noxious weeds in New South Wales. Local Authorities and a number of County Councils established by local authorities to administer noxious weed control for their areas, administer the Act and are responsible for ensuring compliance by owners and occupiers.

Sections 8 and 9 of the Act establish weed control categories and specify the action required in respect of each weed control category. W1 and W2 noxious weeds must be fully and continuously suppressed and destroyed. W1 category noxious weeds in addition must be notified to the local control authority. W3 noxious weeds must be prevented from spreading and its numbers and distribution must also be reduced. W4 noxious weeds must be dealt with as specified in the Order (NSW Agriculture, 2001).

Commonwealth Legislation

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) commenced on 16 July 2000. The Act allows for the Commonwealth to assess and approve actions that have, may have or are likely to have a significant impact on a matter of national environmental significance (NES). This occurs regardless of the approval and consent process of NSW. It is up to the discretion of the Commonwealth to determine whether any referred action will have or may have a **significant** impact.

Matters of NES include:

- declared World Heritage areas
- declared RAMSAR wetlands
- listed threatened species and ecological communities (Commonwealth species)
- listed migratory species
- nuclear actions, and
- the environment of Commonwealth marine areas.

To obtain approval for an action under the EPBC Act where a significant impact on a matter of NES will or may occur, it needs to be referred to the Commonwealth Environment Minister. Once referred to the Commonwealth Environment Minister, he or she will decide whether the Project requires their approval. This should be done within 20 business days. If no approval is required (*ie*, a significant impact on a matter of NES is not likely), then the action may proceed. Otherwise, the proponent will go through the approval process.

Threatening Processes

There are several processes that have been identified as threatening fauna under State and Commonwealth legislation. Those processes that the Proposal has the potential to contribute to or should generally be aware of are listed below.

NSW Threatened Species Conservation Act

- Clearing of native vegetation.

NSW Fisheries Management Act

- Introduction of fish to fresh waters within a river catchment outside of their natural range.
- Removal of large woody debris.
- Change of flow regimes.

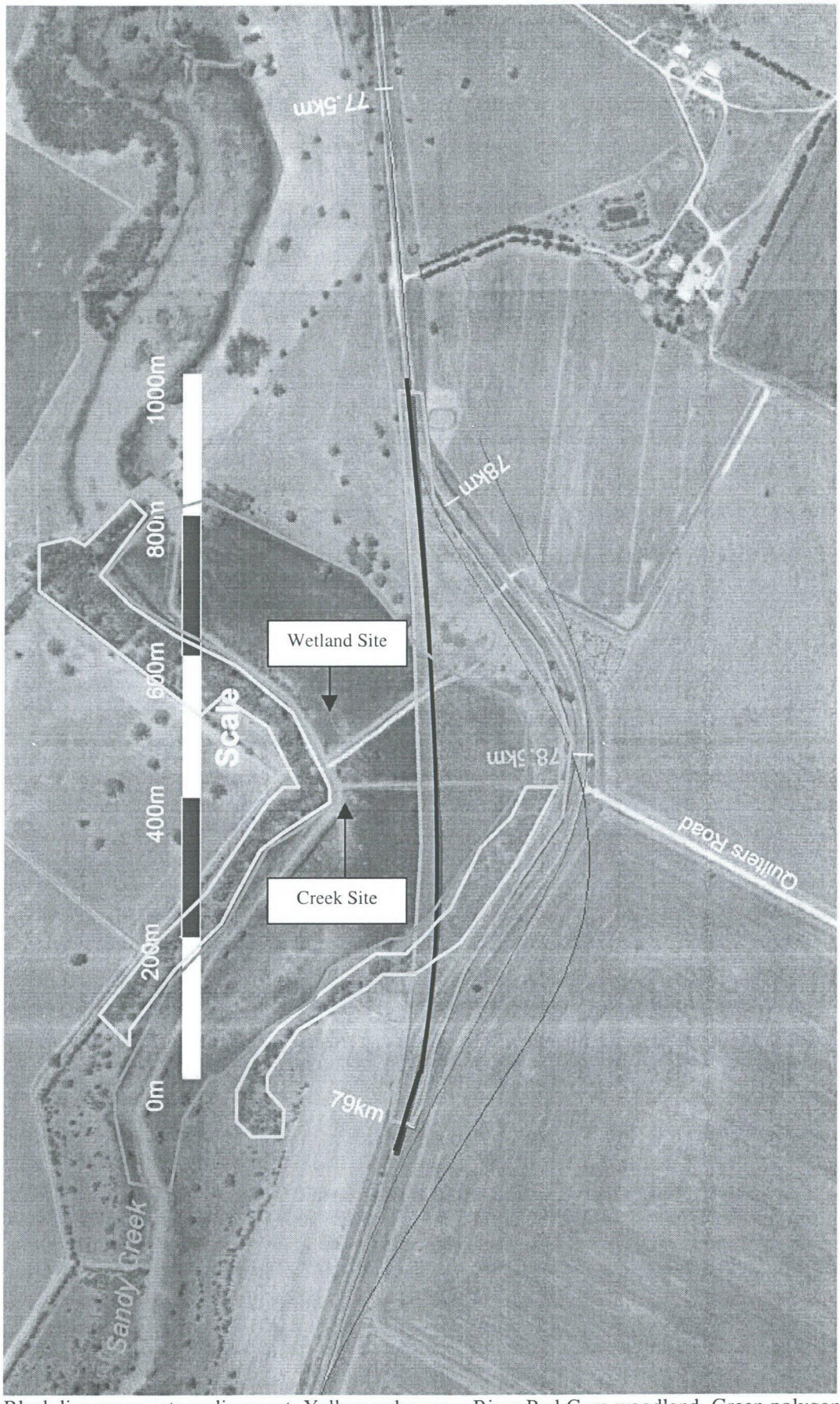
Commonwealth Environmental Protection and Biodiversity Conservation Act

- Land clearance

Appendix 4

Aerial Photograph of Study Area

Location of sampling sites, vegetation communities and realignment



Black line represents realignment. Yellow polygons = River Red Gum woodland. Green polygon = wetland. Pink shaded polygon = Proposal Site.

Appendix 5

Eight Part Tests

Eight Part Test

Under NSW legislation, eight part tests are undertaken to determine whether the impact of a development on species that are known or highly likely to occur on site would be significant. The eight part test will be applied only to those species listed as threatened under NSW legislation. These species will include the Western Starwort, Southern Bell Frog, Grey-crowned Babbler, Superb Parrot, Australasian Bittern, Freckled Duck, Blue-billed Duck and Painted Snipe.

The impact of the Proposal on threatened populations listed in the Fisheries Management Act will also be considered.

Western Starwort

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

The Western Water-Starwort (*Callitriche cyclocarpa*) is a slender aquatic, amphibious or marsh inhabiting glabrous herb that has floating stems or when in terrestrial form is prostrate or weakly erect. According to the limited information available for the species it has only been recorded from Victoria and it is apparently very uncommon with little known about its habitat (Romanowski 1998). However, NSW NPWS database shows a recording for the species in the region in 1991. The family of Callitrichaceae is commonly found in moist to flooded situations.

There is no information available upon the life cycle of this species, and aquatic flora surveys did not identify the species in the Proposal Site. However, given the habitat requirements of other *Callitriche* spp. it is possible that the Western Water-Starwort may occur within the wetland habitat within the Proposal Site. The Proposal will remove an area of approximately 4.2 hectares of ephemeral wetland although extensive areas of interconnected wetland will be retained. It is unlikely that the Proposal will disrupt the life cycle of a local population of the species such that it is likely to be placed at risk of extinction.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

There are no endangered Western Water-Starwort populations listed under the TSC Act.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

It is unknown that the Proposal Site constitutes known habitat for the Western Water-Starwort, however the nature of the Proposal is such that no large tracts of vegetation would be removed. There are large areas of similar habitat on the northern side of the

proposed realignment and throughout the study area along Sandy Creek. It is highly unlikely that a significant area of known habitat will be removed by the Proposal.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The Proposal will result in the removal of approximately 4.2 hectares of ephemeral wetland habitat. This habitat is located on the southern extreme of the floodplain of Sandy Creek and extensive areas (approximately 16 hectares) of similar habitat are located to the north of the proposed realignment. Further, it is unlikely that the wetland within the Proposal Site is known habitat for Western Water-Starwort. Therefore the likelihood of an area of known habitat becoming isolated from currently interconnected or proximate areas of habitat are extremely unlikely.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS for this species.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, this region is poorly represented in conservation reserves. Although large areas of River Red Gum woodland containing floodplain depressions similar to the Proposal Site are conserved in Crown Reserve and State Forests within the region, few areas of River Red Gum woodland are managed specifically for conservation. Given the limited information regarding this species, and the lack of floodplain conservation areas in the region it is likely that the species is not adequately represented in conservation reserves.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The TSC Act 1995 defines threatening process as 'a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities'. Schedule 3 of the TSC Act 1995 provides a list of the key threatening processes regarded to be of relevance to the TSC Act and its implementation. At present, thirteen key threatening processes have been identified:

- Predation by European Red Fox *Vulpes vulpes* (Linnaeus 1758).
- Predation by *Gambusia holbrooki* (Girrard 1859).
- Predation from the Ship Rat *Rattus rattus.*
- Predation by the Feral Cat *Felis catus* (Linnaeus 1758).
- Anthropogenic climate change
- Bushrock removal
- High fire frequency resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition.
- Invasion of plant communities by *Chrysanthemoides monilifera.*

- Loss and/or degradation of sites used for hill-topping by butterflies.
- Clearing of native vegetation.
- Competition and grazing by the feral European rabbit *Oryctolagus cuniculus* (L.).
- Importation of Red Fire Ants *Solenopsis invicta* Buren 1972.
- Alteration to natural flow regimes of rivers and streams and their floodplains and wetlands.

The Proposal is a threatening process given that native wetland vegetation will be removed. However, this area of clearance is approximately 4.2 hectares and represents a minor area of floodplain habitat in the region. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The distribution of this species is poorly understood and therefore it is not possible for this document to comment on its known distribution.

Southern Bell Frog

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

No Southern Bell Frogs were observed or heard chorusing during this survey nor were there any records of this species listed in the NPWS Atlas database for a five kilometre radius around the Proposal Site. Intensive call play back surveys were also undertaken within a number of locations in the study area during periods of high frog chorus activity but failed to attract return calls of this species.

Although no evidence for the occurrence of Southern Bell Frogs within the Proposal Site exists, the proposed activity is of a nature and magnitude that it is unlikely to disrupt the life cycle of the species. The Proposal will result in the clearance of approximately one hectare of ephemeral wetland and segregation of a further 3.2 hectares. The most suitable habitat in the study area for *Litoria raniformis* occurs within the open water areas, a number of which occur approximately 100 metres to the north. The species may also utilise the irrigation channels. Given the minor disturbance to these potential habitats it is unlikely that there will significant impact to the species.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

There are no endangered Southern Bell Frog populations listed under the TSC Act.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The nature of the Proposal is such that no extensive tracts of wetland habitat will be removed. Habitat of similar and greater habitat potential for the species occurs within the surrounding floodplain. Potential habitat for this species is also common within the secondary floodplains of the lower Murrumbidgee River. The Proposal will therefore not result in a significant loss of known habitat for the Southern Bell Frog.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The greatest potential habitat for Southern Bell Frogs within the study area occurs to the north of the Proposal Site in areas of the wetland containing sections of open water. The realignment will not result in these areas being isolated from interconnecting potential habitat for the species. The littoral zones of the two irrigation channels within the Proposal Site also have the potential to support *Litoria raniformis*, although habitat is limited. Although these habitats will be disturbed by the Proposal, there does not appear to be any potential for Southern Bell Frog populations to become isolated from the extensive areas of interconnected habitat to the north. The Proposal does not involve the potential for areas of 'known habitat' for this species 'to become isolated from currently interconnecting or proximate areas of habitat'.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS for this species.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, this region is poorly represented in conservation reserves. Although large areas of River Red Gum woodland containing areas of wetland habitat are conserved in Crown Reserve and State Forests within the region, few areas of River Red Gum woodland are managed specifically for conservation. Recent studies have indicated that strongholds for this species are irrigation bays and channels within the irrigation districts of Coleambally and the Lower Bidgee. As a consequence, the reservation of particular sites is considered, by some, as an inadequate response to the needs of some of these species. Rather, the retention or enhancement of suitable resources for these fauna species throughout the landscape is the most appropriate means of ensuring their continued survival.

In this instance the Proposal is not considered to represent a potential threat to the conservation of Southern Bell Frog.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will clear native vegetation and is, therefore, a threatening process. However it will result in the clearance of 4.2 hectares of ephemeral wetland. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.
The Proposal is not located near the limit of the Southern Bell Frogs range.

Grey-crowned Babbler

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

A family of eight Grey-crowned Babblers were observed during this survey. Grey-crowned Babblers are widely distributed through open woodland and along streams in cleared areas of south eastern Australia. The species is the largest and most conspicuous of the Australia's four babblers and live and breed in a coordinated communal group which may include up to 12 individuals. Recently the species has suffered declines in numbers and population sizes have also decreased. The species was identified foraging within the River Red Gum woodland within the study area and it is likely that the communal group nests in habitat connected to the Proposal Site. The survey failed to identify any current or abandoned nests within the Proposal Site and as such it is not likely that the removal of vegetation will impact breeding success of the species. The magnitude of clearing is minor and may not constitute a significant loss of food resources to the group occurring on site. The likelihood that the Proposal will place the population at the risk of extinction is low.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

There are no endangered Grey-crowned Babbler populations listed under the TSC Act.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The nature of the Proposal is such that no large tracts of vegetation would be removed. The removal of woodland habitat would be confined to approximately 0.2 hectares of highly disturbed River Red Gum woodland. While this does consist of approximately 52 young trees and two hollow bearing trees it is a minor area in respect to the extent of habitat surrounding the Proposal Site.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The woodland habitat that occurs within the Proposal Site is currently fragmented from surrounding stands of River Red Gum but the Proposal will not increase the isolation of the stand. However the proposed works will result in the fragmentation of known habitat for this species given that the population was observed on the southern and northern sides of the proposed realignment. However, considerable areas of habitat for the species occurs to the north west and are reasonably well connected for this mobile species. The Proposal should not have a significant impact on the species through the isolation of habitat.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat for this species had been declared by the Director-General of the NSW NPWS.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west plains is poorly represented with respect to dedicated conservation reserves and can only be described as inadequate. The reservation of particular sites is considered, by some, as an inadequate response to the needs of this species. Rather the retention or enhancement of suitable resources throughout the landscape is considered to be the most appropriate means of ensuring their continued survival (Simpson and Cleland, 1996).

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will clear native vegetation and is, therefore, a threatening process. However it will result in the clearance of only 0.2 hectares of River Red Gum woodland. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal is not at the limit of the Grey-crowned Babblers range.

Superb Parrot

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

A total of eight Superb Parrots were observed during this survey. These birds were observed flying over the Proposal Site on a north south flight line. This species will utilise

food resources within ten kilometres of a nest site on the Murrumbidgee River during the breeding season (August – December) and then venture more widely for food outside this time. It is likely that the birds observed during this survey do in fact nest on the Murrumbidgee River and that feeding areas occur to the south of the Proposal Site.

The survey did not identify any nesting trees during this high visibility period for Superb Parrots within the region. Further only two River Red Gum trees, the preferred nesting species in the region will be removed by the proposed works and as such will not constitute a significant loss to the Superb Parrot population in the area. If the proposed works are undertaken outside of the species breeding season there will be no significant impact upon the life cycle of the species.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

Currently, there are no endangered Superb Parrot populations listed.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

Habitat of greater habitat potential for the Superb Parrot occurs throughout the region and in the surrounding woodland outside of the Proposal Site. Although the Proposal Site is not an area of known habitat, the removal of River Red Gum woodland would not constitute a significant loss to the conservation of the Superb Parrot.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The woodland habitat that occurs within the Proposal Site is currently fragmented from surrounding stands of River Red Gum but the Proposal will not increase the isolation of the stand. Further, the Superb Parrot is a highly mobile species and flies over areas of partially to completely cleared land during feeding excursions. Therefore in respect to any potential Superb Parrot populations within the area, the Proposal will not cause the isolation of known habitat.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS. As a consequence, it is not possible to determine whether 'critical habitat will be affected' by the Proposal with respect to any threatened species of native fauna and flora.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west slopes is poorly represented with respect to dedicated conservation reserves and can only be described as inadequate. Conversely, Superb Parrots are mobile and wide-ranging (Ayers *et al.*, 1996; Reader's Digest, 1986; Strahan, 1983). As a consequence, the reservation of particular sites is considered, by some, as an inadequate response to the needs of some of these species. Rather, the retention or enhancement of suitable resources for these fauna species throughout the landscape is the most appropriate means of ensuring their continued survival.

In this instance the Proposal is not considered to represent a potential threat to the conservation of Superb Parrot.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will clear native vegetation and is, therefore, a threatening process. However it will result in the clearance of only 0.2 hectares of highly disturbed River Red Gum woodland. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal is not located at the limit of the Superb Parrots range.

Australasian Bittern

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

No Australasian Bitterns were observed in this survey. The species spend their entire lives in solitude and secrecy within the cover of rush and reed filled marshes, feeding, roosting and breeding. The wetland habitat that occurs within the Proposal Site constitutes potential habitat for this species given the dense *Juncus sarophorus* that dominates the depression and the extensive areas of open water that could be utilised by the species during feeding.

Approximately 4.2 hectares of potential habitat will be removed by the Proposal and constitutes a minor area in respect to the regional distribution of the habitat. The likelihood of a local population being placed at risk of extinction is considered to be remote.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

Currently, there are no endangered Australasian Bittern populations listed.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The Proposal will remove an area of approximately 4.2 hectares of potential Australasian Bittern habitat. In a study area context this constitutes a 20 percent loss of potential habitat. In a regional context the Proposal will remove only a minor area of potential Australasian Bittern habitat. Although the Proposal Site is not an area of known habitat, the removal of wetland vegetation would not constitute a significant loss to the conservation of the Australasian Bittern, given the availability of similar habitat in the surrounding area and region.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The realignment will result in approximately one hectare of wetland vegetation to be removed and a further 3.2 hectares will be isolated from inundation from irrigation flows. Although the area to become isolated contains habitat that could potentially be inhabited by Australasian Bittern more extensive areas of habitat occur to the north of the Proposal Site. The Proposal does not involve the potential for areas of 'known habitat' for this species 'to become isolated from currently interconnecting or proximate areas of habitat'.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS. As a consequence, it is not possible to determine whether 'critical habitat will be affected' by the Proposal with respect to any threatened species of native fauna and flora.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west slopes is poorly represented with respect to dedicated conservation reserves that contain habitat suitable for the Australasian Bittern and can only be described as inadequate. However, in this instance the Proposal is not considered to represent a potential threat to the conservation of Australasian Bitterns within the region.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will result in the removal of approximately one hectare of native wetland vegetation and as such constitutes a threatening process. However given the magnitude of the area to be cleared in respect to the regional distribution of that habitat the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal is not located at the limit of the Australasian Bitterns range.

Freckled Duck

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

Freckled Ducks occur in most parts of Australia but withdraw to the Murray-Darling Basin, Lake Eyre and Bulloo basins to breed between September and November. However, Freckled Ducks evidently breed out of season when conditions are favourable, particularly following extensive flooding. The species prefers swamps and creeks with heavy growth of cumbungi, lignum or tea tree. The species is dependent upon this particular habitat, although it does visit and sometimes breed in, more temporary and open waters.

The habitat in the study area is temporary and contains relatively small areas of open water in comparison to the Freckled Ducks preferred habitat. It is very unlikely that the species breeds in the area but may be an infrequent visitor. Given the habitat in the area and the magnitude and nature of the Proposal, there will not be a significant impact upon the life cycle of this species.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

An 'endangered population' is defined in the TSC Act 1995 as a population specified in part 2 of Schedule 1. At the time of writing, thirteen endangered populations of native fauna and thirteen endangered populations of flora had been defined in New South Wales. However, the Freckled Duck is not one of these species.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The Proposal Site and study area does not contain known habitat for the Freckled Duck, but the species may occur infrequently in the area. Therefore the Proposal will not remove a significant area of known habitat.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The wetland on site is part of an extensive area of ephemeral wetland and temporary creek habitat. Given that the habitat within the Proposal Site is not considered to be suitable habitat for the species no areas of known habitat will become isolated from proximate or interconnected areas. Further, the Freckled Duck is a highly mobile species and disturbances of the magnitude of the Proposal will not fragment areas of potential use by this species.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS. As a consequence, it is not possible to determine whether 'critical habitat will be affected' by the Proposal with respect to the Freckled Duck.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west slopes is poorly represented with respect to dedicated conservation reserves that contain habitat suitable for the Freckled Duck and can only be described as inadequate. However, in this instance the Proposal is not considered to represent a potential threat to the conservation of Freckled Ducks within the region.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will remove an area of approximately 4.2 hectares of native wetland vegetation and is therefore a threatening process. However, the magnitude of the clearance does not constitute a significant loo to wetland vegetation in the region or locally. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal Site is centrally located within the Freckled Ducks wide distribution range, and is therefore not at the limit of its known distribution.

Blue-billed Duck

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

Freckled Ducks occur in most parts of Australia in deep, densely vegetated freshwater swamps but are most numerous in the Murray-Darling Basin. Unlike most Australian ducks the species has a precise breeding season from September to February. The species is dependent upon this particular habitat, but disperses widely to quiet, sheltered pools and backwaters in swamps to breed.

The habitat in the study area provides quiet, sheltered pools and backwater swamps that could provide potential nesting habitat for Blue-billed Ducks. However, given the magnitude and nature of the Proposal, there will not be a significant impact upon these areas of potential nesting habitats in the study area. Therefore the Proposal is unlikely to disrupt the life cycle of this species.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

An 'endangered population' is defined in the TSC Act 1995 as a population specified in part 2 of Schedule 1. At the time of writing, thirteen endangered populations of native fauna and thirteen endangered populations of flora had been defined in New South Wales. However, the Blue-billed Duck is not one of these species.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The study area contains habitat that may be utilised by nesting Blue-billed Ducks in the region. However, given the magnitude and nature of the proposed works, these areas of potential habitat will not be affected by the Proposal. Therefore a significant area of known habitat will not be removed or altered.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The wetland on site is part of an extensive area of ephemeral wetland and temporary creek habitat. Potential nesting habitat is located outside of the Proposal Site in the open water areas of the wetland and the littoral areas of Sandy Creek. Further, the Blue-billed Duck is a highly mobile species and disturbances of the magnitude of the Proposal will not fragment areas of potential use by this species.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS. As a consequence, it is not possible to determine

whether 'critical habitat will be affected' by the Proposal with respect to the Blue-billed Duck.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west slopes is poorly represented with respect to dedicated conservation reserves that contain habitat suitable for the Blue-billed Duck and can only be described as inadequate. However, in this instance the Proposal is not considered to represent a potential threat to the conservation of Blue-billed Ducks within the region.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will remove an area of approximately 4.2 hectares of native wetland vegetation and is therefore a threatening process. However, the magnitude of the clearance does not constitute a significant loss to wetland vegetation in the region or locally. In this instance, the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal Site is centrally located within the Blue-billed Ducks wide distribution range, and is therefore not at the limit of its known distribution.

Australasian Bittern

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

No Painted Snipes were observed in this survey. The species prefer shallow boggy swamps and in the southern part of their range they favour samphire, a succulent herb growing in salt marshes. The wetland habitat that occurs within the Proposal Site may provide potential habitat for this species, however there are no open mud flats, which this species utilises when foraging.

Approximately 4.2 hectares of wetland habitat will be removed by the Proposal but constitutes only a minor area in respect to the study are and the regional distribution of the habitat. Further, the areas of likely habitat will not be impacted by the Proposal and therefore the likelihood of a local population being placed at risk of extinction is considered to be remote.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

Currently, there are no endangered Painted Snipe populations listed.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

The Proposal Site does not contain known habitat of this species. The Proposal will remove an area of approximately 4.2 hectares of wetland habitat that may be utilised by this species but it is unlikely. Given this and the magnitude and nature of the Proposal, the removal of wetland vegetation would not constitute a significant loss to the conservation of the Painted Snipe, given the availability of similar habitat in the surrounding area and region.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

The realignment will result in approximately one hectare of wetland vegetation to be removed and a further 3.2 hectares will be isolated from inundation from irrigation flows. Although the area to become isolated contains habitat that could potentially be inhabited by Painted Snipe more extensive areas of habitat occur to the north of the Proposal Site. The Proposal does not involve the potential for areas of 'known habitat' for this species 'to become isolated from currently interconnecting or proximate areas of habitat'.

5. Whether critical habitat will be affected.

At the time of preparation of this report, no critical habitat had been declared by the Director-General of the NSW NPWS. As a consequence, it is not possible to determine whether 'critical habitat will be affected' by the Proposal with respect to any threatened species of native fauna and flora.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and the south west slopes is poorly represented with respect to dedicated conservation reserves that contain habitat suitable for the Painted Snipe and can only be described as inadequate. However, in this instance the Proposal is not considered to represent a potential threat to the conservation of Painted Snipes within the region.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Proposal will result in the removal of approximately one hectare of native wetland vegetation and as such constitutes a threatening process. However given the magnitude of the area to be cleared in respect to the regional distribution of that habitat the removal of native vegetation is not likely to result in a reduction of biodiversity in the area.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal is not located at the limit of the Painted Snipes range.

Murray Hardyhead

1. In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction?

The Murray Hardyhead was previously reported to have a wide distribution from the Murray and Murrumbidgee Rivers. Self-maintaining populations occur within a few lakes in Victoria associate with the Murray River. NSW Fisheries surveys have recorded the species at Yanco, approximately 70 river kilometres downstream, but these fish are most probably a result of intensive restocking by NSW Fisheries.

Murray Hardyhead occur in slow flowing streams, swamps and billabongs and usually congregate around submerged aquatic plants. These type of habitats occur within the study area and populations of the species may occur, but would most probably be the result of restocking programs. Given the magnitude and nature of the proposed works there is unlikely to be any impacts upon the species if it occurs in the area. Therefore the species will not be placed at risk of extinction.

2. In the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised?

An 'endangered population' is defined in the Fisheries Management Act 1997 as a population specified in part 2 of the Schedule. At the time of writing, no endangered populations defined in part 2 of the Schedule had been identified and, therefore will not be affected by the proposed development.

The proposed development is being conducted in an area that has not been assessed for viable populations of Murray Hardyhead. This assessment it is unable to draw conclusions upon the presence or absence of an endangered population of the species on site, although it is unlikely that one would occur. From the limited information available it is unlikely that there will be significant impacts upon any 'endangered populations' of Murray Hardyhead, nor that the viability of such populations will be 'significantly compromised' by the proposed development.

3. In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be removed.

Current research has identified that habitat as well as competition from introduced fish species, are limiting factors in the current distribution of Murray Hardyhead. The area proposed for the development possesses many of the features identified as suitable Murray Hardyhead habitat. These include areas of slow flowing water and extensive areas of submerged aquatic vegetation. However, given the magnitude and nature of the Proposal a significant area of this habitat will not be removed.

4. Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Taking note of the description of suitable habitat for the Murray Hardyhead, potential areas occur along the entire length of Sandy Creek in the study area. Further, the nature of the Proposal is such that only minor areas of potential habitat will be removed and no barriers to fish movement will be constructed. The Proposal will not result in the isolation of areas of known habitat to currently interconnecting or proximate areas of habitat.

5. Whether critical habitat will be affected.

The Fisheries Management Act (1994) defines 'critical habitat' as 'habitat declared to be critical to the survival of the species, population or ecological community'. It is further defined as '..any area occupied, or periodically or occasionally occupied, by fish of marine vegetation'. At the time of preparation of this report, no critical habitat had been declared by the Minister. As a consequence, it is not possible to determine whether 'critical habitat will be affected' by the Proposal with respect to the Murray Hardyhead.

Parts (1), (3) and (4) of this section have discussed the potential impacts of the proposed development on the habitat of threatened fauna species.

In terms of the definition of 'critical habitat' provided by the Fisheries Management Amendment Act 1994, it appears that no 'critical habitat' will be affected by the proposed development.

6. Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

In general, the region encompassing Narrandera and south western NSW is poorly represented with respect to dedicated conservation reserves and can only be described as inadequate. Areas known to support Murray Hardyhead have been recommended to be included on the Register of National Estate. Some areas in the Murray River occur in National Parks or nature reserves. However, this representation is not considered to be adequate.

Several measures are in place to ensure that the species becomes secure over its current distribution, although, presently it is poorly represented in conservation reserves. The

conservation of habitat and proper management of riparian and instream environments and introduced fish species will be the key to the conservation of this species.

7. Whether the development or activity is of a class of development or activity that is recognised as a threatening process.

The Fisheries Management Amendment Act 1994 defines threatening processes as 'a process that threatens, or that may threaten, the survival or evolutionary development of species, populations or ecological communities of fish or marine vegetation'. Part 6 of the Schedule is intended to provide a list of key threatening processes and these include:

- The introduction of fish to freshwaters within a river catchment outside of their natural range.
- The removal of large woody debris.
- The degradation of native riparian vegetation along New South Wales watercourses.

The proposed development does not constitute a threatening process.

8. Whether any threatened species, population or ecological community is at the limit of its known distribution.

The Proposal Site is located within an area currently being used for Fisheries releases. The Proposal is located outside of the distribution of self-maintaining populations of the species.

Appendix 6

EPBC - National environmental significance

Commonwealth Legislation

The Southern Bell Frog, Superb Parrot and Murray Hardyhead are listed as vulnerable under the EPBC Act, and is therefore a matter of National Environmental Significance (NES). The table below considers the impact of the development on all matters of NES as described in the EPBC Act 1999.

Matters to be addressed	Impact (Commonwealth Legislation)
(a) any environmental impact on a World Heritage Property;	No. There are no World Heritage Areas within the study area.
(b) any environmental impact on Wetlands of International Importance;	No. There are no Wetlands of International Importance within the study area.
(c) any environmental impact on Commonwealth Listed Threatened Species and Ecological Communities;	No. one Commonwealth listed threatened species was identified in the study area: Superb Parrot (*Polytelis swainsonii*). Investigation also identified that the Southern Bell Frog (*Litoria raniformis*) and Murray Hardyhead (*Craterocephalus fluviatilis*) listed under Part 3 Subdivision C Section 18 – 19 of the EPBC Act, as vulnerable and endangered respectively, may potentially occur on site. *Southern Bell Frog* Administrative Guidelines on Significance' are used to determine whether an action has, or will have, or is likely to have a significant impact on a matter of national environmental significance. The guidelines in terms of the Southern Bell Frog, Superb Parrot and Murray Hardyhead are discussed below: a. lead to a long-term decrease in the size of an important population of a species, or Southern Bell Frogs have been recorded in the Narrandera region and recent research has identified considerable populations in the irrigation districts of Coleambally to the south west. Intensive call play back surveys and census of frog chorusing within the study area did not identify the species. Further, there are no historical or recent records for this species in the area. Given that the occurrence of an important population within the study area is unlikely and the proposed works are unlikely to have an impact on potential Southern Bell Frog habitat the Proposal will not lead to a long-term decrease in population size of the species. b. reduce the area of occupancy of an important population, or The Proposal would slightly reduce the extent of wetland habitat within the Narrandera area. Surveys did not identify the species in the study area and the magnitude of the works will not result in a significant area of potential habitat being removed. Therefore the Proposal will not reduce the area of occupancy of an important population of Bell Frogs if they occurred in the area.

Matters to be addressed	Impact (Commonwealth Legislation)
	c. fragment an existing important population into two or more populations, or The proposed works will remove only a small tract of vegetation with areas of greater habitat potential being unaffected by the Proposal. Given that no populations were identified in the area, the Proposal will not fragment an existing population into two or more populations. d. adversely affect habitat critical to the survival of a species, or The habitat that occurs on site does not constitute habitat critical to the survival of the Southern Bell Frog. Habitat critical to the species occur within the Coleambally Irrigation Area and the Lower Murrumbidgee Irrigation Areas. Further, the Proposal will not result in a loss of potential habitat for the species and therefore the realignment project will not adversely affect habitat critical to the survival of the species. e. disrupt the breeding cycle of an important population, or There is no evidence to suggest that the Proposal Site plays any part in the breeding cycle of the Southern Bell Frog. It is highly unlikely that the removal of ephemeral wetland habitat by the Proposal would disrupt the breeding cycle of Southern Bell Frogs within the region, if the proposed works are conducted outside of the species breeding season. f. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or The habitat that occurs on site does not constitute habitat critical to the survival of the Southern Bell Frog. Further, the Proposal will not result in a loss of potential habitat for the species and therefore the availability or quality of habitat for the species will not be affected to the point where the species will decline further. g. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat*, or It does not appear that any new invasive species (eg. *Gambusia holbrooki*), that are harmful to the Southern Bell Frog, would become established following the actions proposed by the Proposal. h. interferes substantially with the recovery of the species. The recovery of the Southern Bell Frog depends on the management of threats to the species survival, which includes habitat loss and a fungal pathogen. The Proposal would remove habitat that is unlikely to constitute habitat for the Southern Bell Frog. It is unlikely that the removal of this habitat will interfere substantially with the recovery of the species. **Introducing an invasive species into the habitat may result in that species becoming established. An invasive species may harm a vulnerable species by direct competition, modification of habitat, or predation.*

Matters to be addressed	Impact (Commonwealth Legislation)
	Superb Parrot
	a. lead to a long-term decrease in the size of an important population of a species, or
	Superb Parrots have been historically recorded within the Narrandera area. The habitat within the proposed route contains some trees that could provide nesting and roosting habitat for the species. However, a total of only two hollow bearing River Red Gum trees will be removed by the Proposal. Further the survey did not identify any nesting trees during a period of high visibility of the species. Given this, the small area to be removed does not constitute significant habitat to an important population of Superb Parrot in the Narrandera area and as such would not lead to a long term decrease in the size of a population in the region.
	b. reduce the area of occupancy of an important population, or
	The Proposal would slightly reduce the extent of floodplain habitat within the Narrandera area. Surveys conducted during October and November within the Proposal Site failed to identify any areas of occupancy by Superb Parrots. Therefore, the removal of River Red Gum woodland by the Proposal should not reduce the area of occupancy of an important population of Superb Parrots.
	c. fragment an existing important population into two or more populations, or
	The proposed works will remove only a small tract of vegetation, within which only 2 hollow bearing River Red Gum trees will be removed. Further, there is no evidence to suggest that Superb Parrots utilise the Proposal Site for nesting. Given this, it is highly unlikely that the removal of habitat by the Proposal would segregate any potentially existing populations into two or more populations.
	d. adversely affect habitat critical to the survival of a species, or
	On site survey suggest that Superb Parrots do not utilise the Proposal Site for activities such as foraging, breeding, roosting, or dispersal. Estimates suggest that several thousand birds occur along the Murrumbidgee River, 30 – 100 of which occur in colonies in the Wagga Wagga area (Webster 1998). There are no known populations of Superb Parrots in or around the Proposal Site in a five kilometre radius. Habitat that occurs on site is suitable for nesting, but is not considered critical to the survival of the species. Therefore the removal of floodplain habitat by the Proposal would not adversely affect habitat critical to the survival of the Superb Parrot.
	e. disrupt the breeding cycle of an important population, or
	There is no evidence to suggest that the Proposal Site plays any part in the breeding cycle of the Superb Parrot. It is highly unlikely that the removal of floodplain habitat by the Proposal would disrupt the breeding cycle of Superb Parrots within the region, if the proposed works are conducted outside of the species breeding season.
	f. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or
	The River Red Gum woodland to be removed by the Proposal is highly degraded and slightly isolated from proximate areas of floodplain woodland. Surveys only identified

Matters to be addressed	Impact (Commonwealth Legislation)
	two trees along the 1.36 kilometre long Proposal Site that contained hollows, with potential to be used by Superb Parrots during nesting. Further, large areas of more suitable nesting habitat occur within the region. Given the lack of quality habitat on site, it is unlikely that the removal of riparian habitat by the Proposal would modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
	g. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat, or
	It does not appear that any invasive species, that are harmful to the Superb Parrot, would become established following the actions proposed by the Proposal. Flora surveys identified noxious weed species along the bridge corridor, but these species are neither directly or indirectly harmful to Superb Parrots.
	h. interferes substantially with the recovery of the species.
	The recovery of the Superb Parrot depends on the management of threats to the species survival, which includes habitat loss. Namely clearing and degradation of box alliances within the south east Murray Darling Basin (within 15 km of nest sites), logging of River Red Gum nesting habitat and clearing of habitat utilised during non-breeding seasons. Man-induced mortality, which consists of collisions with vehicles are also major threats (Webster 1998). The Proposal would remove habitat that is highly unlikely to constitute nesting habitat for the Superb Parrot, and does not appear to represent non-breeding habitat (Webster 1998). It is unlikely that the removal of semi mature as well as two hollow bearing trees along the Proposal Site would interfere substantially with the recovery of the Superb Parrot.
	Murray Hardyhead
	a. lead to a long-term decrease in the size of an important population of a species, or
	Murray Hardyhead are currently released approximately ten river kilometres downstream of the Proposal Site at the Narrandera Fisheries site on the Murrumbidgee River. Although research that will be used to assess whether Murray Hardyhead are forming self-maintaining populations have not commenced, they are planned for the near future. Although it is possible that the species occurs on site, the limited scientific knowledge means that this assessment is unable to determine if an important population exists. Current knowledge and anecdotal evidence suggests that it is unlikely that an important populations of Murray Hardyhead exists in the area, and therefore the activity is unlikely to lead to a long-term decrease in such a populations size.
	b. reduce the area of occupancy of an important population, or
	The Proposal may result in the removal and slight modification to potential habitat for the Murray Hardyhead in the two irrigation channels in the Proposal Site. However, extensive areas of similar habitat occur throughout the study area along Sandy Creek. The unlikely existence of an important population on site and the minor amount of habitat to be removed means that proposed works will not reduce the area of occupancy of an important population.

Matters to be addressed	Impact (Commonwealth Legislation)
	c. fragment an existing important population into two or more populations, or Currently the irrigation channels and ephemeral wetland that may be utilised by the Murray Hardyhead are interconnected to Sandy Creek and the Proposal will result in a minor area of both being isolated. However, these areas are highly unlikely to contain important populations and therefore the Proposal will not fragment an existing population into two or more populations. d. adversely affect habitat critical to the survival of a species, or The habitat on site is suitable for Murray Hardyhead but similar habitat is abundant in the interconnected areas of Sandy Creek. Further, there is no evidence that the habitat to be altered in the Proposal Site is critical to the survival of the species and is considered to be highly unlikely. Given the magnitude and nature of the Proposal it is unlikely that it will adversely affect habitat critical to the survival of the species. e. disrupt the breeding cycle of an important population, or There is no evidence to suggest that the Proposal Site provides habitat for a self-sustaining population of Murray Hardyhead. Further research is planned for the area to assess the progress of restocking activities upon the recovery of breeding populations. However, given the unlikely occurrence of a self-sustaining population within the Proposal Site, and the nature of the proposed works it should not disrupt Murray Hardyhead breeding if any takes place within the area. f. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline, or The Proposal will result in the removal of a minor area of ephemeral wetland of limited habitat suitability and a small area of open irrigation channel of potential habitat. Further, it is not know if a self-maintaining population occurs within the study area. Given these factors it is highly unlikely that the Proposal will modify, destroy, remove or isolate habitat to the extent that the Murray Hardyhead will further decline. g. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat, or It does not appear that any new invasive species, that are harmful to the Murray Hardyhead, would become established following the actions proposed by the Proposal. Carp (*Cyprinus carpio*) and Plague Minnow (*Gambusia holbrooki)* already exist within the area, and the proposed works will not greatly enhance the habitat for the species. h. interferes substantially with the recovery of the species. The recovery of the Murray Hardyhead depends on the management of threats to the species survival, which includes habitat loss and introduced species. The continued restocking of the species in an attempt to trigger the development of a self-maintaining population in the species former distribution is also an important factor in the Murray Hardyheads recovery. The conservation and enhancement of potential habitat and introduced species management is the most likely way of recovering the species. The Proposal will not interfere substantially with the recovery of the species.

Matters to be addressed	Impact (Commonwealth Legislation)
(c) any environmental impact on Commonwealth Listed Migratory Species;	No. There are no Commonwealth Listed Migratory Species found in the study area.
(d) does any part of the Proposal involve a Nuclear Action;	No. The Proposal does not include Nuclear Action.
(e) any environmental impact on a Commonwealth Marine Area;	No. There are no Commonwealth Marine Areas within the study area.
In addition, any direct or indirect effect on Commonwealth land.	No. The Proposal does not directly or indirectly affect Commonwealth land.

Appendix 7

Noxious Weeds in Narrandera Control Area

Scientific Name	Common Name	Category	Notes
Acacia karoo	Karoo Thorn	W1	
Ailanthus altissima	Tree of Heaven	W3	
Alternanthera philoxeroides	Alligator Weed	W1	
Alternanthera pungens	Khaki Weed	W3	
Cabomba spp.	Cabomba	W4g	Pink Cabomba (*C. furcata) is exempt from declaration*
Cuscuta campestris	Dodder	W2	
Cenchrus incertus	Spiny Burrgrass	W2	
Cenchrus longispinus	Spiny Burrgrass	W2	
Centaurea calcitrapa	Star Thistle	W3	
Centaurea maculosa	Spotted Knapweed	W1	
Centaurea nigra	Black Knapweed	W1	
Chromolaena odornata	Siam Weed	W1	
Eichhornia crassipes	Water Hyacinth	W1	
Emex australis	Spiny Emex	W3	
Equisetum spp.	Horsetail	W1	
Gymnocoronis spilanthoides	Senegal Tea Plant	W1	
Harrisia spp.	Harrisia Cactus	W4f	
Hieracium spp.	Hawkweed	W1	
Hypercium perforatum	St John's Wort	W2	
Ibicella lutea	Devil's Claw (yellow-flower)	W3	
Kochia scoparia	Kochia	W1	Summer or Mock Cypress (*K. scoparia* subsp *tricophylla*) is exempt from declaration.
Lagarosiphon major	Lagarosiphon	W1	
Lycium ferocissimum	African Boxthorn	W2	
Marrubium vulgare	Horehound	W2	
Miconia spp.	Miconia	W1	
Nassella tenuissima	Mexican feather grass	W1	Syn Stipa tenuissima
Opuntia spp.	Prickly Pear	W4f	Indian Fig (*O. ficus indica*) is exempt from declaration.
Orobanche spp.	Broomrape	W1	
Parthenium hysterophorus	Parthenium Weed	W1	
Pistia stratiotes	Water Lettuce	W1	
Proboscidea louisianica	Devil's Claw (purple-flower)	W3	
Prosopis spp.	Mesquite	W1	
Raphanus raphanistrum	Wild Raddish	W2	
Rubus fruticosus (agg. spp.)	Blackberry	W2	
Salix spp.	Willows	W4g	*S. babylonica, S. reichardtii* and *S. calodendron* are exempt from declaration.
Salvinia molesta	Salvinia	W1	
Sclerolaena birchii	Galvanised Burr	W2	
Solanum elaeagnifolium	Silverleaf Nightshade	W3	

Sorghum halepense	Johnson Grass	W2	
Sorghum spp. hybrid cv.	Silk Forage Sorghum	W2	
Sorghum x almum	Columbus Grass	W2	
Toxicodendron succedaneum	Rhus Tree	W2	
Xanthium spp.	Bathurst/Noogoora/ Californian/Cockle Burrs	W3	

Notes:

W1 The presence of the weed on land must be notified to the local control authority and the weed must be fully and continuously suppressed and destroyed.

W2 The weed must be fully and continuously suppressed and destroyed.

W3 The weed must be prevented from spreading and its numbers and distribution reduced.

W4 In accordance with sections 8(3) and 9 of the Act, the action as specified below must be taken in respect of the weed:

a) Where the letter "a" appears beside the control category W4 in the third column of the Schedule:-The weed must not be sold, propagated or knowingly distributed and any part of the weed must be prevented from growing within 3 metres of the boundary of a property.

b) Where the letter "b" appears beside the control category W4 in the third column of the Schedule:-The weed must not be sold, propagated or knowingly distributed and any existing weed must be prevented from flowering and fruiting.

c) Where the letter "c" appears beside the control category W4 in the third column of the Schedule:-The weed must not be sold, propagated or knowingly distributed and the weed must be prevented from spreading onto an adjoining property.

d) Where the letter "d" appears beside the control category W4 in the third column of the Schedule:-The weed must not be sold, propagated or knowingly distributed and the weed must be removed if it is:

- Three (3) metres in height or less, or
- Within half a kilometre of remnant urban bushland, as defined by SEPP 19, and is not deemed by a local control authority as having historical or heritage significance, or
- Is over threes metres in height and not included in a Management Plan approved by the local control authority.

e) Where the letter "e" appears beside the control category W4 in the third column of the Schedule:-The weed must be fully and continuously suppressed and destroyed. All reasonable precautions must be taken to ensure produce, soil, livestock, equipment and vehicles are free of the weed before sale or movement from an infested area of the property.

f) Where the letter "f" appears beside the control category W4 in the third column of the Schedule:-The weed must not be sold, propagated or knowingly distributed. Any biological control or other control program directed by a local control authority must be implemented.

g) Where the letter "g" appears beside the control category W4 in the third column of the Schedule:- The weed must not be sold, propagated or knowingly distributed.

(Source: NSW Agriculture, 1999)

Appendix 8

Raw data – macroinvertebrate identifications

C denotes Channel sampling sites. W denotes wetland sampling sites.

Taxon	C1	C2	C3	C4	W1	W2	W3	W4
Veliidae 1	1		1					1
Veliidae 2	1		1					
Notonectidae	7	22	2	2			2	3
Corixidae	6	12	5	15			3	
Diplonychus sp.	1							
Physa sp.	4	5	4	7	5	6	5	18
Paratya australiensis	9	1	3	3				
Georyssidae	1							
Coenagrionidae	9	21	27	26		2	1	1
Hydrophilidae 1	1	1	1	1	7	1	2	2
Hydrophilidae 2	1	4	7	2	1	2	2	3
Dytiscidae 1	9	2	10	2	2	2	3	11
Dytiscidae 2				1	5	3	13	1
Chironimidae	6	28	11	2	14	9	16	6
Hydrometridae	1	1		1				
Hydracarina	1							
Sigara sp.		3	1	5			1	
Ceratopogonidae		2	2					
Veliidae		4						
Tetragnathidae			2					
Naucoridae				1				
Diplonychus sp.					1			
Leptoceridae							1	
Pygmanisus sp.						1		2
Culicinae					4	5		1
Baetidae			1					

Appendix 9

Descriptions of Threatened Species

Southern Bell Frog (*Litoria raniformis*)
Formerly abundant in the far south west of the state along the Murray River (Sadlier and Pressey, 1994). Its range has since contracted to the Murrumbidgee River between Hay and Balranald where it is common, on the Murray west of Mildura and on the upper reaches of the Murray and Lachlan Rivers in reduced numbers.

This frog is a largely aquatic species found among vegetation within or at the edges of permanent water such as streams, swamps, lagoons and dams.

It is an opportunistic feeder that feeds primarily on invertebrates and other frogs.

Destruction of permanent wetland habitats by hydrological changes, clearing of wetland vegetation and trampling of grazing stock, along with high pesticide concentrations and salination effect the viability of this species.

Magpie Goose (*Anseranas semipalmata*)
The habitat of the Magpie Goose consists of large swamps and dams, particularly with a dense growth of rushes or sedges, wet grasslands and dry floodplains.

Their diet consists mainly of grass seeds in the wet season, sedge rhizomes in season and grass when swamps dry out.
Breeding and nesting occur in a deep cup formed on a mound of floating or trampled vegetation in swamps.

Australasian Bittern (*Botaurus poiciloptilus*)
The Australasian Bittern is a wader that requires a dense reed bed as its principal habitat type. It can be found in waterbodies as diverse as swamps, streams and estuaries.

A member of the Family Ardeidae, the Australasian Bittern preys on insects, crustaceans, frogs, fish and insects.

Breeding and nesting usually take place on a platform of trampled weeds, rushes and cumbungi, usually near water level in heavy cover.

Bush Thick-knee (curlew) (*Burhinus magnirostris*)
The habitat of the Bush Thick-knee is eucalypt woodland with a dry grassy understorey. It is absent from both treeless areas and dense forests. The favoured habitat in western NSW is reported by Maher 1988 (cited in Smith 1991) to be Black Box (*Eucalyptus largiflorens*) woodland.

It is a nocturnal species that forages the ground in woodland and in nearby open areas, including cropland and saltmarshes. The diet comprises seeds, fruits and other plant material along with insects and other invertebrates. Small reptiles and frogs also form part of their food source.
Breeding and nesting take place on bare ground.

Glossy Black-cockatoo (*Calyptorhynchus lathami*)
In NSW the western boundary of the Glossy Black-cockatoo extends from around Inverell to Warrumbungle National Park and the hills west to around Cobar, to the Hervey Ranges,

Mount Hope, Hillston and Griffith (including the Lachlan and Cocoparra Ranges respectively) and south to the Narrandera Range south west of Ardlethan (Pizzey, 1980).

It normally lives in coastal woodlands and forests, open inland woodlands or timbered watercourses where casuarinas are common.

Breeding and nesting usually occur in the hollow of mature or dead trees on flatter ground at the base of hills. The nest is a bed of decayed debris from 3 to 30m above the ground.

Their diet consists almost exclusively of sheoak seeds, although acacia, angophora and eucalypt seeds have occasionally been recorded.

Clearing of woodlands containing feed and nesting trees, grazing and predation by possums on nests are the main threats to this species.

Pink Cockatoo (*Cacatua leadbeateri*)
The Pink Cockatoo is approximately 35 centimetres long with a white back, wings and tail, soft salmon pink head and belly. It has a crest of red and yellow that is tipped with white. The undersides of the body and wings are paler pink to white.

It is found in western NSW, north western Victoria, southern Queensland and through central and western Australia. The habitat of the Pink Cockatoo consists mainly of grasslands, gibber, saltbush and mulga. Often found near timbered watercourses, with stands of native pine, sheoak, belah or larger mallee with suitable nest hollows.

The diet consists of fruit, including that of the native fig and seeds of native and introduced pines.

Breeding and nesting take place on a decayed bed of debris that may include bark fragments and pebbles in a tree hollow.

Brown Treecreeper (*Climacterus picumnus victoriae*)
The eastern subspecies of the Brown Treecreeper *Climacteris picumnus victoriae* is distributed through central NSW on the western side of the Great Dividing Range and sparsely scattered to the east of the Divide in drier areas such as the Cumberland Plain of Western Sydney, and in parts of the Hunter, Clarence, Richmond and Snowy River valleys.

The western boundary of the range of *Climacteris picumnus victoriae* runs approximately through Wagga Wagga, Temora, Forbes, Dubbo and Inverell and along this line the subspecies intergrades with the arid zone subspecies of Brown Treecreeper *Climacteris picumnus picumnus* (Schodde and Mason 1999).

The Brown Treecreeper is a medium-sized insectivorous bird that occupies eucalypt woodlands, particularly open woodland lacking a dense understorey. It is sedentary and nests in tree hollows within permanent territories, breeding in pairs or communally in small groups (Noske 1991). Birds forage on tree trunks and on the ground amongst leaf litter and on fallen logs for ants, beetles and larvae (Noske 1979).

Brown treecreepers are threatened by clearance and the fragmentation of the woodland habitat including removal of dead timber.

Murray Hardyhead (*Craterocephalus fluviatilis*)
Previously reported to have a wide distribution from the Murray and Murrumbidgee Rivers in southern New South Wales to northern tributaries of the Darling River. It is now considered that the latter fish were probably *C. fluviatilis*. The species occurs in slow flowing streams and billabongs where it congregates around submerged aquatic vegetation. Like most Hardyheads, it appears to eat insects as well as plant material.

Painted Honeyeater (*Grantiella picta*)
The Painted Honeyeater occurs in eastern Australia, except for far north Queensland, in open forests and woodland, particularly in areas where casuarinas, acacias and mistletoe occur (Ayers *et al.*, 1996).

A nest is constructed of fibrous roots, casuarina leaves and spider webs in the branch of a eucalypt, casuarina or melaleuca. They feed on mistletoe berries, eucalypt and mistletoe nectar and insects (Ayers *et al.*, 1996).

Competition from other honeyeaters, clearing of suitable habitat and selective thinning of trees possessing mistletoe threaten the persistence of the species (Ayers *et al.*, 1996).

Brolga (*Grus rubicunda*)
The Brolga typically prefers habitats that consist of shallow swamps and their margins, floodplains, grasslands, paddocks and ploughed fields, irrigated pastures, stubble and crops.

Brolgas are omnivorous with their diet consisting of grain crops, in particular sorghum and maize, as well as tubers. A variety of insects, spiders, freshwater and marine molluscs, crustaceans, small mammals and reptiles and frogs comprise the rest of their diet.

Breeding and nesting usually take place in a nest constructed of grasses and plant stems, on small islands in swamps or in water. Occasionally eggs are laid on bare ground.

Black-tailed Godwit (*Limosa limosa*)
The Black-tailed Godwit usually forages in NSW on intertidal sand and mudflats in estuaries, roosting at high tide in a variety of open sites. It also occurs on muddy margins of inland wetlands including sewage treatment works.

The birds typically feed along the waters edge either in shallow water or on soft wet mud with their long bills. The diet includes molluscs, insects and seeds.

Breeding and nesting usually occur from Iceland to western Europe.

Square-tailed Kite (*Lophoictinia isura*)
The habitat of the Square-tailed Kite consists of open forests and woodlands, timbered watercourses, rocky hills and gorges.

Their diet mainly consists of passerine bird species, foliage, insects and sometimes small mammals and lizards.

Breeding and nesting usually occur in trees where the nest is large and constructed of loose sticks.

Turquoise Parrot (*Neophema pulchella*)
The Turquoise Parrot utilises a variety of habitats depending on seasonal conditions, but it generally prefers open woodlands, woodland or open forest edges with a grassy understorey, often in rough, rocky or broken country.

It is a ground feeder of seeds, native grasses and other ground cover or pasture species when available.

For nesting purposes it utilises stumps, hollow logs or tree hollows.

Barking Owl (*Ninox connivens*)
Primarily inhabits open forest and woodland, in warm lowland areas on gentle terrain (Ayers *et al.* 1996). It roosts by day in dense streamside galleries and thickets of Casuarina and Acacia as well as eucalypts, and forages in adjacent woodland; it is often associated with red gum species (Higgins 1999). Barking Owls are assumed to be sedentary, living singly, in pairs or family groups of three to five in permanent territories containing several roost sites.

These owls hunt nocturnally for a variety of mammals up to the size of a rabbit, primarily native gliders (Kavanagh and Bamkin 1995).

Barking Owls are threatening by habitat clearance, logging and firewood harvesting and feral honeybees, which can take over the owls' nesting hollows (Kavanagh and Bamkin 1995).

Blue-billed Duck (*Oxyura australis*)
The Blue-billed Duck prefers habitats of permanent freshwater swamps, dams, lakes and larger rivers, usually with a cover of dense vegetation.

Blue-billed Ducks feed upon a wide variety of seeds and leaves of freshwater plants as well as large numbers of midge, caddisfly and dragonfly larvae.

Breeding and nesting take place in a cup-shaped nest constructed in rushes, reeds, sticks, cumbungi or lignum with a little down lining. Often a canopy of surrounding growth is pulled over it in cumbungi, rush, lignum or tea-tree, either over water or on the ground if on an island. Occasionally they will utilise the old nest of other waterfowl.

Plains Wanderer (*Pedionomus torquatus*)
The Plains Wanderer occurs in south eastern Australia, except along the NSW coast. They require extensive areas of sparse grassland, but not improved pastures. An ideal habitat would consist of 50% bare ground, 10% fallen litter and 40% low cover.

They feed on a variety of insects, native grasses, saltbush, introduced cereals, legumes and weeds at night. The ground based nest consists of a grass lined depression under a low shrub or tuft of grass (Ayers *et al.*, 1996).

Cultivation, habitat alteration by livestock, fire, competition, predation and hunting are all processes that affect the survival of the species (Ayers *et al.*, 1996).

Superb Parrot (*Polytelis swainsonii*)
The habitat of the Superb Parrot primarily consists of riverine forests and neighbouring woodlands of River Oaks (*Casuarina cunninghamiana*), Yellow Box (*Eucalyptus melliodora*) and other eucalypts as well as stubble, pastures, sugar gum windbreaks and homestead gardens.

Their diet consists of seeds of grasses, herbs, crops and weeds. It also feeds upon fruit and blossoms of eucalypts and acacias.

Breeding and nesting usually occur in hollow eucalypt limbs.

Grey-crowned Babbler (*Pomatostomus temporalis*)
Grey-crowned Babblers are the largest and most conspicuous of Australia's four babblers. The species live and breed in a co-ordinated communal group which may include up to 12 individuals. Grey-crowned Babblers have a wide distribution in northern and eastern Australia, west to the Pilbara region, WA, and southeast to southeastern South Australia. The species inhabit open woodland and along streams in cleared areas.

Grey-crowned Babblers breed from July-February and utilise domed nests of twigs and grass reached by a small tunnel. The nests are lined with fine grass and fur or cow dung. The species has a distinctive call, usually a repeated *chuck* and loud *wee-oo*.

Painted Snipe (*Rostratula benghalensis*)
The habitat of the Painted Snipe consists of swamp fringes, dams, sewage farms and marshy areas that generally have a cover of grasses, lignum, low scrub and open timber.

Their diet mainly consists of aquatic plants and seeds, insects, worms, molluscs, crustaceans and other invertebrates.

Breeding and nesting take place in a well made saucer of twigs, reeds and grasses which is often set on a small hummock above water level, usually in cover. The nest may also have a canopy of stems and grasses.

Predation by foxes, reduction of vegetative cover by livestock, cultivation around swamp and marsh edges and changes to flooding patterns threaten the survival of the Painted Snipe (Ayers *et al.*, 1996).

Diamond Firetail (*Stagonopleura guttata*)
The Diamond Firetail is distributed through central and eastern NSW, extending north into southern and central Queensland and south through Victoria to the Eyre Peninsula, South Australia. In NSW, the species occurs predominantly west of the Great Dividing Range, although populations are known from drier coastal areas such as the Cumberland Plain of western Sydney and the Hunter, Clarence, Richmond and Snowy River valleys (Blakers *et al.* 1984, Schodde & Mason 1999).

The Diamond Firetail is a brightly coloured finch that occupies eucalypt woodlands, forests and mallee where there is a grassy understorey. Firetails build bottle-shaped nests in

trees and bushes, and forage on the ground, largely for grass seeds and other plant material, but also for insects (Blakers *et al.* 1984, Read 1994).

The Diamond Firetail has disappeared from parts of its former range and has declined in numbers in many areas. Declines have been recorded on the Cumberland Plain, western Sydney (Hoskin 1991; Keast 1995) with a local extinction near Scheyville (Egan *et al.* 1997). On the New England Tableland, declines in populations are apparent (Barrett *et al.* 1994) and the species has become extinct within Imbota Nature Reserve and surrounds (H. Ford, pers. comm.). Reid (1999) identified the species as a 'decliner' in a review of bird status in the NSW sheep-wheatbelt; and Fisher (1997) predicted that Diamond Firetails would significantly decline from the Bathurst District if current trends in land management persisted.

The Diamond Firetail is threatened by clearance and fragmentation of habitat.

Freckled Duck (*Stictonetta naevosa*)
The habitat of the Freckled Duck is heavily vegetated swamps, large open lakes and associated shores and floodwaters.

They feed by filtering and dabbling, which limits their foraging to aquatic habitats, especially shallow productive waters or soft mud at wetland edges.
Breeding and nesting usually occur in a well constructed bowl shaped nest of stems and sticks in lignum or in overhanging tea-tree branch or flood debris close to water. It will at times utilise old coots nest.

Regent Honeyeater (*Xanthomyza phrygia*)
The Regent Honeyeater inhabits regions in south eastern Australia in eucalypt forest and woodland, and are often associated with *Eucalyptus robusta* and She-oaks. However, roadside verges also provide valuable habitat for the species at certain times of the year (Ayers *et al.*, 1996).

They are a nectivorous species, utilising the resources provided by ironbarks, mistletoe and banksias. They also consume insects, manna, seeds and fruits (Ayers *et al.*, 1996).

The Regent Honeyeater is threatened by clearing of suitable habitat, lack of adequate regeneration of trees along roadsides and logging of ironbark forests (Ayers *et al.*, 1996).

Little Pied Bat (*Chalinolobus picatus*)
Little Pied Bats are microchiropteran bats, weighing between four and seven grams. This species is covered with black fur on the back, head and belly. Two white stripes extend down the sides of their body that form a V in the pubic region. Their diet is poorly understood. Information from a single sample of an individuals stomach revealed only moths (Churchill, 1998).

The Little Pied Bat is found in the drier areas of southern Queensland, NSW and South Australia. This species was originally thought to be rare due to its reliance on caves for roosting sites, which are uncommon throughout it's range. This theory has been disproved however, with the discovery that the Little Pied Bat colonise tree hollows and disused buildings as well (Duncan *et al*, 1999). There is no historical data on abundance available

for this species, however the Little Pied Bat is thought to be declining due to loss of roosting sites. This is especially true given the removal of hollow bearing trees for agriculture and urban development, and the removal and damage of old buildings.

Koala (*Phascolarctos cinereus*)
The Koala has an extensive but disjunct distribution from northern Queensland to southern Victoria (Strahan, 1995). Essentially arboreal it is an extremely agile climber and leaper.

It is restricted to eucalypt forest and feeds almost exclusively on the leaves of eucalypts. In particular the River Red Gum (*Eucalyptus camaldulensis*), Grey Gum (*Eucalyptus punctata*), Manna Gum (*Eucalyptus viminalis*), Swamp Gum (*Eucalyptus robusta*) and Forest Red Gum (*Eucalyptus tereticornis*).

Breeding occurs in trees during summer. Although it lives predominantly in trees, it may travel for some distance on the ground in search of food.

Inland Forest Bat (*Vespadelus baverstocki*)
Inland Forest Bats are small bats, weighing between 3.6 and 7 grams. There is some variation in their colour, ranging from sandy brown on the back with a lighter colouring on the belly, to brownish grey with a paler belly (Churchill, 1998).

This species has been found roosting in tree hollows and abandoned buildings in a range of habitats including Casuarina and eucalypt woodlands, mallee, shrub and grassland communities in inland Australia (Churchill, 1998).

The diet of this species is unknown.

Tree clearing, particularly those trees possessing hollowed limbs, and predation by feral cats are thought to contribute to the threatening of this species (Ayers *et al.*, 1996).

Mossgiel Daisy (*Brachyscome papillosa*)
The Mossgiel Daisy is an erect perennial species that grows to 36cm high. The ray florets of this species are mauve and it flowers from June through to December. The Mossgiel Daisy occurs in saltbush plains, chiefly from Mossgiel to Urana.

Appendix D

Preferred Options Report

Preferred Option Report

1 PROJECT IDENTIFICATION DETAILS

1.1 Identification Details:

Project:	Realignment at Sandigo
Road Name:	Sturt Highway
RTA Region:	South Western
Road Number:	State Highway No 14
Project Location:	77.7km –79km west of Wagga Wagga
Project Length:	1.36km
Council Area:	Narrandera
State Electorate:	Murrumbidgee
Type of Work:	Construction and realignment of existing carriageway.
IMS Project Number:	067104

1.2 Background:

The Sturt Highway connects Adelaide with the Hume Highway east of Wagga Wagga forming the major freight connection for South Australia and the Sunraysia District of Victoria with Sydney and the ACT. The link between Wagga Wagga and Narrandera is generally of minimum 100 km/h geometric standard with the one exception between 77km – 79km west of Wagga Wagga. This section has a combination of substandard 300m radius reverse curves with advisory speeds of 85km/h. The result of this combination has produced a section of highway, which is inconsistent with travel condition on the remainder of the route.

These substandard curves have produced unsafe travel conditions especially for heavy vehicles. As a result of incidents and concerns, additional advance signposting ('tipping truck' signs) have been installed at this location.

The Stage 2 Project Proposal Report has been approved by the Department of Transport and Regional Services (DOTARS) on the 20/04/02.

2 OBJECTIVES

2.1 General:

To realign State Highway No 14 approximately 77km –79km west of Wagga Wagga to improve the existing reverse curved alignment to National Highway standard and reinstatement of an existing local road T-junction (Quilters Road).

2.2 Specific Objectives and Benefits of the Project:

- provides a road constructed to 110km/h design speed and consistent with existing travel conditions on the adjacent sections of the highway;
- improves road safety;
- provides a road that is flood free;
- provide value for money in terms of road user benefits;
- has minimal impact on the flood plain of Sandy Creek;
- minimises adverse impacts on improved agricultural land ;
- affect on improved agricultural land to be shared equally between property owners;
- minimises adverse impacts upon the environment;
- ensures affected landowners are aware of the project, are consulted and have input opportunities throughout the project;
- improves the movement of stock between properties located on the highway;
- has minimum impact on the existing irrigation channels;
- minimises construction problems.

3 ROUTE SELECTION

As part of the selection process for a route which best achieves the project objectives, various alignments, as shown on the Locality Plan, were investigated based on the following design parameters:

- 2x3.5m lanes for a single carriageway;
- 2m outer shoulder widened to 3m adjacent barrier line;
- 1m verge;
- Cut batters at 2:1 (with table drain);
- Fill batters at 4:1 (2:1 behind guardfence);
- Minimum radius 750m to suit the adjacent sections of Highway;
- Designed travel speed - 110km/h;
- Existing waterway requirements to be reinstated or improved.

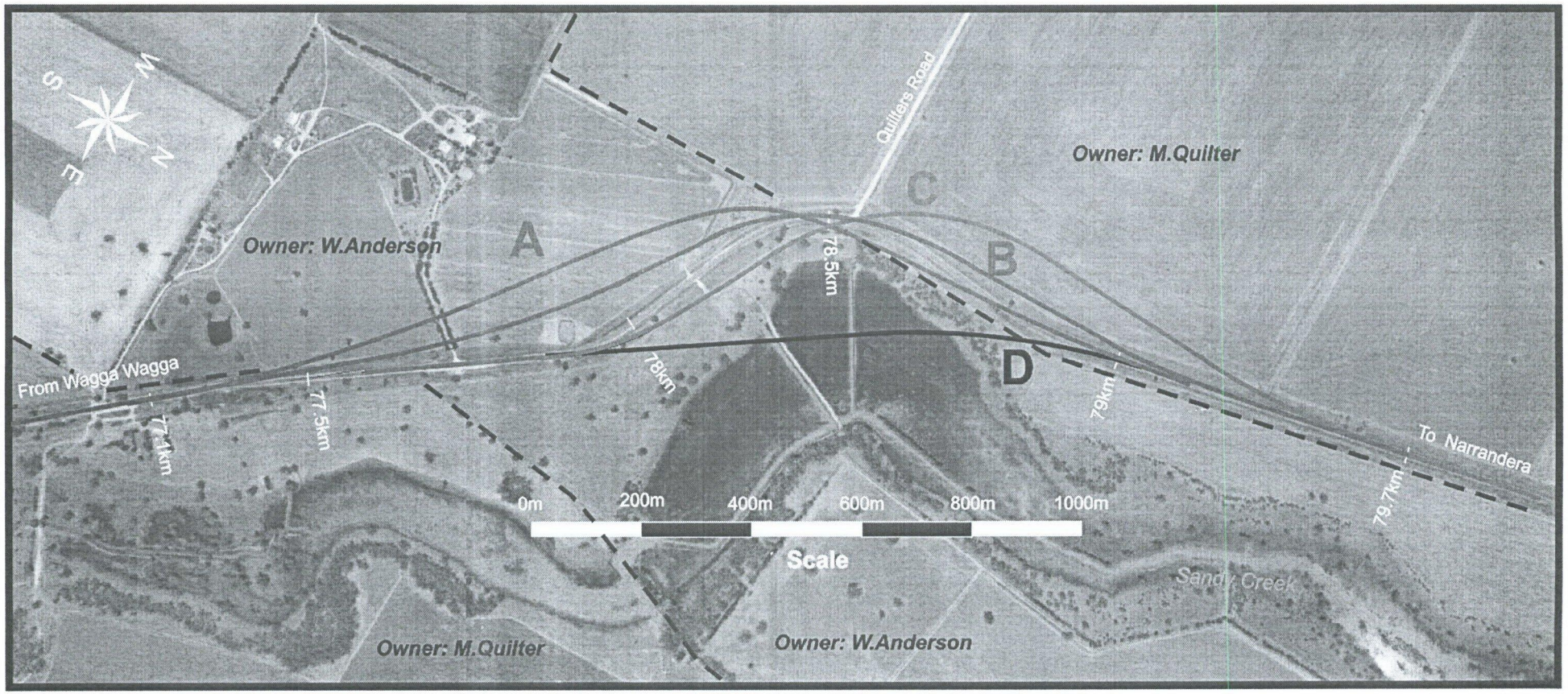
Table 1 contains an assessment of the alignments in the context of the project objectives.

Table 1 Assessment of Alignments against Project Objectives

Alignment A (Green)	*Alignment B (Red)*	*Alignment C (Blue)*	*Alignment D (Black)*
Length 2.03km	Length 2.30km	Length 2.03km	Length 1.36km
OBJECTIVE: provides a road constructed to 110km/h design speed and consistent with existing travel conditions on the adjacent sections of the highway			
Yes	Yes	Yes	Yes
OBJECTIVE: improves road safety			
Reverse curves radii remain but radii increased to 750m Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	Reverse curves radii remain but radii increased to 750m Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	Reverse curves radii remain but radii increased to 750m Sight distance improved but restricted for overtaking on 750m radius curve. Quilters Road intersection located on the back of curve causing some sight restrictions due to the superelevation on the highway.	Eliminates reverse curves Straightest alignment providing optimum sight distance for overtaking Quilters Road intersection located on a straight with optimum sight distance
OBJECTIVE: provides a road that is flood free			
Yes	Yes	Yes	Yes
OBJECTIVE: provide value for money in terms of road user benefits			
Construction Costs $1.95m *(excl. contingency)* $2.74m Net Present Value $2.75m BCR 2.4	Construction Costs $2.14m *(excl. contingency)* $3.0m Net Present Value $2.5m BCR 2.2	Construction Costs $1.95m *(excl. contingency)* $2.74m Net Present Value $2.75m BCR 2.4	Construction Costs $1.98m *(excl. contingency)* $2.79m Net Present Value $4.3m BCR 3.2
OBJECTIVE: has minimal impact on the flood plain of Sandy Creek			
No impact	No impact	No impact	Minimal impact *Will require hydrology study to confirm this and provide sufficient culverts to have minimal effect on flooding*

Alignment A (Green)	*Alignment B (Red)*	*Alignment C (Blue)*	*Alignment D (Black)*
OBJECTIVE: minimises adverse impacts on improved agricultural land			
Approx. 7ha of acquisition from irrigated paddock and 1.5ha unusable residue. One dam to be relocated	Approx. 7ha of acquisition from wheat and irrigated paddock. One dam to be relocated	Approx. 7ha of acquisition from wheat paddock	No impact
OBJECTIVE: affect on improved agricultural land to be shared equally between property owners			
No *All from one owner*	Yes	No *All from one owner*	Not applicable
OBJECTIVE: minimises adverse impacts upon the environment			
Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts as small and manageable*	Yes *Environmental overview identified impacts on swamp vegetation, hydrology and flooding in Sandy Creek. Appear to be minimal but REF to confirm.*
OBJECTIVE: ensures affected landowners are aware of the project, are consulted and have input opportunities throughout the project			
Yes	Yes	Yes	Yes
OBJECTIVE: improves the movement of stock between properties located on the highway			
Minimal *Stock will still use highway to travel between properties. Sight restrictions will exist due to curve obscuring stock.*	Minimal *Stock will still use highway to travel between properties. Sight restrictions will exist due to curve obscuring stock.*	Minimal *Stock will still use highway to travel between properties. Sight restrictions will exist due to curve obscuring stock.*	Yes *Stock will still use old highway to travel between properties with only a short length of travel on the new highway.*
OBJECTIVE: has minimum impact on the existing irrigation channels			
Yes	Yes	Yes	Yes *Irrigation channels will need to be piped under new road*

Alignment A (Green)	Alignment B (Red)	Alignment C (Blue)	Alignment D (Black)
OBJECTIVE: minimises construction problems			
Minimal Likely impact on Telstra, water and fibre optical cable	Minimal Likely impact on Telstra, water and fibre optical cable	Minimal Likely impact on Telstra, water and fibre optical cable	Minimal No impact on utilities however, does require a rock layer over floodplain



LOCALITY PLAN

4 PREFERRED ALIGNMENT

Based on the assessment in Table 1, it was concluded that Alignment D (black) is clearly the best performing option in terms of the majority of the project objectives.

Alignment D has been designed to be flood free and for 110km/h design speed. It is consistent with travel conditions on the adjacent sections of highway and provides the optimum sight distance for overtaking and for vehicles entering the Highway from Quilters Road.

The economic performance of Alignment D in terms of road user cost benefit analysis is superior to the other alignments largely due to the savings in vehicle operating costs of the shorter alignment. It provides a BCR of 3.2 and a net present value of $4.3million.

Alignment D has no impact on improved agricultural land and is the preferred alignment of the affected landowners. It provides the safest route for moving livestock from Quilters Road onto the highway by removing the reverse curves that obscure livestock from motorist's view on the highway.

Alignment D does impact on the environment as it crosses the Sandy Creek floodplain. An environmental overview identified that this route may impact on swamp vegetation, hydrology and flooding in Sandy Creek however, the impacts appears to be minimal. A Review of Environmental Factors will need to confirm this before proceeding with the final design.

Alignment D does not require any relocation of public utilities however, geotech investigations recommended that a 500mm rock layer is required across the floodplain.

5 PREFERRED ALIGNMENT PROJECT SCOPE

The following information provides a description of the scope of work:

5.1 Location

The project is located on State Highway No 14, Shire of Narrandera approximately 77.7km to 79km west of Wagga Wagga.

5.2 Limits of Work

The work extends between the following ROADLOC coordinates:
ROADLOC Reference

Start:	R(14,200,A1,1.84)
Finish:	R(14,200,A1,3.20)
Existing Quilters Road Intersection on SH 14	R(14,200,A1,2.65)

The preferred route is shown as Alignment D on the Locality Plan below.

5.3 Primary Objective

To realign State Highway No 14 approximately 77km –79km west of Wagga Wagga to improve the existing reverse curved alignment to National Highway standard including reinstatement of an existing local road T-junction (Quilters Road).

5.4 Secondary Objectives

- provides a road constructed to 110km/h design speed and consistent with existing travel conditions on the adjacent sections of the highway;
- improves road safety;
- provides a road that is flood free;
- provide value for money in terms of road user benefits;
- has minimal impact on the flood plain of Sandy Creek;
- minimises adverse impacts upon the environment;
- ensures affected landowner is of the project, is consulted and has input opportunities throughout the project;
- improves the movement of stock between properties located on the highway;
- has minimum impact on the existing irrigation channels;
- minimises construction problems.

5.5 Design Standards

- 110km/h design speed;
- 2x3.5m lanes for a single carriageway;
- 2m outer shoulder widened to 3m adjacent barrier line;
- 1m verge;
- Cut batters at 2:1 (with table drain);
- Fill batters at 4:1 (2:1 behind guardfence);
- Minimum radius 1000m;
- Designed travel speed 110km/h;
- Quilters Road intersection – type AUR and BAL;
- Vertical Alignment to match existing.

5.6 Waterway Structures

- Existing waterway requirements to be reinstated and any requirements of the REF to be included
- Irrigation channels to be piped with a nominal 1500mm dia CPC to suit owners requirements.

5.7 Pavement Design

The proposed pavement design from 77.7km – 78.3km and 78.65km – 79.0km is:

	14mm seal over 7mm primer seal
225mm	DGB
225mm	DGS
	Primer seal (7mm)
300mm	Select Fill CBR>15% PI<12. Top 150mm to be lime stabilised with 2% hydrated lime unless the CBR of select is >30%
	Subgrade CBR (to be determined pending test results) Estimated 3%

The proposed pavement design across the floodplain from 78.3km - 78.65km is:

	14mm seal over 7mm primer seal
225mm	DGB
225mm	DGS
	7mm primer seal
300mm	Select fill CBR>30%
1350mm	Lime stabilised clay
	Class B Geotextile
500mm	Free draining rock layer – full width (-125mm with less than 15% passing 19mm sieve)
	Subgrade CBR of 1% Top 150mm stabilised with 3% hydrated lime, or Clas B geotextile.

5.8 Physical Constraints

- Reinstate Quilters Road. Location to be confirmed with affected property owners
- Radius of curve at ch.78800 to be adjusted to minimise tree removal
- Provide for safe movement of stock between properties in Quilters Road and the highway.

5.9 Environmental Constraints

- Minimise impact on floodplain – include recommendations from REF.

5.10 Geotechnical Constraints

- Provide 500mm rock drainage blanket across floodplain.

5.11 Timing

Project Development to be completed by:	October 2002
Investigation and Design to be completed by:	December 2002
Advertise tenders	January 2003
Property Acquisition to be completed by:	February 2003
Construction to commence by:	March 2003
Project completion by:	June 2003

5.12 Estimate of cost

Project Preliminary Estimate - $2.8million (See attachment A for Preliminary Estimate approval)

6 RECOMMENDATION

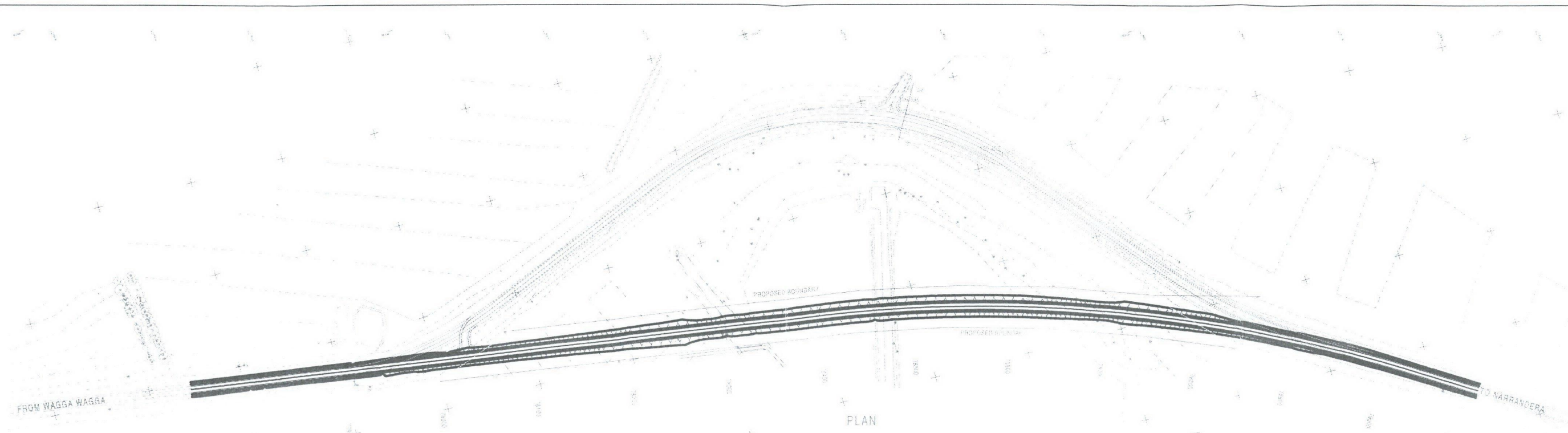
Alignment D is **RECOMMENDED** for approval as the preferred alignment. This alignment shown on the attached locality plan performs significantly better than the other alignments and as such, has been identified as the preferred alignment for consideration in the REF.

RECOMMENDED

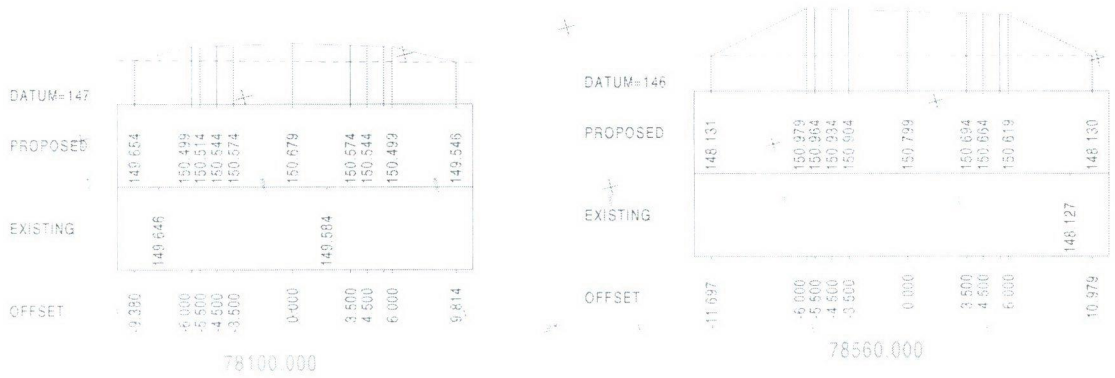
Wayne Walgers
Project Development Manager

Appendix E

Concept Design



PLAN



QUANTITIES

Cut	210 m3
Fill	29.912 m3
Topsoil	3.916 m3
Bitumen seal	12.240 m2
Safety barrier	920 m
Clearing & Grubbing	51.000 m2

PAVEMENT

DGB	3.810 m3
DGS	3.947 m3
Select	3.848 m3
Clay	13.927 m3
Rock layar	4.480 m3

LONGITUDINAL SECTION

Appendix F

Correspondence and Database Searches

ORIGINAL

Wiradjuri Branch
New South Wales Aboriginal Land Council

153 Docker Street, Wagga Wagga 2650. P.O. Box 5515, Wagga Wagga 2650
Telephone: (069) 21 6544 - 21 6339, Fax: (069) 21 7903

Wayne Walgers
Project Development Manager
Roads and Traffic Authority
Simmons Street
WAGGA WAGGA NSW 2650

Dear Wayne

RE: STURT HIGHWAY RE-ALIGNMENT NEAR SANDIGO

Further to our meeting and discussion at the above site on 9 August 2002, I now confirm in writing the recommendations that I stated to you that should occur, before any excavation work is to commence.

The Narrandera Local Aboriginal Land Council is to be contacted so that a representative of the NLALC can be in attendance, to ensure that if any culturally significant material is unearthed during these works that the appropriate action can be taken.

The Narrandera LALC can be contacted on 02 6959 1823.

Please do not hesitate to contact me should you wish to discuss this matter further.

Yours sincerely

RWilliams.

Roland Williams
Branch Manager
11 September 2002

LAND & WATER CONSERVATION

Roads and Traffic Authority
Level 5, Pod D
99 Phillip Street
PARRAMATTA NSW 2124

Contact: Tim Smith
Phone: (02) 6298 4017
Fax: (02) 6299 6619
e-mail:
tjsmith@dlwc.nsw.gov.au

Our Ref:
[letter to rta about sturt highway at sandigo dated 31st october 2002.doc]
Your Ref: WBS Ref: H38643C

31 October 2002

Attention: Peter Ryan

Dear Mr Ryan,

Re: Realignment of Sturt Highway at Sandigo

Thank you for the opportunity to comment on the realignment of the Sturt Highway at Sandigo. I recently met Wayne Walgers and Phanta Khamphounvong on site to discuss the issues involved with the realignment. After discussions on site I am happy that DLWC concerns will be covered in the REF process.

The main issues that DLWC had concerns about were the effect that the new road location would have on localised flood levels and that proper sediment erosion control measures were carried out before, during and after construction of the new road.

If you have any questions regarding the above matter please contact Tim Smith on 02 6298 4017.

Yours sincerely

Tim Smith
Acting Environmental Review Coordinator
NSW Department of Land and Water Conservation

Rural Lands Protection Board
Narrandera

Communications to be addressed to:
THE ADMINISTRATIVE OFFICER
P.O. Box 11, Narrandera 2700
Telephone (02) 6959 2322
Fax (02) 6959 3077

BOARD OFFICE
8 Bolton Street,
NARRANDERA 2700

FAX
TRANSMISSION

Fax to number :	8837 0053
Attention :	Peter Ryan
Date :	4th October, 2002
From :	Chris Wills
Pages :	1

Subject :	Realignment of Sturt Hwy at Sandigo

Comments : Your reference WBS Ref: H38643C

We refer to your e-mail and attachments of 3/10/02 and advise that the Board has no objection to or comments on the proposed realignment of the Sturt Highway near Sandigo.

Signed :

Our ref: RTA021
Your ref: WBS Ref: H38643C

3 October 2002

Mr Peter Ryan
Environmental Officer
Roads and Traffic Authority
Level 5, Pod D
99 Phillip Street
PARRAMATTA NSW 2124

Dear Peter

Re: Realignment of Sturt Highway at Sandigo

I refer to your email of 2 October 2002 requesting NSW Fisheries requirements for the preparation of a Review of Environmental Factors (REF) for the proposed realignment of the Sturt Highway at Sandigo.

A copy of NSW Fisheries requirements is attached for your information.

One of the main issues that NSW Fisheries would like to see addressed in the REF, in addition to those listed in the accompanying document, is the potential impact that the works will have on wetlands and the floodplain in the vicinity of the proposed works. Consideration should also be given to the potential impact that the new road alignment will have on the movement of flood flows and fish passage during these periods.

Once an REF has been prepared for the project NSW Fisheries would like the opportunity to review this document before work commences on the rehabilitation works.

For further information please contact me on 02 6959 9028.

Yours faithfully

Michelle Perry
Conservation Manager

NSW FISHERIES REQUIREMENTS FOR THE PREPARATION OF ENVIRONMENTAL PLANNING AND ASSESSMENT DOCUMENTS

NSW Fisheries is responsible for managing aquatic species (including aquatic invertebrates), aquatic habitat and aquatic biodiversity throughout NSW. Aquatic biodiversity occurs in permanent and intermittent waterways including marine, estuarine, fresh, flowing and still waters.

NSW Fisheries requirements for the preparation of environmental planning and assessment documents are outlined in the current NSW Fisheries *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation 1999* pp 49-51. A copy of which is attached with this letter.

Of primary concern to NSW Fisheries are the disturbance and/or destruction of aquatic habitats and any adverse impacts on aquatic species. Disturbance can be in the form of siltation from excessive sediment runoff, blockages to fish passage such as the construction of causeways, culverts and temporary crossings and direct impacts on aquatic habitat such as the removal of aquatic vegetation and desnagging activities.

NSW Fisheries has also introduced threatened aquatic species legislation, which allows for the listing of aquatic species, populations or communities as either endangered or vulnerable. This legislation is outlined in Part 7A of the *Fisheries Management Act 1994*. Aquatic threatened species are widely distributed across western NSW and should be considered in any environmental assessment process. Up to date information is available on the NSW Fisheries website (www.fisheries.nsw.gov.au) or the Fisheries Scientific Committee website (fsc.nsw.gov.au).

Any environmental planning and assessment documents should include the following information as **an absolute minimum** to allow staff from NSW Fisheries to make an informed decision about the potential impacts that any proposed works may have on aquatic species and their habitats.

- Location of works (including topographic map)
- Name of adjacent watercourse(s)
- Description of works to be undertaken
  - Method/s of construction
  - Timing and duration of works
- Obstructions to fish passage (temporary and permanent) identified
- Aquatic habitat conditions at the site – particularly riparian and aquatic vegetation, water depth, permanence of water flow and snags in the vicinity of the proposed works.
- Potential impacts upon aquatic and riparian habitats (both temporary and permanent)
- Proposals to mitigate impacts upon riparian and aquatic vegetation and aquatic habitats.
- Potential impacts upon water quality of the proposed works.
- Proposals to mitigate impacts upon water quality.
- An assessment of the potential impact that proposed works may have on aquatic threatened species, populations and ecological communities.

The above list outlines the minimal amount of information that is required by NSW Fisheries to undertake an assessment of the potential impacts that a proposed activity or works may have on the local aquatic environment. Large scale works will require more detailed information to be submitted to the Department for assessment.

Further information can be obtained from

Ms Michelle Perry,
Conservation Manager
NSW Fisheries
PO Box 182
NARRANDERA NSW 2700 Ph (02) 6959 9028

Our Ref: DB:NH

11 October 2002

Mr Peter Ryan
Environmental Officer
RTA Operations
Level 5, Pod D
99 Phillip Street
PARRAMATTA NSW 2150

Dear Mr Ryan

Re RTA – Realignment of Sturt Highway at Sandigo

I refer to your correspondence of 2 October 2002 and in response offer the following comments in relation to the proposed realignment of the Sturt Highway at Sandigo,

a) The proposed realignment will place the Sturt Highway through the centre of what appears to be an area subject to flooding from the Sandy Creek. It is therefore advised that a flood study be undertaken of the area indicating the effect on the adjoining properties to the realignment as well as those in the immediate area both up and down stream of the proposed work site,

b) As indicated on the attached photographs two irrigation channels will be affected by the realignment and these facilities need to be identified and the methods explained as to how they will be retained,

c) There appears to be significant vegetation that will be removed from the area to permit the road realignment. The re-vegetation plan needs to be considered indicating how the site is to be rehabilitated,

d) Silt retention during and after construction will be a major concern in relation to Sandy Creek and measures need to be identified as to how this is to be addressed,

e) Due to the narrowing of Sandy Creek in this area as a consequence of the road works, Council recommends consultation with both adjoining land owners and as well as those both up and down stream in the immediate vicinity to ascertain the adverse if any during periods of flooding,

f) The existing roads that currently connect to the Sturt Highway will obviously need to be realigned to enable connection with the new section of road. Council would like to know if the current section of Sturt Highway is to be disregarded or form part of the access system for these local property roads. Is this part of the Sturt Highway to be relegated to a local road status,

g) What is to happen to the residual land that will be located between the new alignment and the existing Sturt Highway? Whose ownership and responsibility will this parcel of land become?

Should you require any additional information regarding this matter, please call Council's Director Environmental Services, Mr Duncan Bains on 6959 5550.

Yours faithfully

Ken Murphy
General Manager

From: Colin.Killick@npws.nsw.gov.au
Sent: Friday, 4 October 2002 12:48
To: RYAN Peter
Subject: RE: RTA - Sandigo, Stuart Highway realignment

I've run this past the staff here and there are no concerns.
J Cheers Colin

RYAN Peter <Peter_RYAN@rta.nsw.gov.au>
02/10/02 16:31

To: "'Colin.Killick@npws.nsw.gov.au'" <Colin.Killick@npws.nsw.gov.au>
cc:
Subject: RE: RTA - Sandigo, Stuart Highway realignment

Hi Colin,
The project objective is to realign State Highway No 14 approximately 77km -79km west of Wagga Wagga to improve the existing reverse curved alignment to National Highway standard.

Wayne Walgers RTA Project Manager (ph 02 6938 1128) can provide more details if needed.

cheers
Peter

-----Original Message-----
From: Colin.Killick@npws.nsw.gov.au [mailto:Colin.Killick@npws.nsw.gov.au]
Sent: Wednesday, 2 October 2002 16:08
To: RYAN Peter
Subject: Re: RTA - Sandigo, Stuart Highway realignment

Peter,
I'm a bit curious why this work is being done. That curve is not particualrly tight and cutting the corner wouldn't save 10 seconds of driving time.
J Cheers Colin

RYAN Peter <Peter_RYAN@rta.nsw.gov.au>
02/10/02 14:18

To: RYAN Peter <Peter_RYAN@rta.nsw.gov.au>
cc: "'colin.killick@npws.nsw.gov.au'" <colin.killick@npws.nsw.gov.au>, "'msouthwell@dlwc.nsw.gov.au'" <msouthwell@dlwc.nsw.gov.au>, "'perrym@fisheries.nsw.gov.au'" <perrym@fisheries.nsw.gov.au>, "'aondrarlpb@webfront.net.au'" <aondrarlpb@webfront.net.au>, "'council@narrandera.nsw.gov.au'" <council@narrandera.nsw.gov.au>
Subject: RTA - Sandigo, Stuart Highway realignment

Dear sir/madam

A letter (and photos) inviting your comment on this proposal are attached.

council@narrandera.nsw.gov.au - please forward to Duncan Barnes

If you have any queries on the above please contact me.
cheers

Peter Ryan
Environmental Officer
Environmental Technology

RTA Operations
Lev 5 Pod D Octagon Building
99 Phillip Street
PARRAMATTA NSW 2150
8837 0583 (ph)
8837 0053 (fax)

<<consultation.doc>> <<work footprint.pdf>> <<site photos.doc>>

NATIONAL NATIVE TITLE TRIBUNAL

Level 25
25 Bligh Street
SYDNEY NSW 2000
AUSTRALIA

GPO Box 9973, SYDNEY NSW 2001
Telephone: (02) 9235 6300
Facsimile: (02) 9233 5613
Website: www.nntt.gov.au

Your Ref:
Our Ref: **27803JR**

October 22, 2002

Mr Peter Ryan
RTA Operations
Environmental Technology
PO Box 3035
PARRAMATTA NSW 2124

Dear Mr Ryan

Re: Your search request in relation to Narrandera Shire Council Local Government Area

Thank you for your search request of 22nd October 2002 in relation to the above area.

Search Result
A search of the Register of Native Title Claims, the Register of Indigenous Land Use Agreements, the National Native Title Register and the Applications Summary, based on the information you supplied, has been conducted.

At the time this search was carried out, there were no relevant entries in the Registers or Applications Summary.

Please note that there may be a delay of up to 48 hours between a claimant native title application being lodged in the Federal Court and its transferral to the Tribunal. As such the information contained in this search, in relation to unregistered claimant applications, may not show claimant applications recently lodged or amended in the Federal Court.

Search charges
The charge for a search of the registers/applications summary is $21.45 per 15 minutes and $7.15 per 5 minutes thereafter. All charges are inclusive of GST.

An invoice for the amount of $21.45 will be forwarded to you shortly.

Tribunal accepts no liability for reliance on enclosed information
The enclosed information has been provided in good faith. Use of this information is at your sole risk. The National Native Title Tribunal makes no representation, either express or implied, as to the accuracy or suitability of the information enclosed for any particular purpose and accepts no liability for use of the information or reliance placed on it.

Should you require any further information, please do not hesitate to contact me on (02) 9235 6300.

Yours sincerely

Jason Roberts
Case Management Unit

Your Ref:
Our Ref: AHIMS #6727

RTA Environment Technology
LVL 5 99 Phillip st
Parramatta NSW 2150

Wednesday, 23 October 2002

Attention: Peter Ryan

Dear Sir or Madam:

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

ABN 30 841 387 271

Re: AHIMS Search for the following area at Sturt Hwy
Zone 55 Eastings: 460194-470194 Northings: 6133413-6143413

I am writing in response to your recent inquiry in respect to Aboriginal objects and Aboriginal places registered with the NSW National Parks and Wildlife Service (NPWS) at the above location.

A search of the NPWS Aboriginal Heritage Information Management System (AHIMS) has shown that no Aboriginal objects and Aboriginal places are recorded in or near the above location. Please refer to the attached report for details.

The information derived from the AHIMS search is only to be used for the purpose for which it was requested. It is not to be made available to the public.

The following qualifications apply to an AHIMS search:

- AHIMS only includes information on Aboriginal objects and Aboriginal places that have been provided to NPWS;
- Large areas of New South Wales have not been the subject of systematic survey or recording of Aboriginal history. These areas may contain Aboriginal objects and other heritage values which are not recorded on AHIMS;
- Recordings are provided from a variety of sources and may be variable in their accuracy. When an AHIMS search identifies Aboriginal objects in or near the area it is recommended that the exact location of the Aboriginal object be determined by re-location on the ground; and
- The criteria used to search AHIMS are derived from the information provided by the client and NPWS assumes that this information is accurate.

All Aboriginal places and Aboriginal objects are protected under the *National Parks and Wildlife Act 1974* (NPW Act) and it is an offence to destroy, damage or deface them without the prior consent of the NPWS Director-General. An Aboriginal object is considered to be known if:

- It is registered on AHIMS;
- It is known to the Aboriginal community; or
- It is located during an investigation of the area conducted for a development application.

Head Office
43 Bridge Street
PO Box 1967
Hurstville NSW
2220 Australia
Tel: (02) 9585 6444
Fax: (02) 9585 6555
www.npws.nsw.gov.au

If you are considering undertaking a development activity in the area subject to the AHIMS search, NPWS would recommend that an Aboriginal Heritage Assessment be undertaken. You should consult with the relevant consent authority to determine the necessary assessment to accompany your development application.

Yours Sincerely

Vanessa Atkins
Aboriginal Information Officer
Information Systems Unit
Cultural Heritage Division
Phone: (02) 9585 6345
Fax: (02) 9585 6325

List of Sites (List)

ahims6727

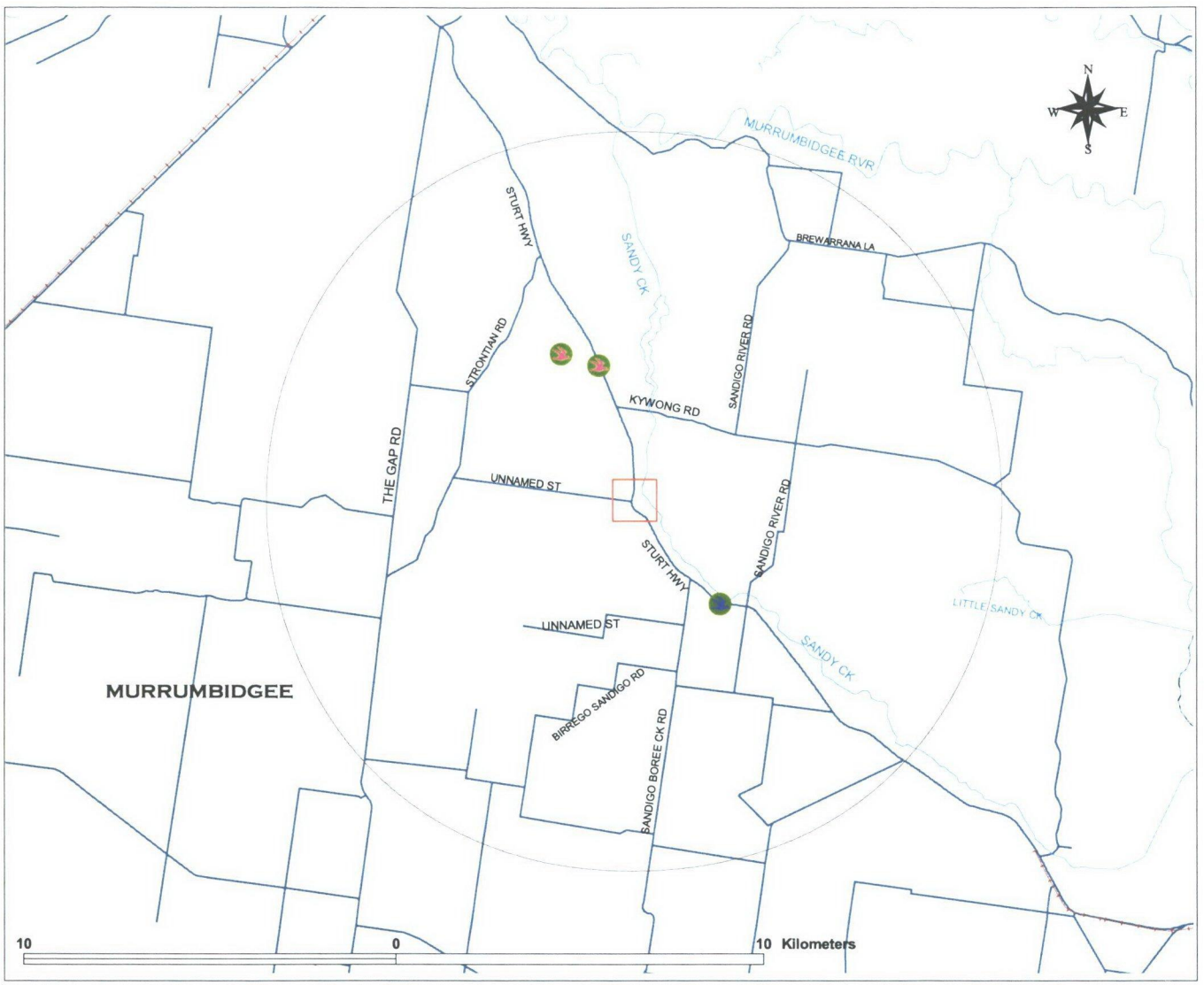
Grid Reference Type = AMG Zone = 55 Easting From = 460194 Easting to = 470194 Northing From = 6133413 Northing to = 6143413 Feature Search Type = AHIMS Features

Site ID	Site Name	Grid.Ref Type	Zone	Easting	Northing	Site Features	Site Types (recorded prior to June 2001)	Recording (Primary)	Reports (Catalogue Number)

Number of Sites : 0

23/10/2002 10:17:52

Location of Threatened Fauna & Flora Species within 10km radius of study area, Sturt Highway, Sandigo.



LEGEND

- Study area
- Rails
- Roads
- Water ways

Fauna

- Brolga
- Superb Parrot

There are no threatened flora species, acid sulphate soils or SEPP14 wetlands present.

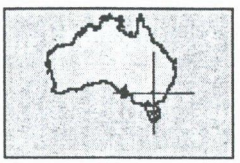
Map produced by RTA Environmental Monitoring Section
Date: 28 Oct 2002

Environment Australia Online

Environment Protection and Biodiversity Conservation Act Online Database

Report created on : Monday, Aug 5 2002
Report on : threatened ecological communities, threatened species, marine protected species, migratory species and , Ramsar sites, Commonwealth areas, World Heritage Areas
Search type : area
Approx buffer : 10 km (minimum buffer is approx 1km)
Coordinates used :

Longitude	Latitude
146.594	-34.87
146.699	-34.87
146.699	-34.97
146.582	-34.97



view map

Threatened ecological communities
0 communities

Threatened species
16 species

Migratory species
5 species

Marine protected species
5 species

World Heritage Areas [dataset information]
None found
Ramsar sites [dataset information]
Within Catchment of Ginini Flats Subalpine Bog Complex

Commonwealth areas
Note: The database on Commonwealth areas is incomplete and includes only Commonwealth marine areas and Commonwealth reserves
None found

Extra Information

Conservation reserves [dataset information]
None found
Regional Forest Agreements
Note: all RFA areas including those still under consideration have been included [dataset information]
None found

Species and Community Report

This report provides a general indication of the species and threatened communities that may occur in your nominated area

Threatened species

	Scientific Name	Common Name	Type of Presence	Status
Amphibia	Litoria raniformis (1828)	Southern Bell Frog, Growling Grass Frog, Warty Bell Frog	Species or species habitat likely to occur within area	Vulnerable
Aves	Lathamus discolor (744)	Swift Parrot	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Endangered
Aves	Pedionomus torquatus (906)	Plains-wanderer	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Vulnerable
Aves	Polytelis swainsonii (738)	Superb Parrot	Species or species habitat likely to occur within area	Vulnerable
Aves	Xanthomyza phrygia (430)	Regent Honeyeater	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Endangered
Mammalia	Nyctophilus timoriensis (South-eastern form) (66888)	Eastern Long-eared Bat	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Vulnerable
Osteichthyes	Macquaria australasica (66632)	Macquarie Perch	Species or species habitat likely to occur within area	Endangered
Plant	Amphibromus fluitans (19215)	River Swamp Wallaby-grass	Species or species habitat likely to occur within area	Vulnerable
Plant	Brachyscome muelleroides (15572)	Mueller Daisy	Species or species habitat likely to occur within area	Vulnerable
Plant	Caladenia arenaria (9275)	-	Species or species habitat likely to occur within area	Endangered
Plant	Caladenia xanthochila (55509)	Yellow-lip Spider-orchid, Fliders Ranges White Caladenia	Species or species habitat likely to occur within area	Endangered
Plant	Callitriche cyclocarpa (7477)	Western Water-starwort	Species or species habitat likely to occur within area	Vulnerable
Plant	Diuris sheaffiana (12177)	Tricolour Diuris	Species or species habitat likely to occur within area	Vulnerable

Plant	Lepidium monoplocoides (9190)	Winged Pepper-cress	Species or species habitat likely to occur within area	Endangered
Plant	Stipa wakoolica (20186)	-	Species or species habitat likely to occur within area	Endangered
Plant	Swainsona murrayana (6765)	Slender Darling-pea, Slender Swainson, Murray Swainson-pea	Species or species habitat likely to occur within area	Vulnerable

Terrestrial species covered by migratory provisions of the EPBC Act, 1999

	Scientific Name	Common Name	Type of Presence
Aves	Haliaeetus leucogaster (943)	White-bellied Sea-Eagle	Species or species habitat likely to occur within area
Aves	Hirundapus caudacutus (682)	White-throated Needletail	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree
Aves	Xanthomyza phrygia (430)	Regent Honeyeater	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree

Wetland species covered by migratory provisions of the EPBC Act, 1999

	Scientific Name	Common Name	Type of Presence
Aves	Gallinago hardwickii (863)	Latham's Snipe, Japanese Snipe	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree
Aves	Rostratula benghalensis (889)	Painted Snipe	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree

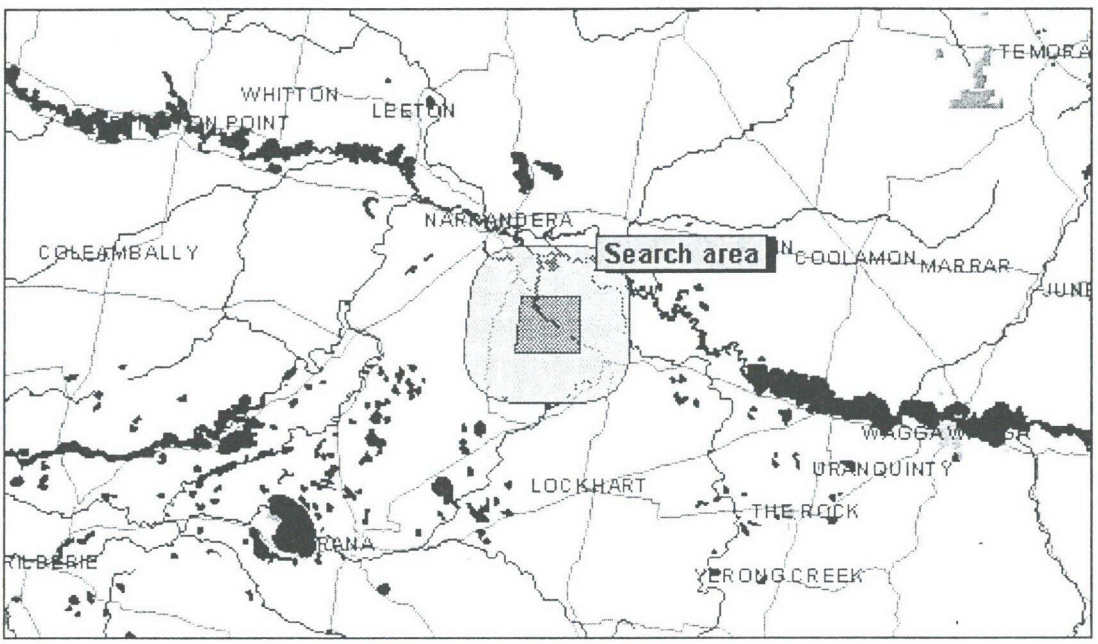
Species covered by marine provisions of the EPBC Act, 1999

	Scientific Name	Common Name	Type of Presence	Status
Aves	Gallinago hardwickii (863)	Latham's Snipe, Japanese Snipe	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Overfly**
Aves	Haliaeetus leucogaster (943)	White-bellied Sea-Eagle	Species or species habitat likely to occur within area	Listed
Aves	Hirundapus caudacutus (682)	White-throated Needletail	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Overfly**
Aves	Lathamus discolor (744)	Swift Parrot	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Overfly**

Aves Rostratula benghalensis (889)	Painted Snipe	Species or species habitat likely to occur within area - Derived from a general distribution map > 1 degree	Overfly**

Species with a ** in the status field are predominantly non-marine, however they are known to overfly or occasionaly visit the Commonwealth marine area.

Map of area defined including buffer



Nominal scale

Km 20 40 60

Legend

- Builtup Areas
- Ramsar Sites
- Water Bodies
- World Heritage
- Roads
- Reserves
- Cwealth Areas
- Land

Aknowledgements

This database has been compiled from a range of data sources. Environment Australia acknowledges the following custodians who have contributed valuable data and advice:

- New South Wales National Parks and Wildlife Service

- Department of Natural Resources and Environment, Victoria (Secretary)
- Department of Primary Industries, Water and Environment, Tasmania
- Department of Environment and Heritage, South Australia Planning SA
- Parks and Wildlife Commission of the Northern Territory
- Queensland Environment Protection Agency
- Birds Australia
- Australian Bird and Bat Banding Scheme
- Australian National Wildlife Collection
- Natural history museums of Australia
- Queensland Herbarium
- Royal Botanic Gardens and 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
- Other groups and individuals

ANUCLIM Version 1.8, Centre for Resource and Environmental Studies, Australian National University was used extensively for the production of draft maps of species distribution. Environment Australia is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

See log of system/dataset changes

For further information see http://www.environment.gov.au/epbc

Scientific Name: Bidyanus bidyanus **Common Name: Silver perch**

Family: Terapontidae **CAAB: 37321008**

NSW Threatened Status: Vulnerable **Protected Status: (N/A)**

Nearest Town	Bioregion	Basin Name	Sighting Date	No. Observed	Source
Balranald	Riverina	MURRUMBIDGEE	17/3/1998	1	NSW Fisheries Survey
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE	25/10/1999	2	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE	27/10/1999	16	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE	18/10/1999	2	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE	19/10/1999	5	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE	20/10/1999	1	Statutory Reporting

Scientific Name: Maccullochella macquariensis **Common Name: Trout cod**

Family: Percichthyidae **CAAB: 37311087**

NSW Threatened Status: Endangered **Protected Status: Protected**

Nearest Town	Bioregion	Basin Name	Sighting Date	No. Observed	Source
Wagga Wagga	NSW South Western Slopes	MURRUMBIDGEE	6/12/2000	1	NSW Fisheries Survey
Wagga Wagga	NSW South Western Slopes	MURRUMBIDGEE	6/12/2000	1	NSW Fisheries Survey
Leeton	Riverina	MURRUMBIDGEE	7/2/2000	1	NSW Fisheries Survey
Leeton	Riverina	MURRUMBIDGEE	7/2/2000	1	NSW Fisheries Survey
Leeton	Riverina	MURRUMBIDGEE	8/12/2000	1	NSW Fisheries Survey
Leeton	Riverina	MURRUMBIDGEE	8/12/2000	1	NSW Fisheries Survey

Leeton	Riverina	MURRUMBIDGEE8/12/2000	1	NSW Fisheries Survey
Cooma	South Eastern Highlands	MURRUMBIDGEE12/3/1998	8	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE31/3/1998	1	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE12/5/1998	1	NSW Fisheries Survey
Cooma	South Eastern Highlands	MURRUMBIDGEE12/5/1998	1	NSW Fisheries Survey
Cooma	South Eastern Highlands	MURRUMBIDGEE12/5/1998	1	NSW Fisheries Survey

Scientific Name: Macquaria australasica **Common Name: Macquarie perch**

Family: Percichthyidae **CAAB: 37311088**

NSW Threatened Status: Vulnerable **Protected Status: (N/A)**

Nearest Town	Bioregion	Basin Name	Sighting Date	No. Observed	Source
Adaminaby	Australian Alps	MURRUMBIDGEE	18/3/1999	65	Statutory Reporting
Adaminaby	Australian Alps	MURRUMBIDGEE	7/4/1998	50	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE	28/3/2001	18	Statutory Reporting
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE	5/2/1995	1	NSW Fisheries Survey
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE	5/2/1995	1	NSW Fisheries Survey
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE	5/2/1995	1	NSW Fisheries Survey
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE	23/2/1998	3	Statutory Reporting
Michelago	South Eastern Highlands	MURRUMBIDGEE	25/2/1998	29	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE	11/3/1998	2	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE	12/3/1998	18	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE	31/3/1998	11	Statutory Reporting
Adaminaby	South Eastern Highlands	MURRUMBIDGEE	1/4/1998	53	Statutory Reporting

Cooma	South Eastern Highlands	MURRUMBIDGEE 12/5/1998	1	NSW Fisheries Survey
Cooma	South Eastern Highlands	MURRUMBIDGEE 12/5/1998	3	NSW Fisheries Survey
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE 15/2/1999	2	Statutory Reporting
Wee Jasper	South Eastern Highlands	MURRUMBIDGEE 19/2/1999	1	NSW Fisheries Survey
Cooma	South Eastern Highlands	MURRUMBIDGEE 1/3/1999	36	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE 2/3/1999	5	Statutory Reporting
Cooma	South Eastern Highlands	MURRUMBIDGEE 3/3/1999	55	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE 20/2/2001	1	Statutory Reporting
Queanbeyan	South Eastern Highlands	MURRUMBIDGEE 21/2/2001	19	Statutory Reporting

Listing Heritage Items

State Heritage Inventory Search Results

Statutory Listed Items

Information and items listed in the State Heritage Inventory come from a number of sources. This means several entries for the same heritage item in the database. For clarity, the search results have been divic

- The first section contains items listed on the State Heritage Register, covered by an Interim Herita under section 130 of the NSW Heritage Act. This information is provided by the NSW Heritage Offi
- The second section contains items listed by Local Councils & Shires and State Government Agencie also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

The search results can be resorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Sta
Derrendi Cottage	30-32 Twynam Street	Narrandera	Narrandera	Yes
Narrandera rail bridge over Murrumbidgee River	Junee-Hay railway	Narrandera	Narrandera	Yes

There were **2** records in this section matching your search criteria.

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Inf (sc
Courthouse	Larmer Street	Narrandera	Narrandera	GA
Item	Yapunyah Street	Barellan	Narrandera	GA
Narrandera Nature Reserve			Narrandera	GA
Narrandera Railway Station, platform, Stationmaster's residence	Whitton Street	Narrandera	Narrandera	GA
National Australia Bank	East Street	Narrandera	Narrandera	GA
Police Station Group	Larmer Street	Narrandera	Narrandera	GA
Post Office	East Street	Narrandera	Narrandera	GA
Steel and Brick Water Tower		North Narrandera	Narrandera	GA

There were **8** records in this section matching your search criteria.

There was a total of **10** records matching your search criteria.

Key:
LGA = Local Government Area

Listing Heritage Items

State Heritage Inventory Search Results

Statutory Listed Items

Information and items listed in the State Heritage Inventory come from a number of sources. This means several entries for the same heritage item in the database. For clarity, the search results have been divic

- The first section contains items listed on the State Heritage Register, covered by an Interim Herita under section 130 of the NSW Heritage Act. This information is provided by the NSW Heritage Offi
- The second section contains items listed by Local Councils & Shires and State Government Agencie also contain additional information on some of the items listed in the first section.

Section 1. Items listed under the NSW Heritage Act.

The search results can be resorted by clicking on the **(sort)** option at the top of each column.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Stat
Berembed Weir and Site	Murrumbidgee River	Narrandera	Narrandera	Yes
Derrendi Cottage	30-32 Twynam Street	Narrandera	Narrandera	Yes
Narrandera rail bridge over Murrumbidgee River	Junee-Hay railway	Narrandera	Narrandera	Yes
Narrandera Railway Station and yard group	Junee-Hay railway	Narrandera	Narrandera	Yes
Wooden Wicket - Berembed Weir Site	Berembed Weir Picnic Site	Narrandera	Narrandera	Yes

There were **5** records in this section matching your search criteria.

Section 2. Items listed by Local Government and State agencies.

Item Name (sort)	Address (sort)	Suburb (sort)	LGA (sort)	Info (sor

There was a total of **5** records matching your search criteria.

Key:
LGA = Local Government Area
GAZ= NSW Government Gazette (statutory listings prior to 1997), HGA = Heritage Grant Application, HS = Heritage Study, LGOV = Local G Government Agency.

Note: The Heritage Office seeks to keep the State Heritage Inventory (SHI) up to date, hov listings in Local and Regional Environmental Plans (LEPs and REPs) may not yet be include with the relevant Local Council or Shire for the most recent listings.

Register of the National Estate Database

[RNE search | AHC Home | Disclaimer | ©]

Found 11 records:

- **Butherwah Homestead**, Urana, [Narrandera Shire], NSW (Indicative Place)
- **CBC Bank (former)**, 142 East St, Narrandera, [Narrandera Shire], NSW (Registered)
- **CWA Rest House**, Yapunyah St, Barellan, [Narrandera Shire], NSW (Registered)
- **Dry Lagoon**, Sturt Hwy, Narrandera, [Narrandera Shire], NSW (Indicative Place)
- **Narrandera Courthouse and Police Station Group**, Larmer St, Narrandera, [Narrandera Shire], NSW (Registered)
- **Narrandera Nature Reserve**, Narrandera, [Narrandera Shire], NSW (Registered)
- **Narrandera Post Office**, 140 East St, Narrandera, [Narrandera Shire], NSW (Registered)
- **Narrandera Rail Bridge**, Narrandera, [Narrandera Shire], NSW (Registered)
- **Narrandera Showground**, Victoria Ave, Narrandera, [Narrandera Shire], NSW (Indicative Place)
- **Railway Station and Station Masters Residence**, Whitton St, Narrandera, [Narrandera Shire], NSW (Registered)
- **St Johns Uniting Church and Hall**, Cadell St, Narrandera, [Narrandera Shire], NSW (Indicative Place)

The Register of the National Estate has been compiled since 1976. The Commission is in the process of developing and/or upgrading official statements of significance for places listed prior to 1991.

Report produced : 5/8/2002
RNEDB URL : http://www.ahc.gov.au/register/easydatabase/database.html

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Appendix G

Geotechnical Assessment

Office Ref: G3236-02
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ROADS AND TRAFFIC AUTHORITY NSW

South Western Region

Project Development

1 Simmons Street

Wagga Wagga NSW 2650

INTER OFFICE MEMO

TO: Ray Tester
South Western Region

FROM: Chris Rodgers
Geotechnical Services Manager
South Western Region
PHONE: 02 6937 1622
MOBILE: 0408 658 035
FAX: 02 6938 1184

DATE: 13th June 2002

SUBJECT: SH14 Realignment at Sandigo 77-79km West of Wagga Wagga

1. INTRODUCTION:

The purpose of this investigation is to provide geotechnical information to Development Section to allow comparison of different proposed alignments. Two alignments were investigated, the "black line" or "D" alignment and the "red line" or "B" alignment.

This report covers

- existing ground conditions, including average topsoil depth, and water tables
- proposed pavement design, including select material zone thickness
- identification of "unsuitable" material
- possible locations of Fill and Pavement material sites

Note: this report is issued before the full results of laboratory testing have been available. Some descriptions and conclusions may be altered on receipt of the test reports. This report will be reissued when all the results are available.

Topograpghy

The topography for both routes is flat.

Route D traverses agricultural land, open land used seasonally as a water ponding area (swamp) and a small stand of woodland. The swamp area had a coverage of 100-200mm of water at the time of the investigation, however the presence of grass under the water indicates the area is not permanently inundated.

Route B traverses open grazing and cultivated land. Some of this area has rows of earth mounds, used to direct irrigation water. At the time of investigation this area was dry.

Drainage

The existing road is well drained and slightly elevated. Both routes have poor to non-existent drainage. The area is characterised by wet subgrade material.

The condition of the pavement surface is good having been recently resealed. There is evidence of minor block cracking and previous investigations here show problems with wet subgrade material and block cracking of stabilised sections of pavement.

2. INVESTIGATION DETAILS:

Eleven test pits were dug as a preliminary investigation to enable determination of a preferred route on geotechnical considerations.

Two pits were dug in the existing pavement and shoulder one at each end of the designated job, being common to both routes.

Six pits were excavated along the D route and three along the B route.

Samples were taken for grading, plasticity, CBR values and moisture content. Dynamic cone penetrometer tests (DCP) were also performed.

3. SUBSURFACE CONDITIONS:

1. Below is a summary of the pavement and subgrade conditions near proposed tie-ins.

Test Location & Chainage	Depth	Pavement	Subgrade and DCP est' CBR
TP1 Ch100m	0-15mm	10mm seal	
	15-500	SILTY SANDY GRAVEL	
	500-		SILTY CLAY 550-650=17% 650-950=8% 1050-1450=15%
TP2 Ch 1800	0-15	7/14mm double seal	
	15-300	SILTY SANDY GRAVEL	
	300-310	Old Seal	
	310-420	SILTY SANDY GRAVEL	
	420-		SILTY CLAY 500-930=3% 930-1330=6%

2. Below is a summary of conditions on the D alignment:

Test Location & Chainage	Depth	Profile	Subgrade and DCP est' CBR
TP 8 Ch 400 Wheat paddock	0-100	Root zone-SANDY CLAY	
	100-800+		SANDY CLAY, hard, dry
TP7 Ch 600	0-200	Root Zone -SILTY CLAY-dry	
	200-750+		SILTY CLAY, grey-black, dry-moist
TP 3, 4, 5 Ch 700, Ch 750, Ch 850	0-100	Root Zone	
	0-1500		SILTY CLAY, grey- black, Very soft, becoming firmer with depth
TP6 Ch 900	0-400	SILTY CLAY, dry, root zone	
	400-1100+		SANDY CLAY, moist 650-1250=6% 1250-1550=12%

3. Below is a summary of the conditions on the B alignment

Test Location & Chainage	Depth	Profile	Subgrade and DCP est' CBR
TP9 Ch 1450	0-110	Root Zone: CLAYEY SILTY SAND, black	
	110+		SANDY CLAY, dry, hard
TP10, 11 Ch 500, 700	0-170	Root Zone: SILT-SAND, grey-black	
	170-1700+		SANDY CLAY, stiff-hard

4. LABORATORY TESTING:

Results are pending. Some preliminary results are on the attached logs.

5. PAVEMENT DESIGN and DISCUSSION:

Alignment B

This route, although longer than route D is the easiest to construct a pavement over. The root-zone needs to be stripped off (nominal 100mm) and the surface compacted. The subgrade is moderately expansive. Most of the area was dry at the time of investigation but any wet areas need to be stabilised with 2% hydrated lime to a depth of 150mm.

The proposed pavement design is:

	14mm seal over 7mm primer seal
150mm	DGB conforming to RTA3051
150mm	DGS conforming to RTA3051
	Primer seal (7mm)
450mm	Select Fill CBR>15% PI<12. Top 150mm to be lime stabilised with 2% hydrated lime unless the CBR of select is >30%
	Subgrade CBR (to be determined pending test results) Estimated 3%

This will give a pavement design life of 40 years according to Circly4. Note: reducing the select layer from 450mm to 300mm nearly halves the life of the pavement.

Alignment D

From Ch 600 to 950 the alignment is the swampy area and will require substantial pavement thickness. The subgrade is moderately expansive.

The DCP results show that for the swampy area, the subgrade becomes firmer with depth (below about 600mm), except for the site at Ch 850m. However the pavement design has been based on the worst case of a CBR of 1%. This design applies to the rest of the swampy area because it is the minimum pavement required in a wet area, even though the CBR may be higher than 1%.

It is likely that in summer the area may be dry and this would be the time to construct. In this case it may be preferable to stabilise the subgrade instead of laying geotextile, to give a working platform and support to the rock drainage layer upon inundation.

The proposed pavement design for the wet area is:

	14mm seal over 7mm primer seal
150mm	DGB conforming to RTA3051
150mm	DGS conforming to RTA3051
	7mm primer seal
300mm	Select fill CBR>30%
	Class B Geotextile
500mm	Free draining rock layer (-125mm with less than 15% passing 19mm sieve)
	Subgrade CBR of 1% Top 150mm stabilised with 3% hydrated lime, or Clas B geotextile.

This will give a pavement design life of 26yrs according to Circly4

For the dry part of this alignment the pavement design is the same as for route B

Tie-in to existing pavement

The tie-ins need to be the same design as for route B above (based on a subgrade CBR of 3%)

The pavement designs have been derived using Circly 4 and guidelines from Technical Direction 99/7.

6. SOURCES OF PAVEMENT MATERIAL:

Select fill can be sourced from Wrights Pit, 74km west of Wagga. This is a siltstone material with a CBR of about 17%. Note, this is unsuitable for the swampy area of route D, where a CBR of 30% is required. Rock fill and DGS/DGB can come from Griffith, Leeton, Wallaroobie or Rankin Springs. Woods Quarries may be developing a quarry about 5km west of the site, off the Sturt Highway. The owner advises the material is a sandstone/quartzite material which has the potential to be used as rockfill. This needs further investigation.

7. RECOMMENDATION:

From a geotechnical viewpoint route B is the easiest to construct and does not require a rock drainage layer, but is 540m longer than route D. This has to be compared to the cost of the rock drainage layer. The rock fill may need to be carted a considerable distance unless a local source, as mentioned above, is used. Both routes are constructible and the choice will depend on a variety of factors as well as geotechnical.

If route B is preferred, then further geotechnical investigation should be performed to afequately determine subsurface conditions. Due to the presence of optic fibre, only 3 test pits were dug, and insufficient CBR samples obtained. Further CBR samples will aid in refining the pavement design for this route.

Chris Rodgers

Geotechnical Services Manager

Southwestern Regional office

ATTACHMENTS

Pavement and Subgrade Invesitigation Schedule

Design Traffic

Circly Printouts

Appendix H

Hydrology Assessment

Name: P Khamphounvong
Ext: 80818
File:----------

RTA OPERATIONS DIRECTORATE

BRIDGE SECTION

To:	Wayne Walgers
From:	Phanta Khamphounvong
cc:	Mark Bennett
Subject:	Shire of Narrandera -SH 14 Sturt highway Waterway Investigation – Sandy Creek at Sandigo
Date:	15/10/2002

1 Introduction

It is proposed to realign a section of the Sturt Highway at Sandigo, approximately 77.6km west of Wagga Wagga. The existing highway is on a curved alignment that follows the edge of the floodplain. The proposed new alignment is straight and crosses the floodplain, separating a parcel of floodplain land from Sandy creek. This portion of cut off flood plain is referred to as Area 1. The length of the new embankment is approximately 1.0km. The realigned route crosses two irrigation canals, which belong to the adjacent landowner.

2 Scope

The scope of this work is to investigate the flooding impact due to this proposal. The investigation also includes the determination of the size of the drainage structures required so that flow into and out of Area 1 is maintained similar to the existing conditions.

3 Flood Data and Survey information

This investigation is based on the following information.

- Proposed Concept Road Design - Plan Registration No. 0014 321 RC 0782
- Survey of Floodplains and Creek Cross Sections over 1.4km
- Murrumbidgee Valley, NSW Inland Rivers Flood Plain Management Studies, Sinclair Knight & Partners 1987
- Narrandera Flood Study, Volume 1 Final report, Sinclair Knight Merz December 2000
- Phone interview of local resident (Mr Warwick Anderson)

4 History of Flooding

Sandy Creek is a tributary of the Murrumbidgee River. During major floods flow overtops its banks and spreads onto the adjacent floodplain. The overflow from the creek to the floodplain is estimated to be of the order of less than 1 in 1 year average recurrence interval (ARI).

Overflow from the creek is also influenced by irrigation activity on Old Man Creek located upstream of Sandy Creek.

The observed duration of flooding is approximately 3 to 5 days. The flow velocity on the floodplain is relatively slow.

Estimates of flood levels for various recurrence intervals based on the flood study by Narrandera Council are given below. The flood level at the site is derived by projecting the flood level at Narrandera using a flood slope of 0.000289 m/m.

Average Recurrence Interval Year	Predicted Flood Level RL AHD (m)
5	150.40
10	150.62
20	150.99
100	151.05

The level of the creek bank and the floodplain is about RL 148.00.

5 Hydraulics

A numerical model was established for the highway crossing in order to compute flood levels and to assess the hydraulic behaviour of the creek due to the new alignment. The steady state backwater computer program HEC-RAS was used for this purpose. Survey of the stream cross sections covering 1.4km from upstream to downstream was used in this model.

The hydraulic analysis of the proposed conditions was analysed based on the assumption that there are no drainage structures on the new alignment of the highway, effectively preventing flow into Area 1.

Results from the analysis for the existing and proposed conditions comparing flood levels and flow velocities for the 1 in 100 average recurrence interval are shown in the table below.

Name: P Khamphounvong
Ext: 80818
File:----------

Flood Level – Existing and Proposed
At approximately 78.5km

Average Recurrence Interval Year	Predicted Flood Level –Existing RL AHD (m)	Predicted Flood Level – Proposed RL AHD (m)	Increase in Flood Level (m)
5	150.40	150.41	0.01
10	150.62	150.63	0.01
20	150.99	151.01	0.02
100	151.05	151.07	0.02

Velocity – Existing and Proposed
At approximately 78.5km

Average Recurrence Interval Year	Predicted Velocity in Channel Existing (m/sec)	Predicted Velocity in Channel Proposed (m/sec)
5	0.53	0.61
10	0.61	0.69
20	0.71	0.82
100	0.73	0.84

From the analysis, the increase in flood level and flow velocity is only marginal.

6 Drainage of Area 1

The new alignment of the highway crosses two irrigation canals that belong to Mr Anderson. A phone discussion with Mr Anderson was carried out to determine the requirements of drainage structures on the new alignment of the highway. The following drainage structures are proposed.

6.1 Irrigation Canal 1 – This canal is located on the Wagga Wagga road approach. The width of the canal is approximately 8.0m. It is proposed to install two 1.2m diameter pipes. The invert of the canal is not known. Detail survey of the intersection of the canal and the highway is required for detailed hydraulic design of the pipes.

6.2 Irrigation Canal 2 – This canal is located on the Narrandera road approach. The width of the canal is approximately 9.0m. It is proposed to install two 1.2m diameter pipes. The invert of the canal is not known. Detail survey at the intersection of the canal and the highway is required for detailed hydraulic design of the pipes.

6.3 General Drainage – The length of the new highway is about 1.0km. The direction of the new highway is parallel to the flood flow. As a result there is a flood gradient (approximately natural slope of the land) within the Area 1. To avoid ponding of water

on this area during flood subsidence and to provide drainage during major floods, it is proposed to install a two1.2m diameter pipes at the northern end of Area 1.

6.4 Rate of Rise and Fall in Flood Level –The rate of floodwater rise and fall of the Murrumbidgee River at Narrandera is attached. The average rise in water level for floods between 1974 to 1995 is 20mm/hour. It is expected that a similar rate of rise in water level will be observed at Sandy Creek.

The three pairs 1.2m diameter pipe allows Area 1 to be inundated with minimum water level difference between Area 1 and the creek. Based on a 1 in 5 year ARI flood and a flow velocity of 1m/sec through the pipes, the cut off floodplain will completely fill in 3 hours.

7 Recommendation

The proposed realignment of the highway is considered acceptable as the change in flood level and flow velocity is only marginally increased. The value of the increase in flood level and flow velocity of 0.02m and 0.11m/sec is predicted.

A slow rate of water rise and fall in water level is predicted at the site. Providing six 1.2m diameter pipes for the new alignment is considered adequate for flow interaction between the creek and the cut off floodplain. It is predicted that a small head water difference at any stage of flooding between the basin and the creek.

It is therefore recommended that a proposed realignment of the highway indicated on the drawing Registration no. 0014 321 RC 0782 be adopted. Installation of two 1.2m diameter pipes should be installed at Irrigation Canals No.1, No. 2 and at the northern end of Area 1.

Consultation with the Department of Land and Water Conservation should be sought for concurrence and advice.

Phanta Khamphounvong
Waterway Engineer
Bridge Section