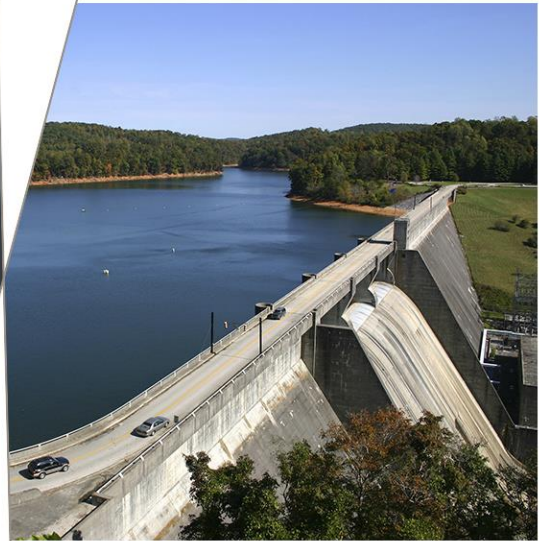


# Feasibility Study

## Nangus Water Supply

8202004301- R01-V02



Prepared for  
Goldenfields Water

17 February 2020

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# 1 Introduction

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Nangus is a village in the Cootamundra Gundagai Regional Council (CGRC) with an estimated population of 80 people. The village is located approximately 18 km west of Gundagai. Nangus does not currently have a reticulated water supply, and residents provide their own water supplies, typically from roof water, bottled water, bore water or water carting.

CGRC recently undertook community consultation for the Villages Strategy, which received strong support for provision of a reticulated water supply. CGRC has requested Goldenfields Water County Council (GWCC) investigate provision of a reticulated town water supply to Nangus.

The objectives of the overall project include:

- > Provide appropriate levels of service (LOS) as part of the design assessment and ensure the LOS can be achieved throughout its design life.
- > Achieve project delivery from initiation to construction completion in 4-6 years (should the project prove feasible).
- > Undertake a feasibility assessment Phase (Phase 1) of the project
- > Undertake a Business Case Phase of the project (Phase 2)
- > Cost estimates for whole of life costs to be equal to or less than 100% of benefit, achieving BCR of 1 or over
- > Achieve best practice principles
- > Secure construction funding
- > Assess and mitigate all risks associated with the delivery and ongoing operation of this project.

Cardno has been engaged by GWCC to undertake the Nangus Water Supply Feasibility Study, which meets Phase 1 in the above objectives. This study investigates and assesses a range of options to provide a reticulated water supply to Nangus.

## 2 Problem Definition

### 2.1 Existing Water Supply Arrangements

Nangus does not currently have a reticulated water supply. Residents are responsible for obtaining their own water supplies. This is typically achieved through the following:

- > Rain water tanks
- > Bottled water
- > Bores
- > Water carting

The current supply arrangements are onerous for residents to operate and maintain, and present potential risks in terms of supply quality and security.

Reticulated potable water supply systems currently exist to the west (GWCC network) and east (CGRC network in Gundagai) of Nangus. The regional context of Nangus is shown in Figure 2-1, while the town centre is shown in Figure 2-2.

### 2.2 Drivers for a Reticulated Water Supply

Drivers for a reticulated water supply in Nangus are outlined below.

- > Growth potential

The lack of a reticulated water supply may be holding back potential growth in the Nangus area.

Investigations by CGRC indicate that provision of a reticulated water supply would support residential and economic growth. The following factors point to the potential for growth in the Nangus area:

- Nangus currently has other infrastructure and services, including a Public School, town hall, general store, post office, mechanic and a bus depot servicing Wagga Wagga and Gundagai. These existing facilities improve the outlook for growth in the area, should a reticulated water supply be provided.
- Nangus Road is currently being upgraded to support B-double traffic. Improved road linkages through the area may lead to increased traffic and demand for services. Nangus could potentially develop as a service hub on this regional route.
- At 15 minutes' drive from Gundagai, Nangus is an affordable residential lifestyle alternative to Gundagai. Nangus is also situated close to a number of other regional employment areas, including Junee (30 minutes), Wagga Wagga (45 minutes) and Cootamundra (45 minutes).
- CGRC estimates that the unoccupied dwelling rate in Nangus is lower than other villages in the Local Government Area (LGA). This may indicate potential demand for additional housing and development in the area.
- CGRC has identified an area adjacent to Nangus for subdivision into lots of 2 ha and 5 ha, as shown in Figure 2-3. It is proposed that this land will be rezoned from RU1 (Primary Production) to RU4 (Primary Production Small Holding).
- There are approximately 27 occupied dwellings in Nangus (data from CGRC). Based on population projections from CGRC, this may increase to approximately 79 occupied dwellings (see Section 3).



Figure 2.1  
Regional Map

NANGUS, NSW

Legend

- GWCC Existing Water Mains
- CGRC Existing Water Mains
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)

1:100,000 Scale at A3



## Figure 2.2 Nangus Town Centre

NANGUS, NSW

### Legend

- Major Road (LPI)
- Local Road (LPI)
- Vehicular Track (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSI-SS, 2017)
- CGRC Owned Lots

1:6,000 Scale at A3

0 50 100 150 200  
m



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-20 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-002-NangusTown.mxd 02  
Aerial Imagery supplied by DFSI (2017)



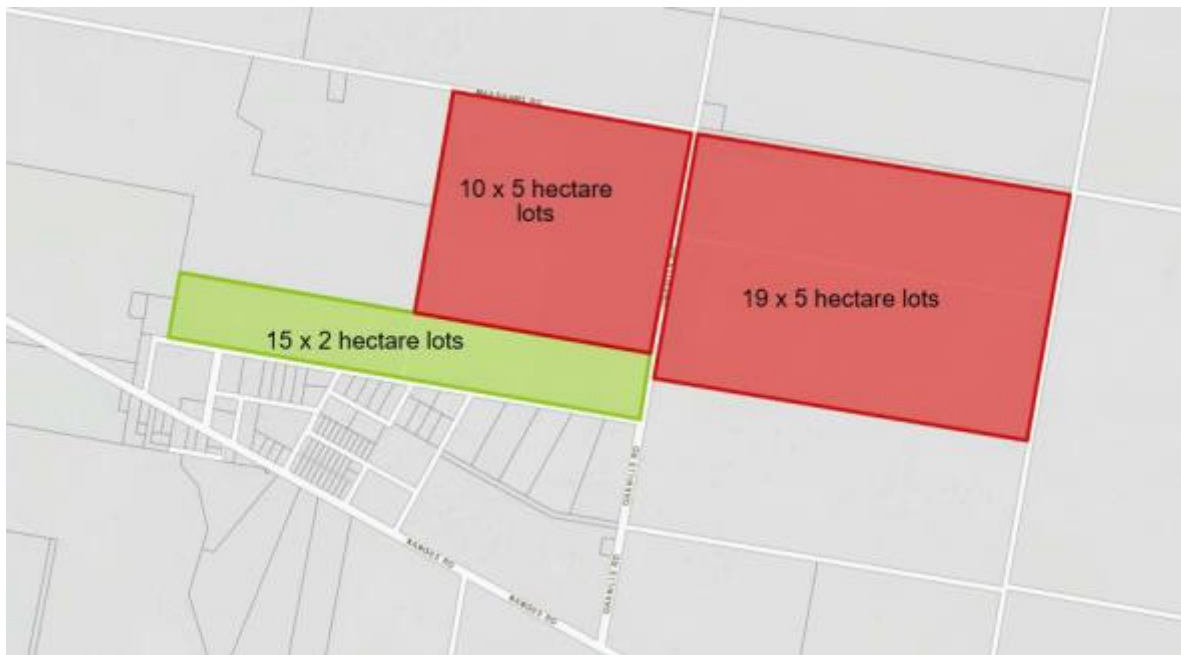


Figure 2-3 Proposed area for rezoning (Source: CGRC)

> Community Support

CGRC recently undertook community consultation as part of preparation of the Villages Strategy. The unanimous response from Nangus residents was in support of a reticulated water supply. Respondents indicated they believed lack of a reticulated water supply was holding the village back from potential residential growth.

> Security and water quality risks associated with current water supply arrangements

Current water supply arrangements are onerous for residents, and present potential health risks to residents. Provision of a reticulated supply would remove the health risks associated with residents' current supplies, and increase supply security, particularly with respect to rainwater tanks.

> Sustainable Development Goals

GWCC takes consideration of the United Nations Sustainable Development Goals (SDG) into account in its operations. Relevant goals to this project include:

- Goal 6: Ensure availability and sustainable management of water and sanitation for all.
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

> Equal opportunity and consistency of services for all townships within CGRC, which enables greater social cohesion through the provision of access to similar standard of water services currently available in the larger centres.

### 3 Water Demand

CGRC estimates the current population of Nangus to be approximately 80 people. The following are currently located within the village:

- > Approximately 27 occupied dwellings
- > Church
- > Hall
- > Public School
- > RFS Shed
- > General Store
- > Workshop

Therefore, there is potential for approximately 33 connections at the existing level of development. In addition, there are currently approximately 36 vacant lots.

Population projections from CGRC estimate a population of 213 people could be possible in the long term. This equates to 79 property connections at the 2016 Nangus census occupation rate of 2.7 people/dwelling.

To allow for additional growth, CGRC and GWCC have agreed the feasibility study should be based on a supply for 100 ET (equivalent tenements) in the village of Nangus. This will allow for all foreseeable growth.

The design average day demand (ADD) and maximum day demand (MDD) from within the village of Nangus are shown in Table 3-1. The design criteria per ET for ADD and MDD are taken from the level of service targets in the GWCC Drinking Water Management System (Atom Consulting, 2017). Note that the ADD is given as 294 kL/y/ET in the above document, which equates to the 0.81 kL/d/ET ADD given in Table 3-1.

Options that involve construction of a pipeline transferring potable water from either GWCC or Gundagai will also present opportunities to provide potable water to rural properties along the route. For all pipeline options an allowance for five rural property connections has been made, each with a MDD of 25 kL/d and ADD of 5kL/d. The total demands for the pipeline options are given in Table 3-1. In the hydraulic modelling it has been assumed that the full demand will be catered for in the pipelines through to Nangus, as it is unknown where these rural demands will be located along the pipeline.

Table 3-1 Water demand

Parameter	Nangus Village		Nangus Village and Rural Demand (pipeline options only)		
	Design Criteria (kL/d/ET)	Total Demand (kL/d)	Design Criteria for Rural Connection (kL/d/ET)	Rural Demand (kL/d)	Total Demand (kL/d)
Average Day Demand	0.81	80.5	5	25	105.5
Maximum Day Demand	4	400	25	125	525
Maximum hour Demand	7	712 (8.2L/s)	45	223	935 (10.8L/s)

A typical residential diurnal pattern was applied to the Nangus demands to determine the maximum hour requirements. The diurnal pattern has a peaking factor 1.78, which occurs at 4pm of a typical day. The applied curve is shown in Figure 3-2.

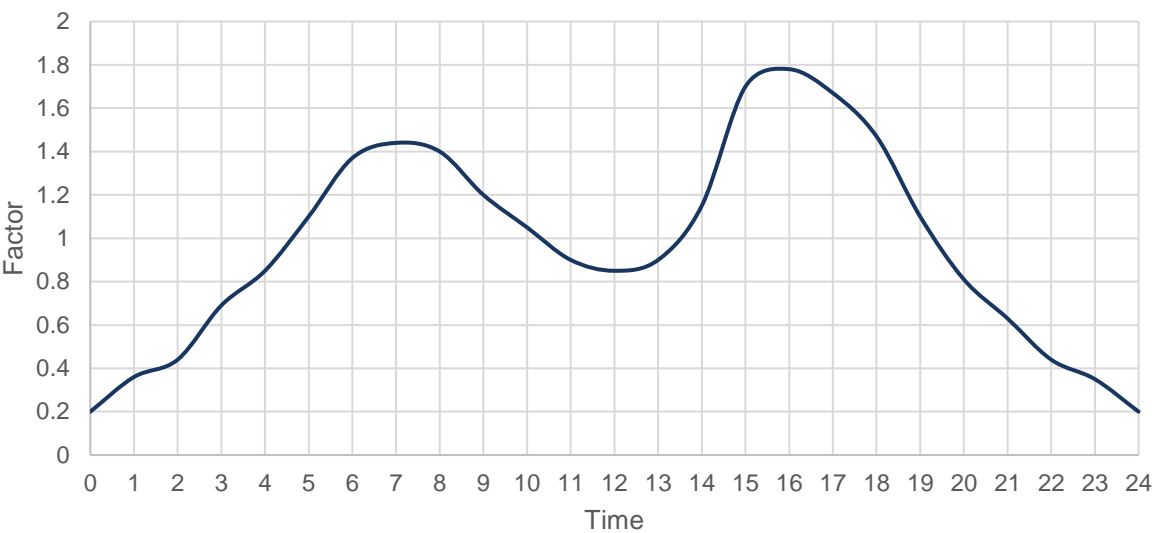


Figure 3-2 Typical Residential Diurnal Pattern

## 4 Options Identification

### 4.1 Options Previously Identified

GWCC previously identified the following potential options for supply of potable water to Nangus:

1. Extend the existing Gundagai potable water supply to Nangus
2. Connection to GWCC's Tenandra scheme at Oura Road to supply Nangus
3. Connection to GWCC's Tenandra, scheme near Tenandra reservoirs, and utilize the existing easement
4. Connection to GWCC's Tenandra reservoir and use the local terrain to determine the alignment to Nangus
5. River extraction including treatment process
6. Ground water extraction including treatment process
7. Do nothing, 'status quo'

### 4.2 Additional Options

A workshop was held with staff from GWCC, CGRC and Cardno to identify possible options not previously considered. The identified options include:

- > Permanent water carting
- > Dam on Billabong Creek with treatment
- > Pipeline to Tarcutta water supply
- > Pipeline to Riverina Water County Council Oura water supply

These options are further discussed below.

#### 4.2.1 Permanent water carting

This option would involve construction of a reservoir and reticulation system in Nangus. However, water would be supplied to the reservoir by carting either from the GWCC system or from Gundagai. With a 20 kL tanker, at ADD this would equate to 4 truck movements per day, while at MDD 20 truck movements per day would be required.

Assuming a 20-minute drive between a truck fill location in Gundagai and a reservoir at Nangus and 50 minutes each for filling and emptying, a round trip would take approximately 2 hours. To accommodate ADD, the carting truck would be operational for 8 hours per day. To accommodate MDD, 5 trucks would be required to be in operation 8 hours per day.

Due to the high volume of truck movements required on a permanent basis, this option has been excluded from further analysis.

#### 4.2.2 Dam on Billabong Creek with treatment

The Billabong Creek flows from the north to its confluence with the Murrumbidgee River west of Nangus. Note that the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016), which includes this creek, refers to it as the Billabong Creek. Other resources refer to this watercourse as the Billabong Creek. The area drained by the Billabong Creek is shown in Figure 4-1.

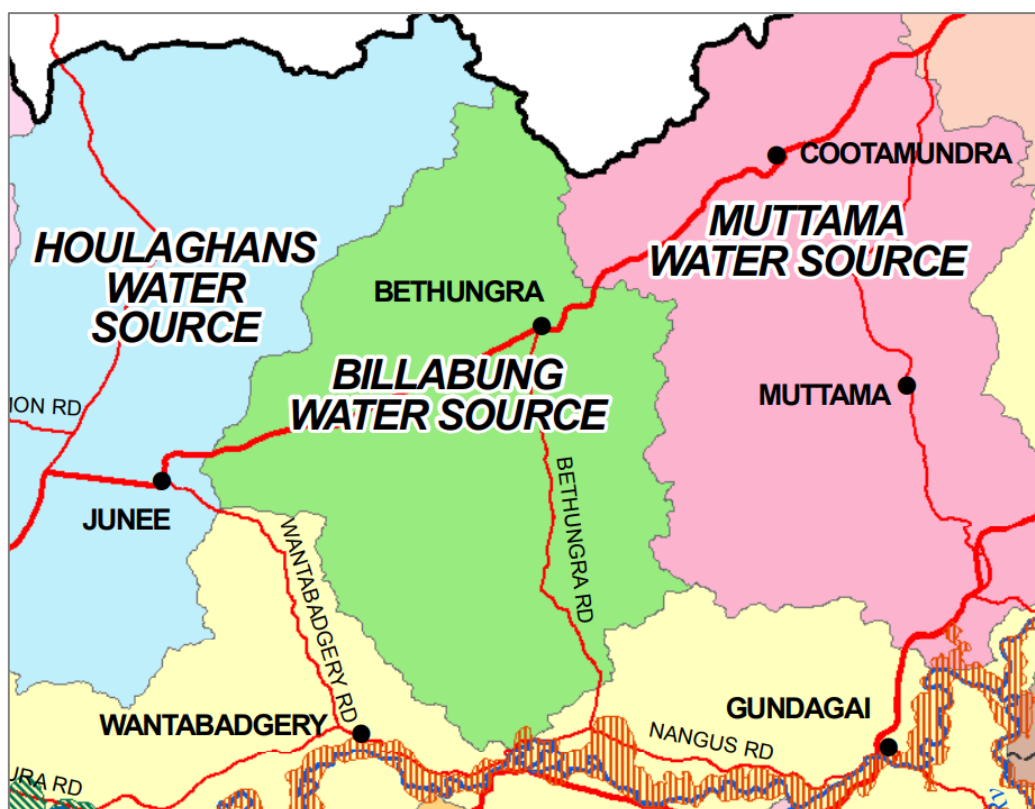


Figure 4-1 Billabong (Billabong) Water Source (Source: Plan Map WSP023\_Version 2 from the Water Sharing Plan for Murrumbidgee Unregulated and Alluvial Water Sources 2012)

The creek is ephemeral, and as such either a dam or off-creek storage ponds would be required. Due to the significant costs associated with development of a new dam or off-creek storage, this option has been excluded from further analysis.

#### 4.2.3 Pipeline to Tarcutta water supply

Riverina Water County Council currently operate a water supply scheme at Tarcutta using a groundwater source. Tarcutta is approximately 46 km from Nangus by road and approximately 31 km in a straight line. As the distance is significantly greater than options from the GWCC and Gundagai water schemes, this option is not considered any further in this study.

#### 4.2.4 Pipeline to Oura water supply

Riverina Water County Council currently operate a water supply scheme at Oura using a groundwater source (separate from GWCC's Oura water supply system). Tarcutta is approximately 41 km from Nangus by road and approximately 35 km in a straight line. As the distance is significantly greater than options from the GWCC and Gundagai water schemes, this option is not considered any further in this study.

### 4.3 Options Assessed in this Feasibility Study

As no further practical options have been identified, the options carried forward for assessment in this Feasibility Study are based on those previously identified by GWCC, and are referred to by the following names in this report:

- > Option 1: Pipeline from Gundagai water supply
- > Option 2: Pipeline from GWCC water supply – from Oura Road
- > Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement
- > Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route
- > Option 5: Murrumbidgee River extraction and treatment
- > Option 6: Groundwater extraction and treatment
- > Option 7: Do nothing

## 5 Evaluation Criteria

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Options analysed in this study have been assessed in terms of capital cost and a risk assessment and multi-criteria analysis (MCA).

### 5.1 Capital Cost Estimate

Capital cost estimates for all options include:

- > Costs for new delivery infrastructure, including pipelines, reservoirs, pump stations, bores, river intakes and treatment plants as required for each option.
- > Modifications to existing water supply infrastructure in the GWCC network and Gundagai network, as required for the pipeline options.
- > Costs for supply infrastructure including town reticulation and property service connections (excluding work after the supply meter required by the homeowner).
- > Land acquisition and easements.
- > Allowance for survey, investigation, design and project management.

Where appropriate, capital cost estimates have been based on the NSW Reference Rates Manual - Valuation of water supply, sewerage and stormwater assets (DPI, 2014), noting the following:

- > 2014 rates have been factored for cost increases through to 2017 using the 2017 factors published by the Department of Industry (DPI). Factors have not been published for 2018 or 2019.
- > Reference rates, which include an allowance for survey, investigation, design and project management, as directed by the manual, have been used.
- > An 'inherent risk' contingency of 30% has been applied, as per guidance in the manual for feasibility studies.
- > A 'contingent risk' of 10% has also been applied.
- > The manual has been used for costs for pipelines, pump stations and reservoirs. Other works, such as WTPs, have been estimated by Cardno.

### 5.2 Multi-criteria Analysis and Risk Assessment

A key component of MCA is to identify the constraints, risks and opportunities that are associated with each option, and categorise each of these under a key heading or theme. Examples of these themes can be; safety (construction and operation), security of supply, flexibility, constructability, environment impact/risk, delivery timeframe risk, etc.

The criteria to be used for this analysis, a description of the scoring criteria and the weighting of each parameter are given in Table 5-1. Through the analysis, each option has been scored against the weighted criteria, providing an MCA score between zero and ten.

Table 5-1 Multi-Criteria Analysis Parameters and Weighting

No.	Criteria	Score and Description				Weighting	
		0		5			10
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	Low security. High frequency of water restrictions	↔		↔	High security. Complies with 5/10/10 rule.	20%
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	Does not consistently meet the existing AWDG health requirements and draft HBTs.	↔	Meets the majority of current ADWG, but will potentially need investment to satisfy future changes to the ADWG.	↔	Will meet current and likely future ADWG health requirements including HBTs.	15%
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	Does not consistently meet the AWDG aesthetic requirements.	↔	Meets the majority of current ADWG aesthetic requirements.	↔	Will meet consistently meet the AWDG aesthetic requirements.	10%
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	Catastrophic risk - likely loss of life and property across a wide area. Alternate water supply needed to support town. High risk of not retaining suitably qualified operational staff.	↔	Moderate Injury risk to operations staff. Moderate risk to public and property.	↔	Minimal risk to operations. No risk to public or property. Failure would result in a minor disruption to water supply. Low risk of not retaining suitably qualified operational staff.	15%
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	Constrained or limited access and egress for construction, significant impacts to day to day usage of the area. High WHS risk. Poor ground conditions. Complex work requiring specialist contractors.	↔	Average access and egress for construction, some impacts to day to day usage of the area. Moderate WHS risk.	↔	Easy access and egress for construction, minimal impacts to day to day usage of the area. Low WHS risk. Good ground conditions. Lower complexity work.	15%
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	Absence of available information for project definition increases the potential for project delays and budget exceedance.	↔	Reasonable level of project definition achieved. Typical project, with standardised design and construction needs. Moderate risk for project delays and budget exceedance.	↔	High level of project definition. Typical project, with standardised design and construction needs.	10%
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	Critical heritage likely to be impacted. Adverse/significant impact to key vegetation communities. Potential for extended approvals period. Risk of approvals not obtained.	↔	PADs likely to be impacted - AHIP approval required. Minor impact to key vegetation communities. Moderate risk extended approvals period. Moderate risk approvals not obtained.	↔	No heritage impact anticipated / Ability to avoid identified heritage sites. Avoid mapped key vegetation communities. Extended approvals period unlikely. Low risk of approvals not being obtained.	15%
	<b>Total</b>						100%

## 6 Existing GWCC Tenandra Water Supply

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GWCC water distribution infrastructure currently extends to the Tenandra Reservoirs, located on a hilltop approximately 8.6 km west of Nangus. At Tenandra there are two concrete reservoirs with a total storage of 3.2 ML.

The rising/gravity main to the Tenandra Reservoirs is a DN300 cast iron (CI) pipe constructed in the 1930s. The reservoirs and main were originally part of a scheme used to supply water from the Murrumbidgee River (extracted approximately 2km west of the reservoir site) through to Junee. When the Oura groundwater source was developed in the 1970s the river extraction at Tenandra became redundant and was decommissioned. However, the reservoirs were retained to service the current system. The mains supplying the other villages within the Tenandra scheme consist of mostly PVC pipe ranging in sizes from 50 mm to 200 mm, constructed between the early 1970s and mid-1980s.

The Oura scheme, which currently supplies the Tenandra part of the network, consists of a borefield that extracts water from the Wagga Wagga Alluvial Groundwater Source. Water is treated by way of aeration, chlorination and fluoridation.

Access to the Wagga Wagga Alluvial Groundwater Source is controlled by the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016). GWCC has a licence for extraction of 6 GL/y from the Oura system. The current demand on the supply is approximately 4.0 GL/y, projected to increase to 4.6 GL/y in 2048 (Cardno, 2019), not including Nangus. The peak day demand on the Oura scheme is currently 26.2 ML/d, projected to increase to 30.2 ML/d in 2048 (Cardno, 2019), not including Nangus. The Oura system supplies approximately 45% of the total water consumed by GWCC customers.

The Tenandra Reservoirs are used as header storage for the villages of Wantabadgery, Eurongilly, Illabo, Bethungra and minor rural consumers. Water is supplied from the Junee to Temora trunk main via an offtake to the Junee Silos Booster Pump Station, filling the Marinna reservoirs. Marinna Pump Station pumps to Tenandra, Wantabadgery, Eurongilly, Illabo and Bethungra reservoirs. Under gravity, water is fed out of the Tenandra Reservoirs via a common inlet/out supplying water to the reservoirs of Wantabadgery, Eurongilly, Illabo, Bethungra minor rural consumers and the east of Junee.

It is noted that GWCC's assets between the Junee Silos Pump Station and the Tenandra Reservoirs all have a condition rating of 3 (fair) or 4 (poor). Future investigations of options that incorporate supply from GWCC's network should include consideration of the condition of these assets, and what renewals may be necessary to ensure reliability of supply.

## 7 Existing CGRC Gundagai Water Supply

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The Gundagai water supply scheme is owned and operated by CGRC. The scheme draws raw water from the Murrumbidgee River under water access licence (WAL) 6455, which allows an annual take of 1,250 ML. Access to water in the Murrumbidgee River is controlled under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* (NSW Government, 2018).

The Gundagai WTP process incorporates coagulation, flocculation, clarification, filtration, chlorination and fluoridation. Treated water is delivered to four reservoirs and to the reticulation network (see Figure 8-1).

CGRC has confirmed that there is sufficient spare capacity in the raw water supply and treatment plant to supply Nangus.

## 8 Options Assessment

### 8.1 Nangus Service Area

For all options, allowance has been made for reticulation to service the existing developed lots within the town. As per Figure 2-3, CGRC propose to rezone land to the north and north-west of the existing town to allow future development. Allowance has been made in the design service pressure to service these areas. The lowest elevation in the service area is approximately RL 215 m (along Nangus Road), while the highest elevation is approximately RL 260 m (at the north-west edge of the area noted for rezoning). GWCC design service pressure is 12 m to 90 m. Therefore, it is proposed to service the town in a single pressure zone.

### 8.2 Desktop Environmental Constraints Analysis

Cardno has undertaken a desktop environmental constraints analysis as part of the Nangus Water Supply Feasibility Study. The intent of the analysis was to highlight any 'red-flags' which may influence the alignment/location of the infrastructure involved in the various options. The analysis was desktop based, and therefore site specific investigations will be required in future project stages. The constraints analysis for each option is detailed in the relevant section below.

### 8.3 Options 1 to 4: Overview

Options 1 to 4 incorporate pipelines delivering potable water from existing networks; Option 1 from the CGRC system in Gundagai and Options 2 through 4 from the GWCC system to the west of Nangus. The pipeline routes are mapped on Figure 8-1, with comparative elevation profiles shown on Figure 8-2. Detailed maps are provided for the options in Appendix A.

For each option, reservoirs have been situated at locations of appropriate elevation along the pipe routes, as close as possible to Nangus. The elevations have been selected to provide sufficient service pressure as noted in Section 8.1.

In all options a DN100 pipeline between the supply source and the reservoir is suitable to convey peak day flows, while a DN150 pipeline is required between the reservoirs and the town to allow for peak hour flows.

A map of the proposed reticulation within Nangus (common to all options) is given in Figure 8-3. The reticulation is proposed to be constructed from DN100 PVC-O.

## Figure 8.1 Pipeline Route Options Map

NANGUS, NSW

### Legend

- Reservoir Option 1
- Reservoir Option 2
- Reservoir Options 3 and 4
- ⊗ Booster Pump Station (Option 1)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- GWCC Existing Water Mains
- CGRC Existing Water Mains
- Major Roads (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)

1:100,000 Scale at A3



 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-12-06 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-003-PipelineOptions.mxd 02  
Aerial Imagery supplied by DFSI (2017)

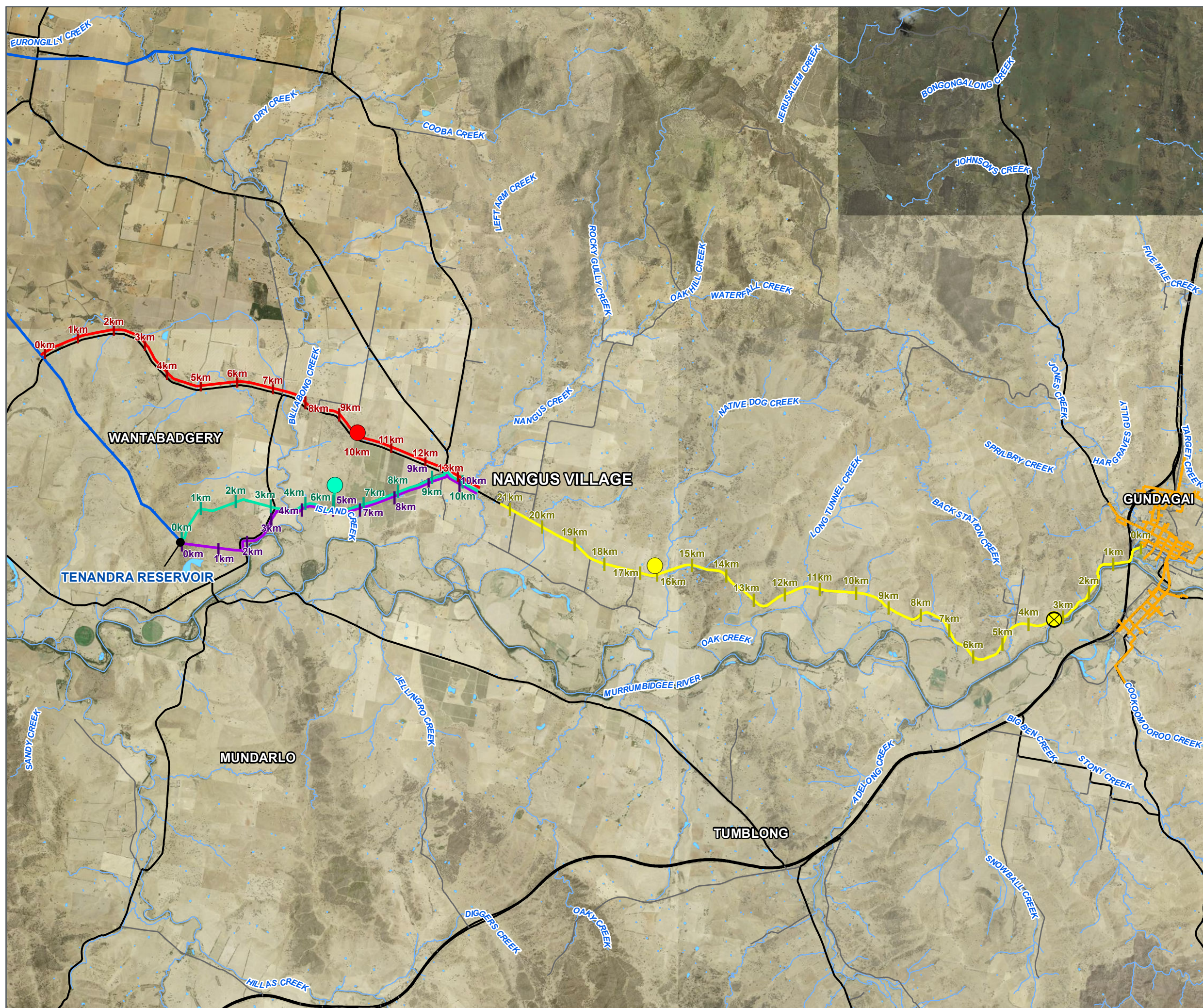




Figure 8-2 Pipeline Route Options Elevation Profile  
Note: Nangus is located at distance 0m in the above figure for ease of comparison.

## Figure 8.3 Nangus Reticulation Map

NANGUS, NSW

### Legend

- Proposed Reticulation
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Major Road (LPI)
- Local Road (LPI)
- - - Vehicular Track (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSI-SS, 2017)
- CGRC Owned Lots

1:6,000 Scale at A3

0 50 100 150 200  
m



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-12-06 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-004-NangusReticulation.mxd 02  
Aerial Imagery supplied by DFSI (2017)



## 8.4 Option 1: Pipeline from CGRC Water Supply at Gundagai

### 8.4.1 Description

Option 1 incorporates the supply of potable water from CGRC's water supply in Gundagai to Nangus. Key components of this option include:

- > Connection to the existing CGRC watermain near the intersection Nangus Road and Sheridan Lane in Gundagai.
- > Approximately 16.3 km of DN100 PVC-O pipeline from Gundagai to Nangus reservoir, located to the east of Nangus, as mapped in Appendix A.
- > Booster pump station located at approximately CH3400 to deliver water from Gundagai to Nangus reservoir.
- > Nangus reservoir, with a usable volume of 250 kL.
- > Chlorine dosing facility at Nangus Reservoir to maintain quality.
- > Approximately 5.2 km of DN150 PVC-O pipeline from Nangus reservoir to Nangus.
- > Reticulation (DN100 PVC-O) to service the existing developed area in Nangus.

### 8.4.2 Preliminary Design and Pipeline Hydraulics

The pipeline connects to CGRC's water network in Gundagai via the existing watermain currently installed in Nangus Road, fronting Lot 11 DP1128590. From the connection point, the pipeline heads west towards Nangus. For the first 3,000 m of the pipe alignment Nangus road is followed closely by the Murrumbidgee River. For parts of this section, the road reserve becomes narrow and steeply battered. Specific consideration into the pipe's constructability through this section would need to be made.

A booster pump station is proposed to be located at CH3400. A pressure boost of approximately 85 m will be required. Existing overhead powerlines are adjacent to Nangus road at this location.

The proposed Nangus reservoir (CH16300) is located on elevated ground approximately 5 km east of Nangus. The reservoir will have a usable volume of 250 kL (three days of storage for the average day demand). This reservoir will be a steel standpipe type reservoir, due to the lack of sufficient ground elevation.

While a chlorine dosing facility has been allowed for at the proposed Nangus reservoir, water quality must comply with ADWG requirements at all locations in the network. There is the potential for chlorine residuals to fall between the chlorine dosing at Nangus reservoir and Nangus, and a secondary chlorination facility may be required downstream in the network to ensure chlorine residuals are maintained at suitable levels.

Refer to Appendix A for further details on the proposed pipe alignment for Option 1. The hydraulic grade line and elevation profile are shown in Figure 8-4.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-3, matching the other options.

The pipeline infrastructure has been sized to convey the Nangus and rural demand MDD to the reservoir as outlined in Table 3-1. From the reservoir to Nangus, the infrastructure has been sized to convey the peak hour demand.

A water pressure of 60 m (or a head of RL 275 m) has been assumed at the point of connection in Gundagai. Actual pressures were not available for the study, so the pressure was estimated using the elevation of the Gundagai reservoirs (approximately RL 295 m) and making an allowance of 20 m headloss between the reservoirs and the connection point. The hydraulics were modelled using Infoworks WSPRO software.

GWCCs preference is for the pipeline to be installed within private property where possible, adjacent to the road reserve. GWCC's recent experience has shown installation in private property provides a more efficient pathway to obtaining environmental approvals than installation within road reserves.

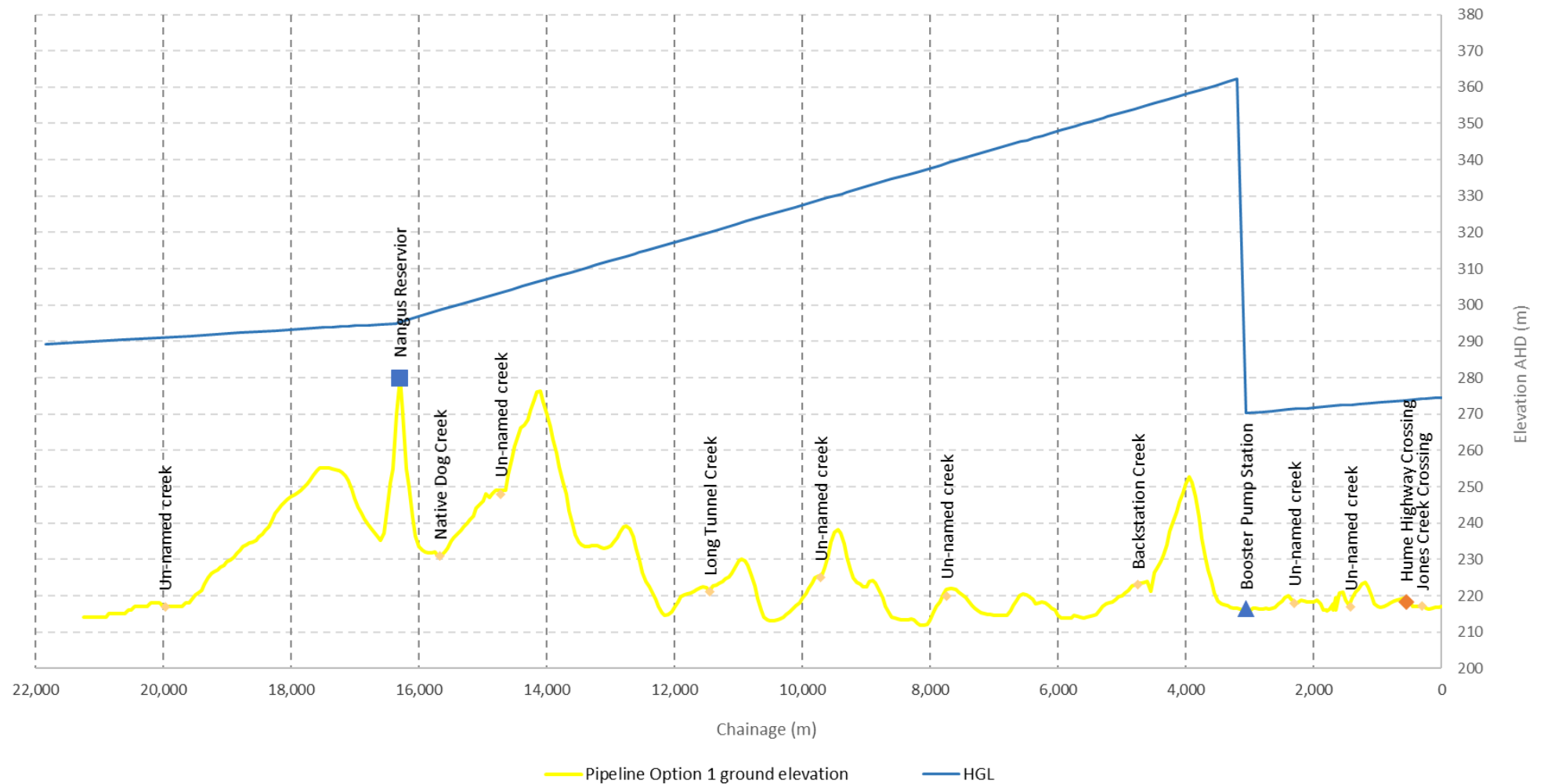


Figure 8-4 Option 1 – Hydraulic Grade & Elevation Profile

The proposed pipe alignment for Option 1 crosses the following watercourses (stream order 3 and higher) as shown on Figure 8-4. Crossing methodologies are also proposed.

- > Jones Creek – attached to bridge.
- > Backstation Creek – attached to bridge.
- > Long Tunnel Creek – open trench.
- > Native Dog Creek – attached to bridge.
- > Six un-named creeks – all open trench.

### 8.4.3 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 1 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts. This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.4.3.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- > The area is primarily dominated by non-native vegetation
- > There are eight native vegetation communities present along the alignment of Option 1. These Plant Community Types (PCT's) may be associated with Threatened Ecological Communities (TEC's) protected under the *Biodiversity Conservation Act 2016* (BC Act) as shown in Table 8-1.
- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities undertaken on 22/11/2019 found 33 listed species under the BC Act recorded within the vicinity of the alignment. The alignment directly impacts on three recorded threatened flora species locations (Bionet, 2019).
- > A search of DPI – Key Fish Habitat found that Option 1 crosses a number of waterbodies that are considered Key Fish Habitat including:
  - Native Dog Creek
  - Backstation Creek
  - Murrumbidgee River
  - Long Tunnel Creek
- > According to the Gundagai LEP, Option 1 will have an impact on areas mapped as 'sensitive land' according to the Natural Resources Sensitivity Biodiversity Map. The objective of the mapped sensitive land is to help maintain terrestrial and aquatic biodiversity.

Table 8-1 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum herbaceous-grassy very tall open forest wetland on inner floodplains in the lower slopes sub-region of the NSW South Western Slopes Bioregion and the eastern Riverina Bioregion.	Not listed under the BC Act	NA
79	River Red Gum Shrub/Grass Riparian Tall Woodland or Open Forest Wetland	** Status of this vegetation under state and federal legislation is currently unknown and should be investigated further in later project development stages.	**
266	White Box Grassy Woodland	White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	TEC
276	Yellow Box Grassy Tall Woodland	White Box Yellow Box Blakely's Red Gum Woodland	EEC
277	Blakely's Red Gum - Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	EEC
289	Mugga Ironbark – Inland Scribbly Gum – Red Box Shrub/Grass Open Forest	Not listed under the BC Act	NA
347	White Box – Blakely's Red Gum Shrub/Grass Woodland	White Box Yellow Box Blakely's Red Gum Woodland	EEC
796	Derived Grassland	Listed	EEC

\* Derived from the NSW Vegetation Information System (VIS) which allows you to match PCTs with probable TECs.

\*\* Data not available in the VIS.

### Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 9 listed species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) found within the vicinity of this option.
- > A search of the Protected Matters Search Tool (PMST) (Department of Environment and Energy (DOEE), 2019) was undertaken on 22/11/2019. The following Matters of National Environmental Significance (MNES) have been identified within 10 km of this option. Federally listed TEC's have been identified below in Table 8-2.
  - Four Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 1.
  - 31 threatened species and 11 migratory species.

Table 8-2 Federally listed TECs

TEC	Status: Endangered (EEC) or Critically Endangered (CEEC)
Grey Box ( <i>Eucalyptus microcarpa</i> ) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	EEC
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC
Derived Grassland	CEEC

### Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the (now repealed) *Threatened Species Conservation Act 1995* (TSC Act) have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 1 does not impact on any listed National Parks and Wildlife Services (NPWS) reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA. No Biobanking sites were located within the area of this option.

#### 8.4.3.2 Heritage

##### 8.4.3.2.1 Historic Heritage

### Local Heritage

Heritage item '114 – Nangus Station Group' is identified under Gundagai LEP 2011 as a local heritage item and is located approximately 800m south of the alignment of Option 1. There are also 12 locally listed items under the Gundagai LEP 2011 in the township of Gundagai. The alignment does not intersect any of the above mentioned heritage items.

Heritage item '120: War Memorial Nangus' is identified under Gundagai LEP 2011 as a local heritage item, but will not be impacted by the proposed option.

### State Heritage

Two State Heritage registered items reside within the town of Gundagai:

- > Gundagai Rail Station and Yard Group
- > Gundagai Rail Bridge

There are also two listed Conservation Areas within the town of Gundagai:

- > Gundagai Rail Station and Yard Group
- > Old Gundagai Town Site

These are items in the vicinity of Option 1 however the option does not have a direct impact on the items.

### Federal Heritage

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- > The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA.

#### 8.4.3.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 56 Aboriginal sites and 0 (zero) Aboriginal places within the vicinity of Option 1. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

#### 8.4.3.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > From east to west, the proposed Option 1 would traverse:
  - Jones Creek
  - Backstation Creek
  - Long Tunnel Creek
  - Native Dog Creek
  - Unnamed drainage channels
- > Waterways range in size and, under the Strahler stream order system, are classified as ranging from major order streams (Murrumbidgee River) to third order watercourses (Department of Primary Industries (DPI) Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).
- > While works will be within 40m of these watercourses, a controlled activity approval under the Water Management Act 2000 (WM Act) is not required as the works would be undertaken by a public authority.
- > Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. The named waterways crossed by the pipeline which are listed as low potential GDE. Option 1 also runs near the Murrumbidgee River which has been classified as having a high potential GDE (Bureau of Meteorology (BOM), 2019).
- > The pipeline would cross areas mapped as 'sensitive land' according to Gundagai LEP.
- > There are numerous groundwater bores along Option 1 pipeline route, with a number of them being approximately 50m from the proposed alignment. It is not expected that the pipeline would have any impact on the bores as the alignment could be set to avoid them.
- > According to the Australian Flood Study Database, there have been three studies conducted surrounding the Murrumbidgee River and surrounds. The studies include:
  - Gundagai Flood Scoping Study – 2013
  - Oura to Braehour Flood Model Extension – 2011
  - Murrumbidgee River Flood Modelling

A thorough investigation into these studies will help shape future stages of the proposed development.

#### 8.4.3.4 Soil and Contamination

- > Soils present within the area are shown on the Soils figure in Appendix B.
- > Option 1 traverses multiple different soil classes including:
  - Kurosols
  - Kandosols
  - Rudosols (Aluvial)
  - Sodosols
- > Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the Protection of the Environment Operation (POEO) Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 6 locations where a POEO License has been issued in the town of Gundagai. The listed locations of issued licences are not

impacted by Option 1. There are no known contaminated sites listed on the OEH Contaminated Land Register. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.4.3.5 Socio-economic, Land Use and Zoning

- > The majority of Option 1 alignment is within land zoned RU1 – Primary Production (see the land use and zoning map in Appendix B) however part of the pipeline route extends into land zoned RU5 – Village and SP3 – Tourist.
- > The pipeline option traversed across private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.4.3.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects). The register was searched for Cootamundra - Gundagai LGA and one major project was identified (the Adjungbilly Wind Farm), however the project is not in close proximity to this option and is therefore unlikely to generate cumulative impacts

Cootamundra – Gundagai Regional Council Development Application (DA) Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project. It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.4.3.7 Summary of Environmental Constraints & Approval Pathway

##### Summary

The key environmental constraints related to Option 1 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

##### Initial approval pathway advice

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a “water reticulation system”.

Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act.

Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

#### **8.4.4 Cost Estimate**

The estimated capital cost for Option 1 is \$4.56 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

#### **8.4.5 Multi-criteria Analysis and Risk Assessment**

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-3.

Table 8-3 Option 1 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	<ul style="list-style-type: none"> <li>It is assumed that CGRC's Gundagai water supply will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	8	<ul style="list-style-type: none"> <li>It is assumed that water supplied by CGRC's Gundagai water supply network will meet the ADWG health requirements.</li> <li>Chlorine dosing facility to be provided at Nangus reservoir to maintain residual.</li> <li>Nangus reservoir is proposed to be a standpipe type to gain the required elevation. A significant dead volume of water will be stored in the reservoir, increasing water age.</li> <li>Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to aesthetic criteria.	10%	10	<ul style="list-style-type: none"> <li>It is assumed that water supplied by CGRC's Gundagai water supply network will meet the ADWG aesthetic requirements.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	7	<ul style="list-style-type: none"> <li>Proposed infrastructure (pipeline, booster pump station and chemical dosing facility) considered familiar to operators.</li> <li>Pump station required for Option 1 (no pump station required for other pipeline options). Potential point of failure.</li> <li>Longest pipeline option – more potential failure points.</li> <li>Majority of infrastructure will be located close to roads – easy access.</li> <li>In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir.</li> <li>Materials readily available and close by in case of repair.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	7	<ul style="list-style-type: none"> <li>Mostly conventional construction methods – open trenching.</li> <li>No specialised materials.</li> <li>Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW.</li> <li>The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW.</li> <li>Due consideration to be made for steep batters and narrow road reserve along alignment, particularly near the Hume Highway crossing.</li> <li>Terrain considered generally suitable for pipeline installation works.</li> <li>Some constructability risk related to unknown geotechnical conditions.</li> <li>Ten creek crossings to be suspended from bridge, open trenched or directional drilled.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	7	<ul style="list-style-type: none"> <li>Geotechnical conditions unknown, however, the pipeline can be installed at minimum depth and rock is not considered to be a significant risk.</li> <li>Some unknown issues around pressure at the point of connection at Gundagai and the ability of the Gundagai network to deliver the required flow rate to the connection point.</li> </ul>

No.	Criteria	Weighting	Score	Discussion
				<ul style="list-style-type: none"> <li>Ability to mount pipeline on bridges (proposed at three locations) is not known. Underboring or open trenching are alternatives.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	7	<ul style="list-style-type: none"> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> <li>Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. The majority of the pipeline will be installed adjacent to the road reserve, so if significant barriers to implementing easement at certain locations are encountered, diverting to the road reserve will provide an alternative.</li> <li>Environmental approvals unlikely to significantly delay the project as careful route selection should allow avoidance of impacts.</li> </ul>
	<b>Total</b>	100%	8.1	

## 8.5 Option 2: Pipeline from GWCC Water Supply – from Oura Road

### 8.5.1 Description

Option 2 incorporates the supply of potable water from GWCC's Oura Water Supply Scheme. This option would see the supply of water via a pipeline built along Oura Road from an existing DN300 CI watermain to the township of Nangus.

Key components of this option include:

- > Connection to the existing DN300 CI rising / gravity main operating between Marina Reservoir and the Tenandra Reservoir.
- > Pressure reducing valve (PRV).
- > Approximately 9.8 km of PN35 DN100 DI pipeline from the existing network to Nangus reservoir, located west of Nangus.
- > Nangus reservoir, with a usable volume of 250 kL.
- > Chlorine dosing facility at Nangus reservoir to maintain quality.
- > Approximately 3.9 km of DN150 PVC-O pipeline from Nangus reservoir to Nangus.
- > Reticulation (DN100 PVC-O) to service the existing developed area in Nangus.

### 8.5.2 Preliminary Design and Pipeline Hydraulics

The pipeline connects to GWCC's Oura Water supply scheme via an existing DN300 CI watermain that Crosses Nangus Road and fronts Lot 2 DP541744. From the connection point, the pipeline heads east towards Nangus.

A PRV will be located near the connection to reduce the pressure to that required to convey the water to Nangus.

The proposed Nangus reservoir (CH9770) is located on elevated ground approximately 4 km east of Nangus. The reservoir will have a usable volume of 250 kL (three days of storage for the average day demand). A concrete reservoir is proposed.

While a chlorine dosing facility has been allowed for at the proposed Nangus reservoir, water quality must comply with ADWG requirements at all locations in the network. There is the potential for chlorine residuals to fall between the chlorine dosing at Nangus reservoir and Nangus, and a secondary chlorination facility may be required downstream in the network to ensure chlorine residuals are maintained at suitable levels.

Refer to Appendix A for further details on the proposed pipe alignment for Option 2. The hydraulic grade line and elevation profile are shown in Figure 8-5.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-3, matching the other options.

The pipeline infrastructure has been sized to convey the Nangus and rural demand MDD to the reservoir as outlined in Table 3-1. From the reservoir to Nangus, the infrastructure has been sized to convey the peak hour demand.

GWCC's preference is for the pipeline to be installed within private property where possible, adjacent to the road reserve. GWCC's recent experience has shown installation in private property provides a more efficient pathway to obtaining environmental approvals than installation within road reserves.

The proposed pipe alignment for Option 2 crosses the following watercourses (stream order 3 and higher) as shown on Figure 8-5. Crossing methodologies are also proposed.

- > Billabong Creek – attached to bridge.
- > Nangus Creek – attached to bridge.
- > Four un-named creeks – all open trench.

The model of the existing GWCC network was also analysed to determine any impacts due to the Nangus supply. No significant impacts were observed and it is therefore considered that no upgrade to the existing network will be required to supply Nangus on the basis of the additional demand. However, as noted in Section 6, future investigations should include consideration of the condition of these existing assets, and what renewals may be necessary to ensure reliability of supply.

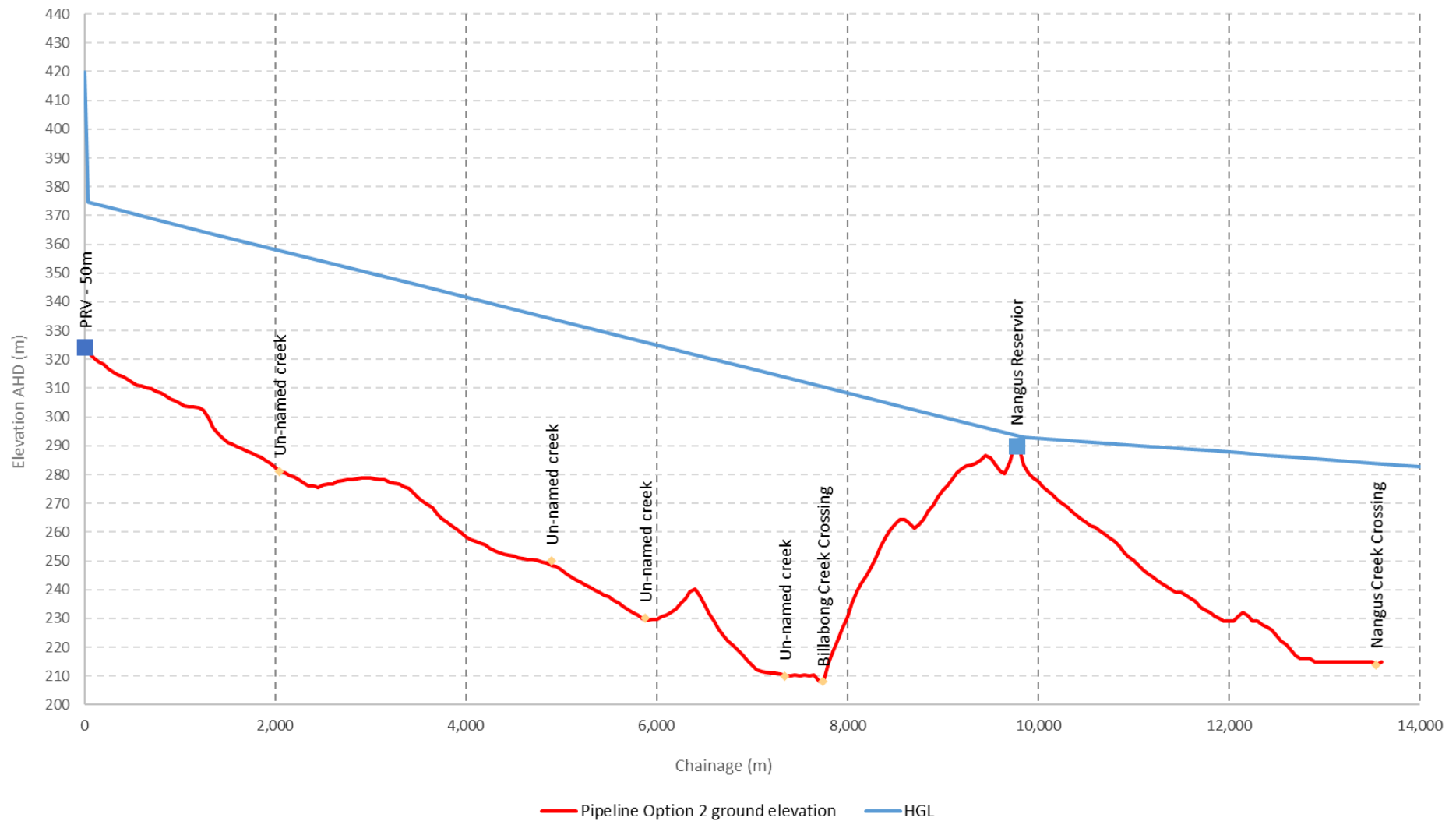


Figure 8-5 Option 2 – Hydraulic Grade & Elevation Profile

As noted in Section 6, the MDD and annual demand on the Oura WTP are projected to be 30.2 ML/d and 4,600 ML/y respectively by 2048 (without the Nangus supply). Supply of water to Nangus would equate to an additional 1.7% to the MDD and 0.8% to the annual demand.

### 8.5.3 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 2 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts.

This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.5.3.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- > The area is primarily dominated by non-native vegetation
- > There are three native vegetation communities present along the alignment of Option 2. These PCT's may be associated with TEC's protected under the BC Act as shown in Table 8-4.

Table 8-4 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
79	River Red Gum Shrub/Grass Riparian Tall Woodland or Open Forest Wetland	** Status of this vegetation under state and federal legislation is currently unknown and should be investigated further in later project development stages.	**
266	White Box Grassy Woodland	White Box Yellow Box Blakely's Red Gum Woodland	EEC
277	Blakely's Red Gum - Yellow Box grassy tall woodland of the NSW South Western Slopes Bioregion	White Box Yellow Box Blakely's Red Gum Woodland	EEC

\* Derived from the NSW Vegetation Information System (VIS) which allows you to match PCTs with probable TECs.

\*\* Data not available in the VIS.

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 22 listed species under the BC Act were recorded within the vicinity of the alignment. The alignment directly impacts on four recorded threatened flora species locations (Bionet, 2019).
- > A search of DPI – Key Fish Habitat found that Option 2 crosses two waterbodies that are considered Key Fish Habitat including:
  - Nangus Creek
  - Billabong Creek
- > According to the Gundagai LEP and Junee LEP, Option 2 will have an impact on areas mapped as 'sensitive land' according to the Natural Resources Sensitivity Biodiversity Map. The objective of the mapped sensitive land is to help maintain terrestrial and aquatic biodiversity.

## Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 5 listed species under the *EPBC Act* within the vicinity of the alignment.
- > A search of the PMST (DoEE, 2019) was undertaken on 22/11/2019. The following MNES have been identified within 10km of this option. Federally listed TEC's have been identified below in Table 8-5:
  - 4 Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 2.
  - 30 threatened species and 11 migratory species

Table 8-5 Federally listed TECs

TEC	Status: Endangered (EEC) or Critically Endangered (CEEC)
Grey Box ( <i>Eucalyptus microcarpa</i> ) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	EEC
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC

## Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 2 does not impact on any listed National Parks and Wildlife Services (NPWS) reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA and Junee LGA. No Biobanking sites were located within the area of this option.

### 8.5.3.2 Heritage

#### 8.5.3.2.1 Historic heritage

### Local Heritage

There is one heritage item identified under the Gundagai LEP 2011 in proximity to the proposed option (and none under the Junee LEP 2012).

- > I20: War Memorial Nangus – located on the outskirts of the town of Nangus

The abovementioned locally listed heritage item will not be impacted by the proposed option.

### State Heritage

There are no State Heritage Register listed heritage items within proximity of Option 2.

### Federal Heritage

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 14 federally listed heritage items within the Junee LGA.
- > The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA and Junee Shire Council LGA.

#### 8.5.3.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 7 Aboriginal sites and 0 (zero) Aboriginal places within the vicinity of Option 2. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

#### 8.5.3.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > From east to west, the proposed Option 2 would traverse:
  - Nangus Creek
  - Billabong Creek
- > Waterways range in size and under the Strahler stream order system are classified as ranging from fifth order streams to third order watercourses (DPI Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).
- > While works will be within 40m of these watercourses, a controlled activity approval under the Water Management Act 2000 (WM Act) is not required as the works would be undertaken by a public authority.
- > Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Two named waterways are crossed by the pipeline (Nangus Creek and Billabong Creek) which are listed as moderate potential GDE (BOM, 2019).
- > The pipeline would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011 and within Groundwater Vulnerable areas mapped in Junee LEP 2012.
- > In the vicinity of Option 2, there are a number of groundwater bore locations. The eastern extent of the alignment in Nangus Village has a large number of bores within 50m of the alignment. It is not expected that the pipeline would have any impact on the bores as the alignment could be set to avoid them.
- > According to the Australian Flood Study Database, there have been three studies conducted surrounding the Murrumbidgee River and surrounds. The studies include:
  - Gundagai Flood Scoping Study – 2013
  - Oura to Braehour Flood Model Extension – 2011
  - Murrumbidgee River Flood Modelling

A thorough investigation into these studies will help shape future stages of the proposed development.

#### 8.5.3.4 Soil and Contamination

- > Soils present within the area are shown on the Soils figure in Appendix B.
- > Option 2 traverses multiple different soil classes including:
  - Kurosols
  - Kandosols
- > Option 2 passes through soils that are identified as saline land according to the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the Protection of the Environment Operation (POEO) Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in Cootamundra – Gundagai LGA and 4 issued in Junee LGA. The listed locations of issued licences are not impacted by Option 2. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 2. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.5.3.5 Socio-economic, Land Use and Zoning

- > The majority of Option 2 alignment is within land zoned RU1 – Primary Production land zoning (see the land use and zoning map in Appendix B).
- > This option traverses both Junee LGA and Cootamundra – Gundagai LGA
- > The pipeline option traversed across private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10 km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.5.3.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment or approved. The register was searched for Cootamundra - Gundagai LGA and Junee LGA. Three major projects were identified (the Adjungbilly Wind Farm, Sebastopol Solar and Young to Wagga Looping Pipeline), however the projects are not in close proximity to Option 2 and is therefore unlikely to generate cumulative impacts.

Cootamundra – Gundagai Regional Council DA Tracking portal for Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

Junee Council DA Tracking portal for Junee LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from October 2019 through to November 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.5.3.7 Summary of Environmental Constraints & Approval Pathway

##### Summary

The key environmental constraints related to pipeline Option 2 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

##### Initial approval pathway advice

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a “water reticulation system”. Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act. Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed during future stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of ‘significant impacts’ on the environment which could trigger the need for an EIS.

#### **8.5.4 Cost Estimate**

The estimated capital cost for Option 2 is \$3.26 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

#### **8.5.5 Multi-criteria Analysis and Risk Assessment**

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-6.

Table 8-6 Option 2 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	<ul style="list-style-type: none"> <li>It is assumed that GWCC's Oura water supply network will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	9	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the ADWG health requirements.</li> <li>Chlorine dosing facility to be provided at Nangus reservoir to maintain residual.</li> <li>Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the majority of current ADWG aesthetic requirements.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	9	<ul style="list-style-type: none"> <li>Operation and maintenance of pipeline, PRV, reservoir and chemical dosing facility considered familiar to operators.</li> <li>Majority of infrastructure will be located close to roads – easy access.</li> <li>In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir.</li> <li>Materials readily available and close by in case of repair.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	9	<ul style="list-style-type: none"> <li>Mostly conventional construction methods – open trenching.</li> <li>No specialised materials.</li> <li>Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW.</li> <li>The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW.</li> <li>Terrain considered favorable for pipeline installation works.</li> <li>Some constructability risk related to unknown geotechnical conditions.</li> <li>Six creek crossings to be suspended from bridge, open trench or directional drilled.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	9	<ul style="list-style-type: none"> <li>Geotechnical conditions unknown, however, the pipeline can be installed at minimum depth and rock is not considered to be a significant risk.</li> <li>Ability to mount pipeline on bridges (proposed at two locations) is not known. Underboring or open trenching are alternatives.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	8	<ul style="list-style-type: none"> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> </ul>

No.	Criteria	Weighting	Score	Discussion
				<ul style="list-style-type: none"> <li>Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. The majority of the pipeline will be installed adjacent to the road reserve, so if significant barriers to implementing easement at certain locations are encountered, diverting to the road reserve will provide an alternative.</li> <li>Environmental approvals unlikely to significantly delay the project as careful route selection should allow avoidance of impacts.</li> </ul>
	<b>Total</b>	100%	9.2	

## 8.6 Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route

### 8.6.1 Description

Option 3 incorporates the supply of potable water from GWCC's Oura Water Supply Scheme. This option would see the supply of water via a pipeline built from the existing Tenandra Reservoirs to the township of Nangus.

Key components of this option include:

- > Connection to the existing Tenandra Reservoirs outlet pipeline.
- > Approximately 2.7 km of PN35 DN100 DI pipeline from the Tenandra Reservoirs to a PRV, located near River Road.
- > A PRV located near River Road.
- > Approximately 2.8 km of PN35 DN100 DI from the PRV to Nangus reservoir.
- > Nangus reservoir, with a usable volume of 250 kL.
- > Chlorine dosing facility at Nangus reservoir to maintain quality.
- > Approximately 5.0 km of DN150 PVC-O pipeline from Nangus reservoir to Nangus.
- > Reticulation (DN100 PVC-O) to service the existing developed area in Nangus.

### 8.6.2 Preliminary Design and Pipeline Hydraulics

The pipeline connects to GWCC's Oura Water supply scheme at the Tenandra Reservoirs located in Lot 1 DP172773, before heading east towards Nangus. The alignment for pipeline Option 3 primarily follows the top of natural ridge lines, fence lines, Island Creek and local access roads to Nangus. Refer to Appendix A for further details on the proposed pipe alignment for Option 3.

A PRV will be located near River Road at the base of the Tenandra mountain to reduce the pressure to that required to convey the water to Nangus.

The proposed Nangus reservoir (CH5500) is located on elevated ground approximately 5 km east of Nangus. The reservoir will have a usable volume of 250 kL (three days of storage for the average day demand). A concrete reservoir is proposed.

While a chlorine dosing facility has been allowed for at the proposed Nangus reservoir, water quality must comply with ADWG requirements at all locations in the network. There is the potential for chlorine residuals to fall between the chlorine dosing at Nangus reservoir and Nangus, and a secondary chlorination facility may be required downstream in the network to ensure chlorine residuals are maintained at suitable levels.

Refer to Appendix A for further details on the proposed pipe alignment for Option 3. The hydraulic grade line and elevation profile are shown in Figure 8-6.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-3, matching the other options.

The pipeline infrastructure has been sized to convey the Nangus and rural MDD to the reservoir as outlined in Table 3-1. From the reservoir to Nangus, the infrastructure has been sized to convey the peak hour demand.

GWCC's preference is for the pipeline to be installed within private property where possible, adjacent to the road reserve. GWCC's recent experience has shown installation in private property provides a more efficient pathway to obtaining environmental approvals than installation within road reserves.

The proposed pipe alignment for Option 3 crosses the following watercourses (stream order 3 and higher) as shown on Figure 8-6. Crossing methodologies are also proposed.

- > Billabong Creek – horizontal directional drill.
- > Nangus Creek – attached to bridge.

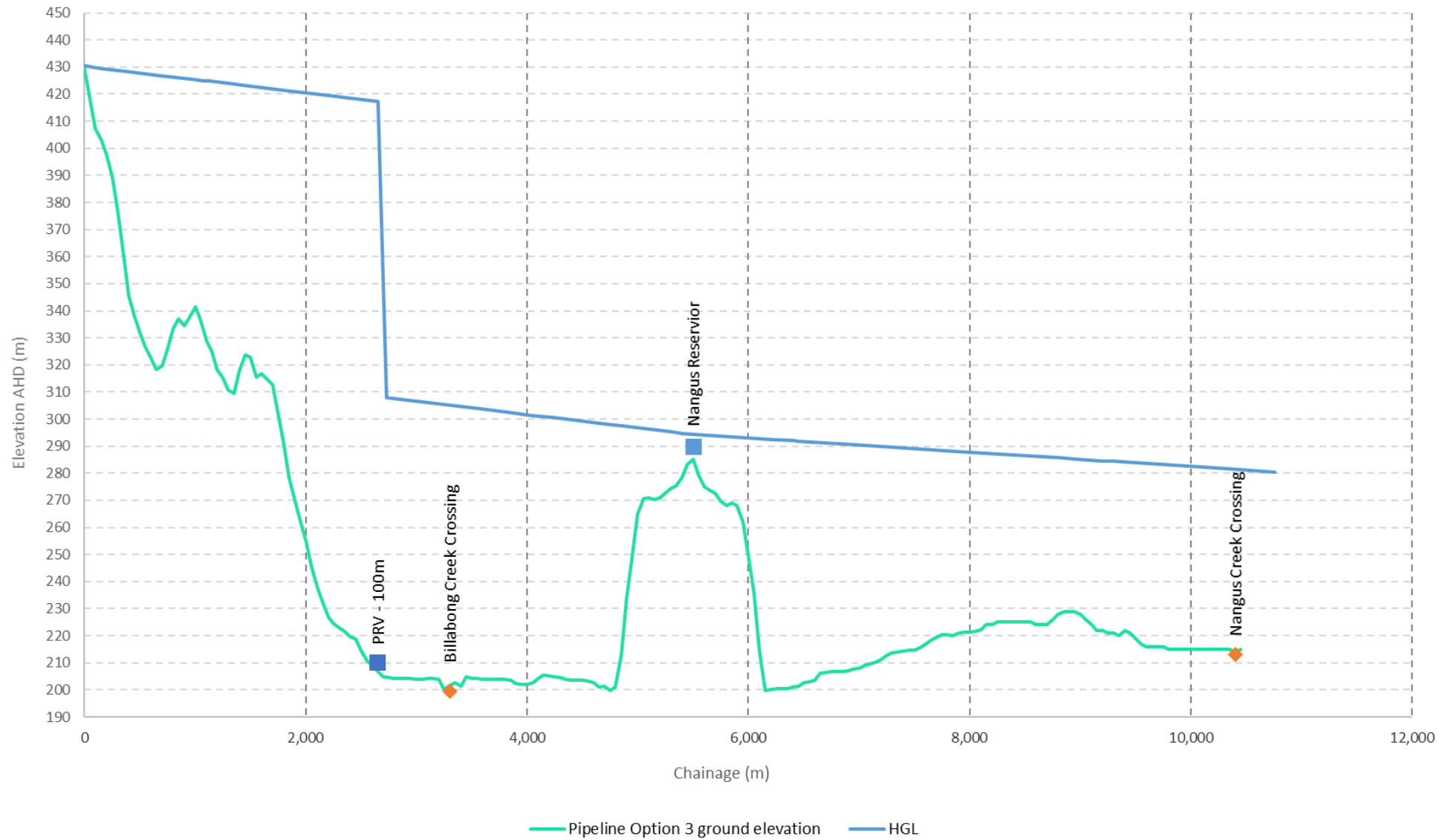


Figure 8-6 Option 3 – Hydraulic Grade & Elevation Profile

The model of the existing GWCC network was also analysed to determine any impacts due to the Nangus supply. No significant impacts were observed and it is therefore considered that no upgrade to the existing network will be required to supply Nangus on the basis of the additional demand. However, as noted in Section 6, future investigations should include consideration of the condition of these existing assets, and what renewals may be necessary to ensure reliability of supply.

As noted in Section 6, the MDD and annual demand on the Oura WTP are projected to be 30.2 ML/d and 4,600 ML/y respectively by 2048 (without the Nangus supply). Supply of water to Nangus would equate to an additional 1.7% to the MDD and 0.8% to the annual demand.

### 8.6.3 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 3 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts.

This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.6.3.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below.

- > The area is primarily dominated by non-native vegetation
- > There are two native vegetation communities present along the alignment of Option 3. These PCT's may be associated with TEC's protected under the BC Act as shown in Table 8-7.

Table 8-7 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA
79	River Red Gum Shrub/Grass Riparian Tall Woodland or Open Forest Wetland	** Status of this vegetation under state and federal legislation is currently unknown and should be investigated further in later project development stages.	**

\* Derived from the NSW Vegetation Information System (VIS) which allows you to match PCTs with probable TECs.

\*\* Data not available in the VIS.

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 20 listed species under the BC Act were recorded within the vicinity of the alignment. The alignment does not directly impact on known sighting locations of threatened flora or fauna.
- > A search of DPI – Key Fish Habitat found that Option 3 crosses two waterbodies that are considered Key Fish Habitat including:
  - Billabong Creek
  - Nangus Creek

- > According to the Gundagai LEP 2011 and Junee LEP 2012, Option 3 will have an impact on areas mapped as 'sensitive land' according to the Natural Resources Sensitivity Biodiversity Map. The objective of the mapped sensitive land is to help maintain terrestrial and aquatic biodiversity.

### Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 4 listed species under the *EPBC Act* found within the vicinity of this option.
- > A search of the PMST (DoEE, 2019) was undertaken on 22/11/2019. The following MNES have been identified within 10 km of this option. Federally listed TEC's have been identified below in Table 8-8:
  - 4 Wetlands of International Significance all of which are located approximately 400km – 800km downstream of Option 3.
  - 30 threatened species and 11 migratory species

Table 8-8 Federally listed TECs

TEC	Status: Endangered (EEC) or Critically Endangered (CEEC)
Grey Box ( <i>Eucalyptus microcarpa</i> ) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	EEC
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC

### Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 3 does not impact on any listed National Parks and Wildlife Services (NPWS) reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA and Junee LGA. No Biobanking sites were located within the area of this option.
- > Option 3 traverses across a federally listed environmental stewardship zone for the maintenance or improvement of the condition and extent of the Box Gum Grassy Woodland Ecological Community. The pipeline will have a direct impact on this stewardship zone P1-Z1, a zone with an area of 413.9 ha. The landholder is under a legal obligation to ensure the management actions stipulated in the Environmental Stewardship Funding Deed are met and achieved for the lifetime of the agreement. The management actions that may impact Option 3 are shown in Table 8-9.

Table 8-9 Environmental Stewardship Funding Deed management actions that may impact Option 3

Management Action	Management Objective	Description of Management Actions
No cultivation or major soil disturbance	Remediate and minimise soil disturbance	The land manager will not cultivate, including cultivation for fire breaks, or undertake other measures resulting in significant soil disturbance within the area. Revegetation, where required, is to be undertaken only by means that involve minimal soil disturbance.

Soil disturbance is expected to be significant in the direct area of the proposed option alignment as a result of trenching for installation of the pipeline. Impacts are not expected to be widespread like cultivation works would induce.

### 8.6.3.2 Heritage

#### 8.6.3.2.1 Historic Heritage

##### **Local Heritage**

There is one heritage item identified under the Gundagai LEP 2011 in proximity to the proposed option (and none under the and Junee LEP 2012).

- > I20: War Memorial Nangus – located on the outskirts of the town of Nangus

The abovementioned locally listed heritage item will not be impacted by the proposed option.

##### **State Heritage**

There are no State Heritage Register listed heritage items within proximity of Option 3.

##### **Federal Heritage**

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- > A search of the Australian Governments Australian Heritage Database (DoEE, 2019) identified 14 federally listed heritage items within the Junee LGA.
- > The PMST search undertaken on 25/7/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA and Junee LGA.

#### 8.6.3.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 5 Aboriginal sites and 0 (zero) Aboriginal places within the locality of Option 3. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

### 8.6.3.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > From east to west, the proposed Option 3 would traverse:
  - Nangus Creek
  - Billabong Creek
- > Waterways range in size and under the Strahler stream order system are classified as ranging from sixth order stream to fourth order watercourses (DPI Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017)
- > While works will be within 40m of these watercourses, a controlled activity approval under the Water Management Act 2000 (WM Act) is not required as the works would be undertaken by a public authority.
- > Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Two named waterways are crossed by the pipeline (Nangus Creek and Billabong Creek) which are listed as moderate potential GDE (BOM, 2019).
- > The pipeline would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011 and within Groundwater Vulnerable areas mapped in Junee LEP 2012.
- > There are numerous groundwater bore locations along Option 3 pipeline route. The eastern extent of the alignment in Nangus Village has multiple bores within 50 m of the alignment and the western extents will join the GWCC existing water mains. It is not expected that the pipeline would have any impact on the bores as the alignment could be set to avoid them.

- > According to the Australian Flood Study Database, there have been three studies conducted surrounding the Murrumbidgee River and surrounds. The studies include:
  - Gundagai Flood Scoping Study – 2013
  - Oura to Braehour Flood Model Extension – 2011
  - Murrumbidgee River Flood Modelling

A thorough investigation into these studies will help shape future stages of the proposed development.

#### 8.6.3.4 Soil and Contamination

- > Soils present within the area are shown on the Soils figure in Appendix B.
- > Option 3 traverses multiple different soil classes including:
  - Rudosols and Tenosols
  - Kandosols
  - Kurosols
  - Rudosols (Aluvial)
- > Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the Protection of the Environment Operation (POEO) Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai and 4 issued in Junee LGA. The listed locations of issued licences are not impacted by Option 3. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 3. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.6.3.5 Socio-economic, Land Use and Zoning

- > The majority of Option 3 alignment is within land zoned RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village. (see the land use and zoning map in Appendix B)
- > This option traverses both Junee LGA and Cootamundra – Gundagai LGA
- > The pipeline option traversed across private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.6.3.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment or approved. The register was searched for Cootamundra - Gundagai LGA and Junee LGA. Three major projects were identified (the Adjungbilly Wind Farm, Sebastopol Solar and Young to Wagga Looping Pipeline), however the projects are not in close proximity to Option 3 and is therefore unlikely to generate cumulative impacts.

Cootamundra – Gundagai Regional Council DA Tracking portal for Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

Junee Council DA Tracking portal for Junee LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from October

2019 through to November 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.6.3.7 *Summary of Environmental Constraints & Approval Pathway*

##### **Summary**

The key environmental constraints related to pipeline Option 3 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

##### **Initial approval pathway advice**

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a “water reticulation system”. Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act. Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of ‘significant impacts’ on the environment which could trigger the need for an EIS.

Further investigations into the direct impacts on the environmental stewardship zone (Zone P1-Z1) will need to occur pending the outcomes of the options analysis. Land use applications and further studies will likely be required if Option 3 proceeds.

#### **8.6.4 Cost Estimate**

The estimated capital cost for Option 3 is \$3.07 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

#### **8.6.5 Multi-criteria Analysis and Risk Assessment**

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-10.

Table 8-10 Option 3 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	<ul style="list-style-type: none"> <li>It is assumed that GWCC's Oura water supply network will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	9	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the ADWG health requirements.</li> <li>Chlorine dosing facility to be provided at Nangus reservoir to maintain residual.</li> <li>Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the majority of current ADWG aesthetic requirements.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	7	<ul style="list-style-type: none"> <li>Operation and maintenance of pipeline, PRV, reservoir and chemical dosing facility considered familiar to operators.</li> <li>Significant length of the pipeline will be located through steep farmland with potentially difficult access for maintenance.</li> <li>Access to reservoir and chlorine dosing facility will pose difficulties.</li> <li>In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir.</li> <li>Materials readily available and close by in case of repair.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	5	<ul style="list-style-type: none"> <li>A significant length of the pipeline is through steep, rocky terrain.</li> <li>Some constructability risk related to unknown geotechnical conditions.</li> <li>Mostly conventional construction methods – open trenching.</li> <li>No specialised materials.</li> <li>Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW.</li> <li>The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW.</li> <li>Two creek crossings to be suspended from bridge or directional drilled.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	6	<ul style="list-style-type: none"> <li>Geotechnical conditions unknown. Rock is likely to be a risk in elevated terrain near Tenandra and the proposed Nangus reservoir.</li> <li>Geotechnical conditions for proposed directional drilling of Billabong Creek are not known.</li> <li>Ability to mount pipeline on bridge (proposed at one location) is not known. Directional drilling or open trenching are alternatives.</li> </ul>

No.	Criteria	Weighting	Score	Discussion
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	5	<ul style="list-style-type: none"> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> <li>It is understood from CGRC that there is local opposition to the Option 3 route due to land use issues.</li> <li>Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. Significant portions of the pipeline are not close to road reserves, so diverting into the road reserve is not an option if there are issues with easements.</li> <li>The route passes through an Environmental Stewardship area for Box Gum Grassy Woodlands, for which the landowner has a contractual agreement with the federal government to protect/enhance the ecological value of the area. Mitigation measures, including 'no major soil disturbance' are included within the agreement. The construction of the pipeline will induce major soil disturbance localised to the construction footprint. This presents a risk to the viability of this project, and further investigation will be required to confirm the impact on the approvals.</li> </ul>
	<b>Total</b>	100%	7.5	

## 8.7 Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement

### 8.7.1 Description

Option 4 incorporates the supply of potable water from GWCC's Oura Water Supply Scheme. This option would see the supply of water via a pipeline built from the existing Tenandra Reservoirs to Nangus.

Key components of this option include:

- > Connection to the existing Tenandra Reservoirs outlet pipeline.
- > Approximately 1.7 km of PN35 DN100 DI pipeline from the Tenandra Reservoirs to a PRV, located near River Road.
- > A PRV located near River Road.
- > Approximately 3.9 km of PN35 DN100 DI from the PRV to Nangus reservoir.
- > Nangus reservoir, with a usable volume of 250 kL.
- > Chlorine dosing facility at Nangus reservoir to maintain quality.
- > Approximately 5.0 km of DN150 PVC-O pipeline from Nangus reservoir to Nangus.
- > Reticulation (DN100 PVC-O) to service the existing developed area in Nangus.

### 8.7.2 Preliminary Design and Pipeline Hydraulics

The alignment for pipeline Option 4 connects to GWCC's Oura Water supply scheme at the Tenandra Reservoirs located in Lot 1 DP172773. From here, the pipe heads east along an old pipeline alignment to River Road. The alignment then follows the River Road corridor, before crossing Billabong Creek and following Island Creek and local access roads to Nangus.

A PRV will be located near River Road at the base of the Tenandra mountain to reduce the pressure to that required to convey the water to Nangus.

The proposed Nangus reservoir (CH5600) is located on elevated ground approximately 5 km east of Nangus. The reservoir will have a usable volume of 250 kL (three days of storage for the average day demand). A concrete reservoir is proposed.

While a chlorine dosing facility has been allowed for at the proposed Nangus reservoir, water quality must comply with ADWG requirements at all locations in the network. There is the potential for chlorine residuals to fall between the chlorine dosing at Nangus reservoir and Nangus, and a secondary chlorination facility may be required downstream in the network to ensure chlorine residuals are maintained at suitable levels.

Refer to Appendix A for further details on the proposed pipe alignment for Option 4. The hydraulic grade line and elevation profile are shown in Figure 8-7.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-3, matching the other options.

The pipeline infrastructure has been sized to convey the Nangus and rural MDD to the reservoir as outlined in Table 3-1. From the reservoir to Nangus, the infrastructure has been sized to convey the peak hour demand.

GWCC's preference is for the pipeline to be installed within private property where possible, adjacent to the road reserve. GWCC's recent experience has shown installation in private property provides a more efficient pathway to obtaining environmental approvals than installation within road reserves.

The proposed pipe alignment for Option 3 crosses the following watercourses (stream order 3 and higher) as shown on Figure 8-7. Crossing methodologies are also proposed.

The proposed pipe alignment for Option 4 crosses the following watercourses:

- > Un-named creek (River Road) – within pavement above culvert.
- > Billabong Creek – horizontal directional drill.
- > Nangus Creek – attached to bridge.

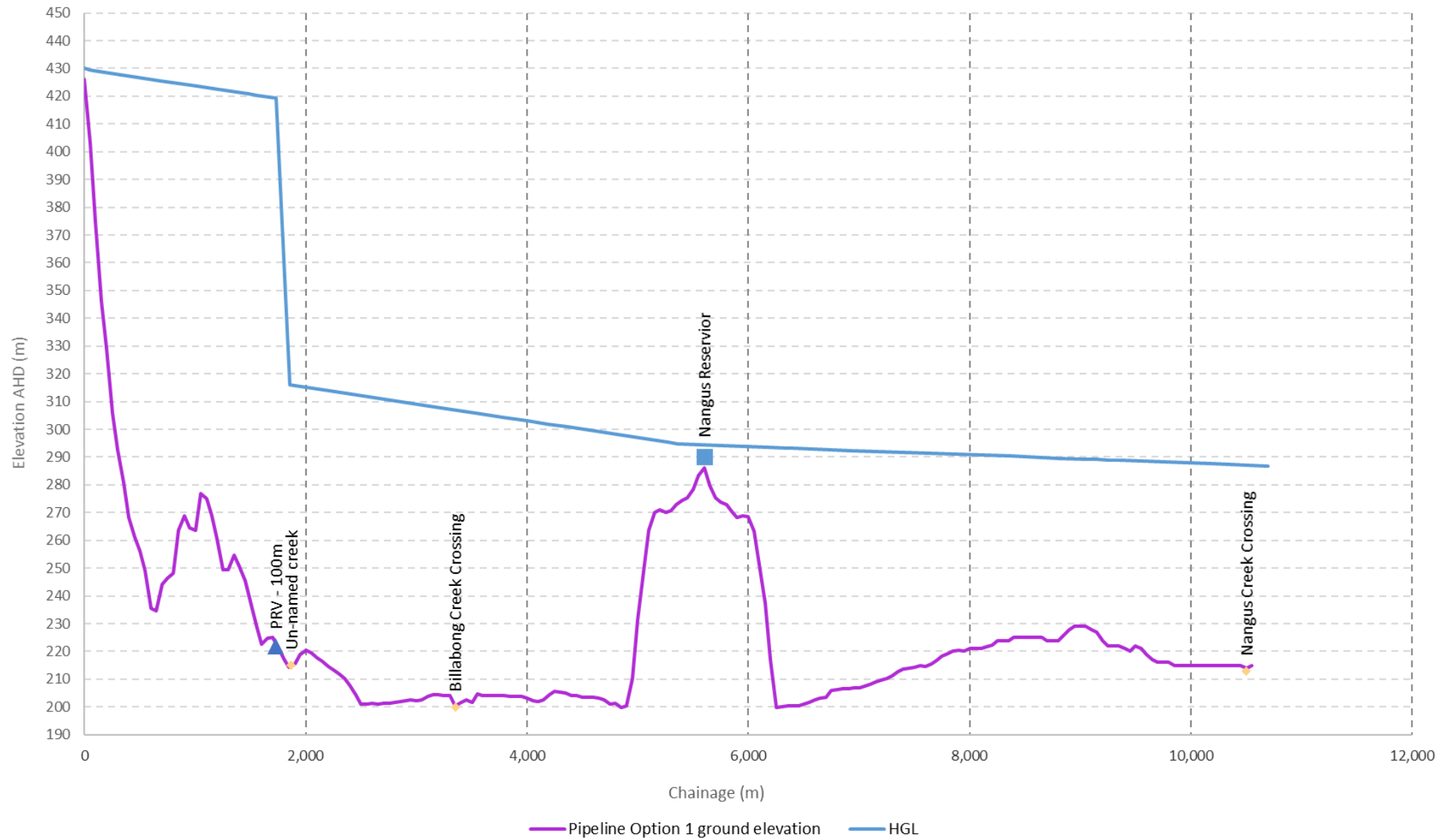


Figure 8-7 Option 4 – Hydraulic Grade & Elevation Profile

The model of the existing GWCC network was also analysed to determine any impacts due to the Nangus supply. No significant impacts were observed and it is therefore considered that no upgrade to the existing network will be required to supply Nangus on the basis of the additional demand. However, as noted in Section 6, future investigations should include consideration of the condition of these existing assets, and what renewals may be necessary to ensure reliability of supply.

As noted in Section 6, the MDD and annual demand on the Oura WTP are projected to be 30.2 ML/d and 4,600 ML/y respectively by 2048 (without the Nangus supply). Supply of water to Nangus would equate to an additional 1.7% to the MDD and 0.8% to the annual demand.

### 8.7.3 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 4 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts. This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.7.3.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- > The area is primarily dominated by non-native vegetation
- > There are three native vegetation communities present along the alignment of Option 4. These PCT's may be associated with TEC's protected under the BC Act as shown in Table 8-11.

Table 8-11 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA
79	River Red Gum Shrub/Grass Riparian Tall Woodland or Open Forest Wetland	** Status of this vegetation under state and federal legislation is currently unknown and should be investigated further in later project development stages.	**
266	White Box Grassy Woodland	White Box grassy woodland in the upper slopes sub-region of the NSW South Western Slopes Bioregion	EEC

\* Derived from the NSW Vegetation Information System (VIS) which allows you to match PCTs with probable TECs.

\*\* Data not available in the VIS.

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 14 listed species under the BC Act were recorded within the vicinity of the alignment. The alignment does not directly impact on known sightings of threatened flora or fauna.
- > A search of DPI – Key Fish Habitat found that Option 4 crosses three waterbodies that are considered key Fish Habitat including:

- Billabong Creek
  - Nangus Creek
  - Island Creek
- > According to the Gundagai LEP 2011 and Junee LEP 2012, Option 4 will have an impact on areas mapped as 'sensitive land' according to the Natural Resources Sensitivity Biodiversity Map. The objective of the mapped sensitive land is to help maintain terrestrial and aquatic biodiversity.

#### Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 22/11/2019 with 4 listed species under the *EPBC Act* found within the vicinity of this option.
- > A search of the PMST (DOEE, 2019) was undertaken on 22/11/2019. The following MNES have been identified within 10km of this option. Federally listed TEC's have been identified below in Table 8-12.
- 4 Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 4 alignment.
  - 30 threatened species and 11 migratory species

Table 8-12 Federally listed TECs

TEC	Status: Endangered (EEC) or Critically Endangered (CEEC)
Grey Box ( <i>Eucalyptus microcarpa</i> ) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia	EEC
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CEEC

#### Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 4 does not impact on any listed National Parks and Wildlife Services (NPWS) reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA and Junee LGA. No Biobanking sites were located within the area of this option.

#### 8.7.3.2 Heritage

##### 8.7.3.2.1 Historic Heritage

#### Local Heritage

There is one heritage item identified under the Gundagai LEP 2011 in proximity to the proposed option (and none under the Junee LEP 2012).

- > I20: War Memorial Nangus – located on the outskirts of the town of Nangus

The abovementioned locally listed heritage item will not be impacted by the proposed option.

#### State Heritage

There are no State Heritage Register listed heritage items within proximity of Option 4.

#### Federal Heritage

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.

- > A search of the Australian Governments Australian Heritage Database (DoEE, 2019) identified 14 federally listed heritage items within the Junee LGA.
- > The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA and Junee LGA.

#### 8.7.3.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 5 Aboriginal sites and 0 (zero) Aboriginal places within the locality of Option 4. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

#### 8.7.3.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > From east to west, the proposed Option 4 would traverse:
  - Nangus Creek
  - Billabong Creek
- > Waterways range in size and under the Strahler stream order system are classified as ranging from sixth order stream to fourth order watercourses (DPI Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).
- > While works will be within 40m of these watercourses, a controlled activity approval under the Water Management Act 2000 (WM Act) is not required as the works would be undertaken by a public authority.
- > Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Two named waterways are crossed by the pipeline (Nangus Creek and Billabong Creek) which are listed as moderate potential GDE (BOM, 2019).
- > The pipeline would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011 and within Groundwater Vulnerable areas mapped in Junee LEP 2012.
- > There are numerous groundwater bore locations along Option 4 alignment. The eastern extent of the alignment in Nangus Village has a large number of bores within 50m of the alignment and the western extents will join the GWCC existing water mains. It is not expected that the pipeline would have any impact on the bores as the alignment could be set to avoid them.
- > According to the Australian Flood Study Database, there have been three studies conducted surrounding the Murrumbidgee River and surrounds. The studies include:
  - Gundagai Flood Scoping Study – 2013;
  - Oura to Braehour Flood Model Extension – 2011; and
  - Murrumbidgee River Flood Modelling

A thorough investigation into these studies will help shape future stages of the proposed development.

#### 8.7.3.4 Soil and Contamination

- > Soils present within the area are shown on the Soils figure in Appendix B.
- > Option 4 traverses multiple different soil classes including:
  - Rudosols and Tenosols
  - Kandosols
  - Kurosols
  - Rudosols (Aluvial)
- > Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEHL Contaminated Land Record and the Protection of the Environment Operation (POEO) Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai and 4 issued in Junee LGA. The listed locations of issued licences are not impacted by Option 4. There are no known contaminated sites listed on the OEHL Contaminated Land Register in the vicinity of Option 4. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.7.3.5 Socio-economic, Land Use and Zoning

- > The majority of Option 4 alignment is within land zoned RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).
- > This option traverses both Junee LGA and Cootamundra – Gundagai LGA.
- > The pipeline option traversed across private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10 km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during pipeline installation
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.7.3.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment or approved. The register was searched for Cootamundra - Gundagai LGA and Junee LGA. Three major projects were identified (the Adjungbilly Wind Farm, Sebastopol Solar and Young to Wagga Looping Pipeline), however the projects are not in close proximity to Option 4 and is therefore unlikely to generate cumulative impacts.

Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

Junee Council DA Tracking portal for Junee LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from October 2019 through to November 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.7.3.7 Summary of Environmental Constraints & Approval Pathway

##### Summary

The key environmental constraints related to pipeline Option 4 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final alignment during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis,

and given the proposed pipeline route could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

### **Initial approval pathway advice**

The project will need assessment under the EP&A Act. State Environmental Planning Policy (SEPPs) guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP), as the pipeline and associated ancillary structures is considered a “water reticulation system”. Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the pipeline project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent, and therefore it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act. Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of ‘significant impacts’ on the environment which could trigger the need for an EIS.

#### **8.7.4 Cost Estimate**

The estimated capital cost for Option 4 is \$3.04 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

#### **8.7.5 Multi-criteria Analysis and Risk Assessment**

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-13.

Table 8-13 Option 4 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	<ul style="list-style-type: none"> <li>It is assumed that GWCC's Oura water supply network will meet or exceed the 5/10/10 rule. Water is sourced from the Murrumbidgee Regulated Water Source, and has a high level of security.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	9	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the ADWG health requirements.</li> <li>Chlorine dosing facility to be provided at Nangus reservoir to maintain residual.</li> <li>Potential for chlorine residuals to fall between chlorine dosing at Nangus reservoir and Nangus, which would necessitate an additional chlorine dosing facility.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	<ul style="list-style-type: none"> <li>It is assumed that water supplied by GWCC's Oura water supply network will meet the majority of current ADWG aesthetic requirements.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	7	<ul style="list-style-type: none"> <li>Operation and maintenance of pipeline, PRV, reservoir and chemical dosing facility considered familiar to operators.</li> <li>Significant length of the pipeline will be located through steep farmland with potentially difficult access for maintenance.</li> <li>Access to reservoir and chlorine dosing facility will pose difficulties.</li> <li>In the event of a prolonged failure of the pipeline water may be carted from Gundagai or GWCC to the Nangus reservoir.</li> <li>Materials readily available and close by in case of repair.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	6	<ul style="list-style-type: none"> <li>A significant length of the pipeline is through steep, rocky terrain.</li> <li>Some constructability risk related to unknown geotechnical conditions.</li> <li>Mostly conventional construction methods – open trenching.</li> <li>No specialised materials.</li> <li>Many experienced contractors available for this type of work. Similar works are currently being undertaken at other locations across NSW.</li> <li>The ability to swiftly construct water pipelines similar to this project has been proven at other sites in NSW.</li> <li>Three creek crossings to be suspended from bridge or directional drilled.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	6	<ul style="list-style-type: none"> <li>Geotechnical conditions unknown. Rock is likely to be a risk in elevated terrain near Tenandra and the proposed Nangus reservoir.</li> <li>Geotechnical conditions for proposed directional drilling of Billabong Creek are not known.</li> <li>Ability to mount pipeline on bridge (proposed at one location) is not known. Directional drilling or open trenching are alternatives.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	8	<ul style="list-style-type: none"> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> </ul>

No.	Criteria	Weighting	Score	Discussion
				<ul style="list-style-type: none"> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> <li>Obtaining easements for installation of the pipeline within private property presents a possible project delivery risk. However, experience has shown that use of private property can avoid delays due to environmental approvals for installation in the road reserve. Significant portions of the pipeline are not close to road reserves, so diverting into the road reserve is not an option if there are issues with easements.</li> <li>Environmental approvals unlikely to significantly delay the project as careful route selection should allow avoidance of impacts.</li> </ul>
	<b>Total</b>	100%	8.1	

## 8.8 Option 5: Murrumbidgee River extraction and treatment

### 8.8.1 Description

For Option 5 raw water would be extracted from the Murrumbidgee River via a new water intake. The raw water would be pumped to a new WTP located near Nangus. The water would be treated in compliance with the ADWG and draft ADWG health based targets (HBTs) and discharged to a reservoir. From the reservoir, treated water would be pumped into the reticulation system for supply.

A map of Option 5 is shown in Figure 8-8. Note that this plan is indicative only, for the purposes of generally displaying the infrastructure required. Locations for the river intake and WTP have not undergone a site selection process.

### 8.8.2 Preliminary Design

A detailed analysis of the proposed surface water treatment option is in the Surface and Groundwater Treatment Options report in Appendix C. A schematic of the proposed process is shown in Figure 8-9. The system is proposed to comply with all requirements of the ADWG.

A new raw water intake and pump station would be constructed at the Murrumbidgee River to transfer water to the WTP. A typical surface water intake would comprise a wedgewire screen to prevent entry of coarse solids and to ensure that fish are protected. This would be surrounded by a reinforced concrete structure to protect the screen and channel floor. A pumping station on the shore would transfer the raw water to the treatment plant. It is noted that the actual configuration would need to be determined based on a detailed investigation of the river conditions and adjacent flood plain.

From the raw water pump station a DN100 pipeline would convey raw water to the WTP site.

It has been assumed that the raw water source is a vulnerability category 4 (unprotected) catchment under the draft ADWG HBTs. The water treatment process would involve the following major process components:

- > Powdered activated carbon (PAC) dosing for taste and odour control
- > pH correction
- > Oxidation for iron and manganese removal
- > Coagulation, flocculation and sedimentation
- > Membrane ultrafiltration
- > Ultraviolet disinfection
- > Chlorine dosing
- > Fluoridation
- > Sludge ponds for solids management

The production capacity of the WTP would be 400 kL/d, matching the peak demand from Nangus. The peak extraction from the Murrumbidgee River would be approximately 420 kL/d, allowing for 5% losses in waste streams.

A reservoir of approximately 250 kL storage volume is required, to provide for three days of average day demand, in line with GWCC requirements. It is proposed that this reservoir be constructed at ground level from concrete, and the reticulation network be supplied by pumps drawing from the reservoir. A standby generator would be provided for backup power to the pumps.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-8, matching the other options.

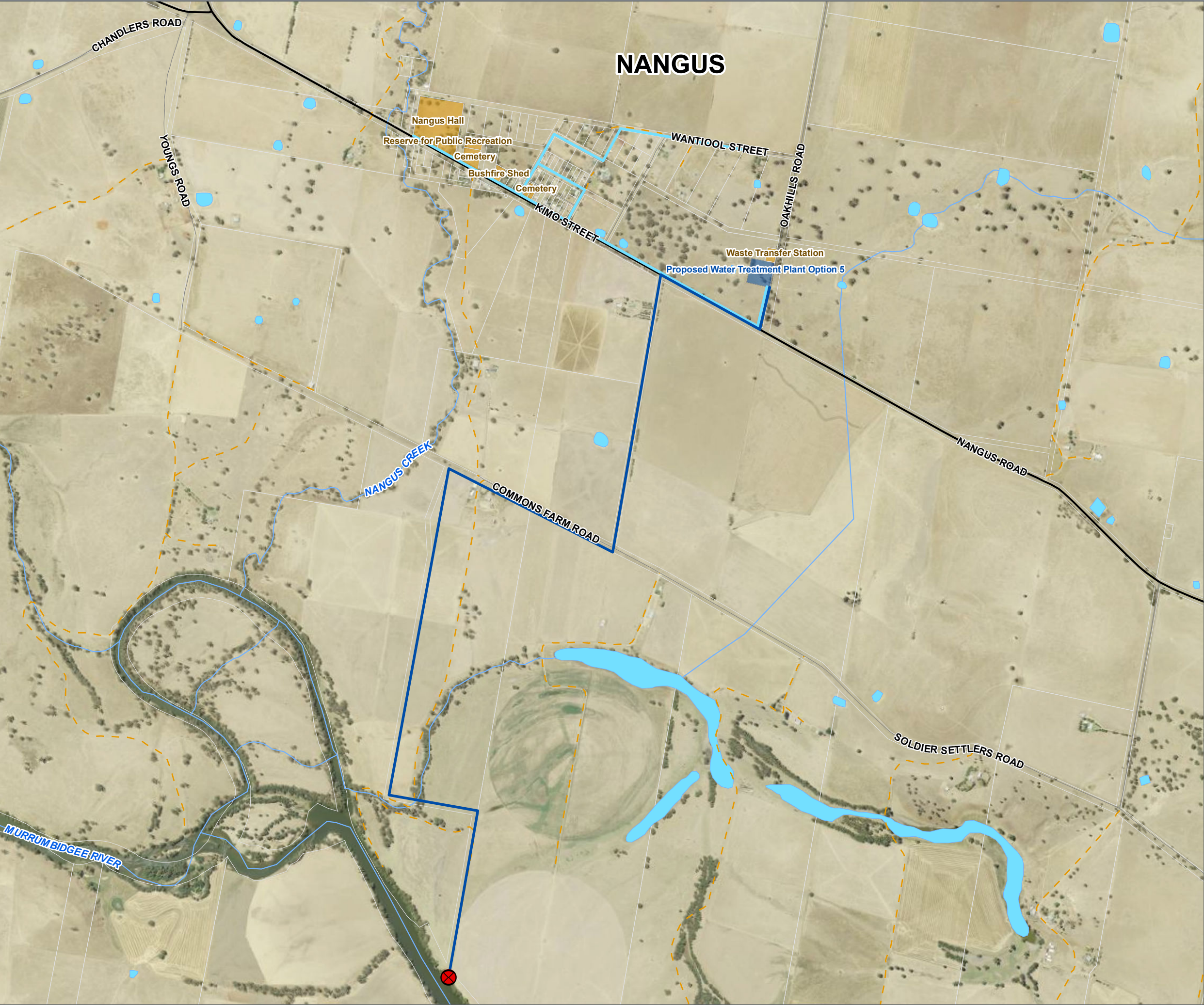


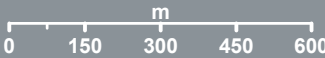
Figure 8.8  
Option 5 - River  
Extraction Plan

NANGUS, NSW

Legend

- Indicative River Intake and Pump Station
- Proposed Reticulation
- Proposed Raw Water Pipeline
- Major Road (LPI)
- Local Road (LPI)
- Vehicular Track (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSI-SS, 2017)
- CGRC Owned Lots
- Water Treatment Plant

1:15,000 Scale at A3



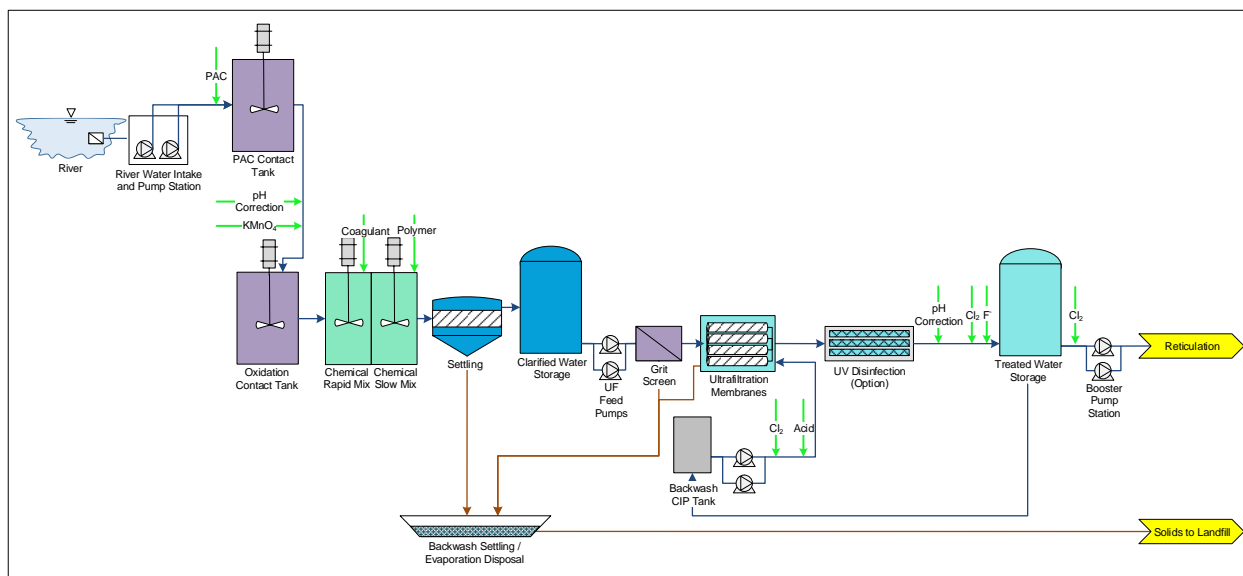


Figure 8-9 Option 5 – Water Treatment Process

### 8.8.3 Water Access Licence Implications

Option 5 involves extraction of water from the Murrumbidgee Regulated River Water Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee Regulated River Water Source 2016* (NSW Government, 2018). A specific purpose WAL in the 'Local Water Utility' category is required to extract water from the Murrumbidgee Regulated River Water Source for town water supply.

GWCC currently holds WAL6456 for extraction of 5,590 ML/y from the Murrumbidgee Regulated River Water Source for use in town water supply. Water extraction for GWCC's Jugiong WTP is carried out under this WAL.

CGRC currently holds WAL6455 for extraction of 1,250 ML/y from the Murrumbidgee Regulated River Water Source for use in town water supply. Water extraction for CGRC's Gundagai WTP is carried out under this WAL.

Both the above WALs do not specify a particular location for the water withdrawal, other than in the referenced works approvals, which specifically relate to the intake works at Jugiong and Gundagai respectively. Advice obtained from the Natural Resource Access Regulator (NRAR) indicates that it should be possible to use the allocations under either of these WALs for Nangus, provided that a new works approval can be obtained for an intake at Nangus, and attached to either WAL. A new works approval would be processed by NRAR, but linking of the works approval to the WAL would be approved via WaterNSW. Both organisations would need the concurrence of DPIE.

Alternatively, under the Water Sharing Plan, a new specific purpose WAL may be granted by the Minister responsible, provided "the Minister is satisfied that the share and extraction component of the access licence is the minimum required to meet the circumstances in which the access licence is proposed to be used". An application would need to be made to the NRAR for approval, and would require endorsement by DPIE. A new works approval for the intake would also be required from NRAR.

### 8.8.4 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 5 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts. This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.8.4.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the vegetation map in Appendix B and a brief description of the constraints is provided below:

- > The area is primarily dominated by non-native vegetation.
- > A small portion of the proposed alignment will have an impact on one native vegetation community – the River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland (known as PCT 5 - PCT 5 is not listed as a threatened ecological community under state or federal legislation.

Table 8-14 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name	Probable TEC Status
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 39 listed species under the BC Act recorded within the vicinity of the alignment.
- > A search of DPI – Key Fish Habitat) found that Option 5 directly extracts from the Murrumbidgee River which is listed as Key Fish Habitat.

##### Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 13 listed species under the *EPBC Act* found within the vicinity of the alignment.
- > A search of the PMST (DOEE, 2019) was undertaken on 25/11/2019. The following MNES have been identified within 10km of this option.
  - Four Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 5.
  - PMST results identified 28 threatened species and 11 migratory species within 10km of Option 5.
- > No federally listed TEC within the vicinity of this option.
- > According to the Gundagai LEP, Option 5 passes through land that is mapped as sensitive land on the Natural Resources Sensitivity Biodiversity Map.

##### Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 5 does not impact on any listed NPWS reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA. No Biobanking sites were located within the vicinity of this option.

#### 8.8.4.2 Heritage

##### 8.8.4.2.1 Historic Heritage

##### Local Heritage

There are two heritage items identified under the Gundagai LEP 2011 in proximity to the proposed option.

- > I20: War Memorial Nangus – located on the outskirts of the town of Nangus

- > I14 Nangus Station Group – located east of the option

Neither of these items will be impacted by the proposed option.

### State Heritage

There are no State Heritage Register listed heritage items within the vicinity of Option 5.

### Federal Heritage

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- > The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of Option 5.

#### 8.8.4.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 23 Aboriginal sites and 0 (zero) Aboriginal places within the vicinity of Option 5. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA.

#### 8.8.4.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > This option would draw water directly from the Murrumbidgee River and cross one associated drainage course as the alignment travels north towards Nangus Village. The Murrumbidgee River has been classed as a higher order watercourse (>8) under the Strahler stream order system. The alignment also crosses an unnamed drainage channel close to the Murrumbidgee (DPI Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017).
- > While works will be within 40m a watercourse, a controlled activity approval under the WM Act is not required as the works would be undertaken by a public authority.
- > The requirements for a Water Access Licence and Works Approval are discussed in Section 8.8.3.
- > Waterway crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Option 5 proposes to extract water directly from the Murrumbidgee River which is classed as high potential GDE (BOM, 2019).
- > This option would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011.
- > Option 5 does not impact on any existing bores in its proposed locations. It is not expected that the option would have any impact on existing bores as the locations of infrastructure could be set to avoid them.

#### 8.8.4.4 Soil and Contamination

- > Soils present within the area are shown on the soils figure in Appendix B.
- > Option 5 traverses two different soil classes including Kurosols and Rudosols (Aluvial)
- > Soil is not mapped as saline land (DPE, 2019).

A search of the OEH Contaminated Land Record and the POEO Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai. The listed locations of issued licences are not impacted by Option 5. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 5. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.8.4.5 Socio-economic, Land Use and Zoning

- > The majority of Option 5 is covered by RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).

- > The option traversed private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during construction.
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.8.4.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed, under assessment or approved (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects). The register was searched for Cootamundra - Gundagai LGA and 1 major project was identified (the Adjungbilly Wind Farm), however the project is not in close proximity to this option and is therefore unlikely to generate cumulative impacts.

The Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.8.4.7 Summary of Environmental Constraints & Approval Pathway

##### Summary

The key environmental constraints related to Option 5 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final infrastructure locations during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. This proposed option would be directly extracting water from the Murrumbidgee River, a key ecosystem for aquatic and terrestrial biodiversity. A detailed investigation into the Murrumbidgee River would be necessary to scope appropriate extraction points and alignment with the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes and budgets allocated could be substantially increased. From this high level desktop constraints analysis, the river extraction option could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

##### Initial approval pathway advice

The project will need assessment under the EP&A Act. SEPPs guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP). The pipelines and associated ancillary structures are considered a “water reticulation system”. Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent.

Under Clause 125(3A) of ISEPP, development for the purpose of water treatment facilities may be carried out by or on behalf of a public authority without consent on land in a prescribed zone. The proposed location of the Water Treatment Plant for Option 5 is on land in a prescribed zone and is therefore permissible without consent. Therefore, it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act.

Option 5 involves the extraction of water directly from the Murrumbidgee River. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee River Water Source 2016* (NSW Government, 2018). A specific purpose Water Access License (WAL) in the 'Local Water Utility' category is required to extract water from the Murrumbidgee River for town water supply. As discussed above in Section 9.3.6, there are multiple options to consider when it comes to accessing this WAL. Advice obtained by NRAR indicates that it should be possible to use allocations of existing WAL's in Nangus for Option 5. A new works approval would be processed by NRAR, but linking of the works approval to the WAL would be approved by WaterNSW.

Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage or water treatment facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and project footprint. The potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of 'significant impacts' on the environment which could trigger the need for an EIS.

#### **8.8.5 Cost Estimate**

The estimated capital cost for Option 5 is \$9.12 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

#### **8.8.6 Multi-criteria Analysis and Risk Assessment**

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-15.

Table 8-15 Option 5 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	10	<ul style="list-style-type: none"> <li>A high level of water security is provided from the Murrumbidgee River.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	9	<ul style="list-style-type: none"> <li>The proposed treatment system will meet the requirements of the ADWG and the draft HBTs.</li> <li>Potential risks in maintaining treatment performance at a small facility with low staffing level.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	9	<ul style="list-style-type: none"> <li>The proposed treatment system will meet the requirements of the ADWG.</li> <li>Potential risks in maintaining treatment performance at a small facility with low staffing level.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	6	<ul style="list-style-type: none"> <li>Risk of damage to intake structure and raw water pump station during flood conditions and from debris.</li> <li>Relatively complex WTP required due to water quality. Higher risk of operational failure than pipeline options.</li> <li>Moderate resourcing risk.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	6	<ul style="list-style-type: none"> <li>Work to install intake in Murrumbidgee River – high risk.</li> <li>Moderate risk related to procuring suitably qualified construction contractors that can meet program requirements. Construction delays have been observed in treatment plant construction in recent projects in NSW.</li> <li>Land acquisition delays are a potential risk.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	5	<ul style="list-style-type: none"> <li>Impacts of flooding unknown.</li> <li>Geotechnical conditions unknown.</li> <li>Unknown risks around site selection of intake location – site specific impacts, river morphology etc.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	6	<ul style="list-style-type: none"> <li>Potential direct impacts to the Murrumbidgee River to be investigated further.</li> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> <li>Environmental approvals unlikely to significantly delay the project as careful selection of the locations for infrastructure should allow avoidance of impacts.</li> <li>Several options existing for obtaining rights (WAL) to extract water from the Murrumbidgee River. However, risk remains around this approval.</li> <li>A new works approval will be required from NRAR for the river intake.</li> </ul>
	<b>Total</b>	100%	7.5	

## 8.9 Option 6: Groundwater extraction and treatment

### 8.9.1 Description

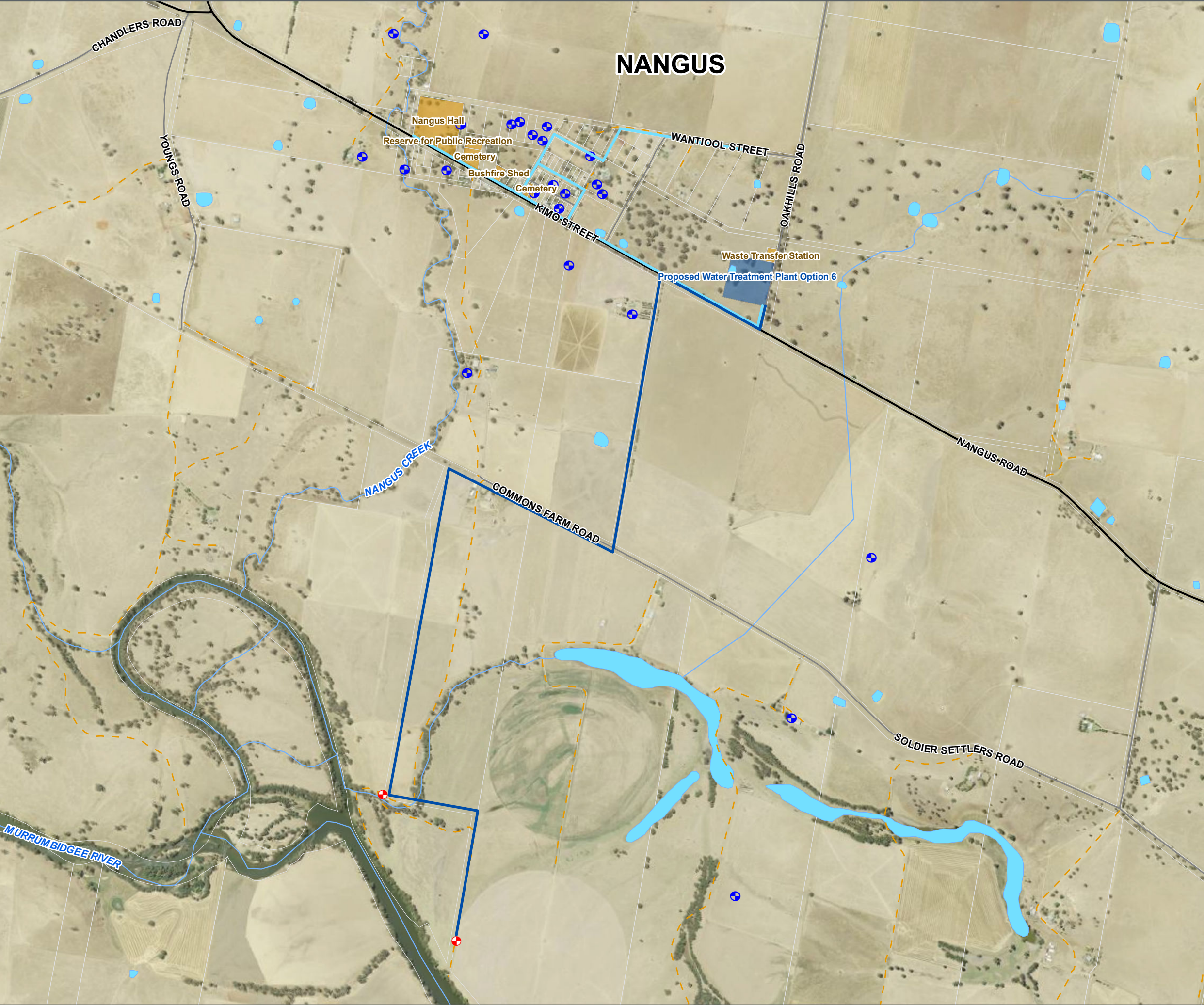
For Option 6 raw water would be taken from new groundwater bores. The raw water would be pumped to a new WTP located near Nangus. The water would be treated in compliance with the ADWG and draft ADWG health based targets (HBTs) and discharged to a reservoir. From the reservoir, treated water would be pumped into the reticulation system for supply.

A map of Option 6 is shown in Figure 8-10. Note that this plan is indicative only, for the purposes of generally displaying the infrastructure required. Locations for the bores and WTP have not undergone a site selection process.

### 8.9.2 Hydrogeological Study

Cardno has undertaken a Desktop Hydrogeological Review (see Appendix D) to investigate the viability of groundwater resources in the area around Nangus. The Gundagai Alluvial Groundwater Source underlies Nangus, and is controlled under the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016). The report concluded that:













- > Groundwater in the study area is likely be present in porous media alluvial aquifers or in fractured bedrock aquifers.
- > Groundwater in alluvial aquifers may occur at depths ranging from approximately 5 m to 19 m below ground surface, based on existing bores near the town of Nangus. Depth of groundwater in bedrock aquifers is not known at this stage.
- > Groundwater yields are reported to range from approximately 1 to 13 L/s in the alluvial aquifer in the study area, with an average yield of about 3 L/s. Bore yields are expected to be relatively high in the alluvial aquifers, but may not be sufficient for the peak daily requirement which is understood to be 4.6 L/s. Bore yield in the bedrock aquifers is expected to be variable, though generally lower.
- > Groundwater quality, with respect to salinity, is expected to be fair to unacceptable in alluvial aquifers (based on available data) and poor to unacceptable in bedrock aquifers (based on our experience of bedrock aquifers).
- > A total of 51 registered groundwater bores have been identified within the study area. Groundwater uses mostly include water supply and irrigation, with minor stock/ domestic and monitoring uses. Potential impacts on existing registered bores would need to be considered if town supply bores were to be installed in the study area.
- > It is considered that there is potential for suitable groundwater resources to exist in the study area. However, testing of bore yields and salinity is required to confirm this. Low yields may be addressed by using more than one bore for the groundwater supply. Poor groundwater quality can be addressed through the treatment of the groundwater prior to use as drinking water. Further, it is likely that groundwater salinity may be lower closer to the Murrumbidgee River, and groundwater investigations could target areas closer to the river.
- > Further investigation is required to confirm the potential yield and quality of groundwater available. This would involve exploratory drilling of one or more groundwater bores at selected locations in the alluvial aquifer in the study area, followed by pumping tests and water quality testing.



**Figure 8.10**  
**Option 6 - Groundwater**  
**Extraction Plan**

NANGUS, NSW

**Legend**

-  Existing Bore (BoM)
-  Indicative Bore Location
-  Proposed Reticulation
-  Proposed Raw Water Pipeline
-  Major Road (LPI)
-  Local Road (LPI)
-  Vehicular Track (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)
-  Cadastre (DFSI-SS, 2017)
-  CGRC Owned Lots
-  Water Treatment Plant

1:15,000 Scale at A3

0 150 300 450 600  
m



 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-12-06 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-022-GroundwaterExtractionPlan.mxd 01  
Aerial Imagery supplied by DFSI (2017)

### 8.9.3 Preliminary Design

New bores will be required to be constructed into the alluvial aquifer. We have assumed two bores will be required to provide sufficient yield and redundancy. Each bore would require a bore pump, surface well head protection to prevent contamination and backflow, and an electrical supply.

Bore locations have been indicatively shown near to the Murrumbidgee River, as salinity levels are expected increase with distance from the river (NSW DPI, 2016). The required bore depth is estimated to be around 25 m. There are also few existing bores near these locations that may be impacted.

From the bores, a DN100 raw water pipeline would convey the water to the WTP.

A detailed analysis of the proposed groundwater treatment option is in the Surface and Groundwater Treatment Options report in Appendix C. A schematic of the proposed process is shown on Figure 8-11. The system is proposed to comply with all requirements of the ADWG.

The Draft Chapter 5 Microbial Quality of Drinking Water (NHMRC, 2018) states that for groundwater a starting point for classification of the source is to “assume a groundwater resource is unprotected until objective, credible scientific evidence can conclusively demonstrate otherwise”. In the worst case, if information is not available, the aquifer should be considered to be the same category as the surface water that recharges the aquifer.

Based on evidence that existing bores in the locality are shallow, the recharge source is likely to be the Murrumbidgee River and surface rainfall/runoff. There is not yet any water quality monitoring of the particular source, therefore, a conservative approach needs to be taken. For these reasons the groundwater sources within the study area have been given a preliminary microbiological risk assessment of Category 4. With further assessment of an actual source it is possible that the result could be a Category 3 classification.

Based on available data for water quality in the aquifer, total the dissolved solids (TDS) are elevated, ranging from 800 - 4,200mg/L (estimate based on converting electrical conductivity measurements to TDS). According to the ADWG this degree of salinity would be poor to unacceptable quality, with TDS required to be below 600mg/L to be aesthetically acceptable. It is also common that groundwater in the region has elevated iron and manganese. Therefore, it is highly likely that a suitable groundwater treatment process will have to address iron, manganese and TDS.

The proposed water treatment process would involve the following major process components:

- > Iron and Manganese oxidation and filtration
- > Chlorine neutralisation
- > Reverse osmosis for TDS and pathogen removal
- > Recarbonation / pH Correction
- > UV for disinfection
- > Chlorine dosing for disinfection
- > Fluoridation
- > Brine storage and evaporation
- > Sludge ponds for solids management

The production capacity of the WTP would be 400 kL/d, matching the peak demand from Nangus. The peak extraction from the bores would be approximately 600 kL/d, allowing for losses in waste streams, in particular the brine from the reverse osmosis process.

A reservoir of approximately 250 kL storage volume is required, to provide for three days of average day demand, in line with GWCC requirements. It is proposed that this reservoir be constructed at ground level from concrete, and the reticulation network be supplied by pumps drawing from the reservoir. A standby generator would be provided for backup power to the pumps.

The reticulation system would consist of DN100 PVC-O, with the extents as shown on Figure 8-8, matching the other options.

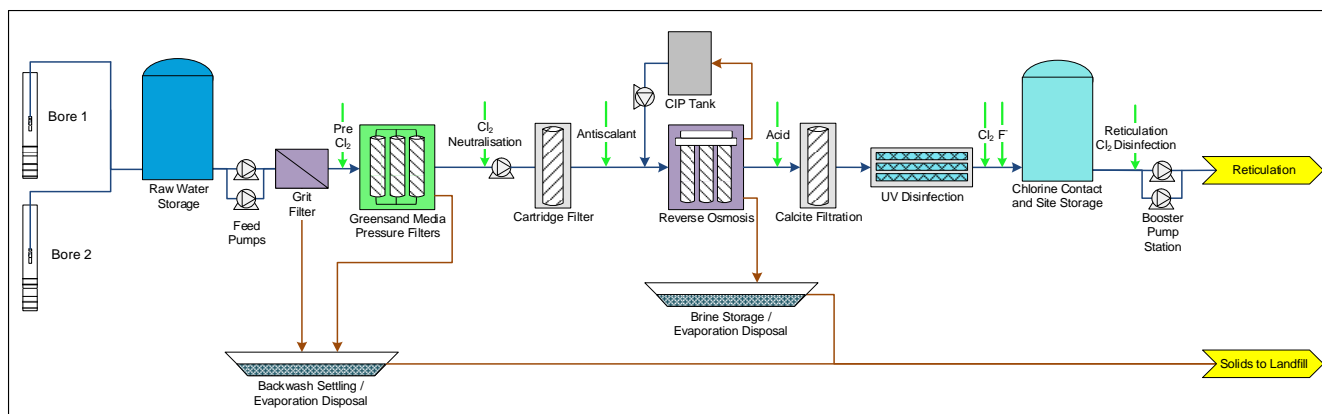


Figure 8-11 Option 6 – Water Treatment Process

### 8.9.4 Water Access Licence Implications

Option 6 involves extraction of water from the Gundagai Alluvial Groundwater Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012* (NSW Government, 2016).

GWCC currently holds WAL33469 for extraction of 6,000 ML/y from the Wagga Wagga Alluvial Groundwater Source for use in town water supply. This water feeds GWCC's Oura system. As the licence is for a different Source, it cannot be used for groundwater extraction at Nangus, and the water sharing rules for the Gundagai Alluvial Source prevent trading from other sources into this one. Further specific advice may be obtained from WaterNSW relating to water dealings that may allow transfer of a portion of the licence to the Gundagai Alluvial Source, however, these discussions will need to be undertaken directly between GWCC and WaterNSW.

A new WAL will likely be required under the Water Sharing Plan. The Minister responsible may grant a new specific purpose licence, provided "the Minister is satisfied that the share and extraction component of the access licence is the minimum required to meet the circumstances in which the access licence is proposed to be used". An application would need to be made to NRAR for approval, and would require endorsement by DPIE.

A water supply works approval will be required for construction and use of new bores to supply groundwater. The application would be made to NRAR and require the concurrence of DPIE. The Water Sharing Plan and Gundagai Alluvial Groundwater Source rules place a number of conditions on bore construction, including distance restrictions and construction standards. Distance restrictions are implemented to minimise interference between bores, and include:

- > 1,000 m from an aquifer access licence bore on another landholding.
- > 400 m from a basic landholder rights bore on another landholding.
- > 1,000 m from a local or major water utility access licence bore.
- > 1,000 m from a DPI Water monitoring bore.
- > 500 m from a property boundary.

It may not be possible to comply with the above rules (for example, the property boundary restriction, which would require the purchase of a large amount of land or consent of the adjacent landholders). However, these requirements may be waived by the Minister responsible provided it can be demonstrated "to the Minister's satisfaction that the location of the water supply work at a lesser distance will result in no more than minimal impact on existing extractions within these water sources". A hydrogeological study would be required to determine the impact on existing bores, and confirm the suitability of reduced distances.

### 8.9.5 Environmental Constraints

A desktop review has been undertaken using online resources to provide initial high level advice of the environmental constraints associated with Option 6 which includes biodiversity, heritage, major waterbodies and watercourses, socio-economic considerations, soils and contamination, cumulative impacts and land use and land zoning.

Key features are presented in Appendix B and the findings of the desktop review are discussed below. Database searches were conducted between 20 and 25 November 2019 and are considered accurate at the

time of writing. Most of the searches conducted present findings at a scale that does not allow for precise impact assessment, and the constraints would need to be confirmed on-site during future stages of the project in order to determine and either avoid and/or minimise potential impacts.

This is particularly the case for heritage items and threatened flora, fauna and vegetation communities where the records reported generally relate to those found within a 10 km search area and/or are recorded imprecisely in public databases.

#### 8.9.5.1 Biodiversity

##### NSW listed biodiversity constraints

The vegetation communities present in the area are mapped on the Vegetation map in Appendix B and a brief description of the constraints is provided below.

- > The area is primarily dominated by non-native vegetation
- > A small portion of the proposed alignment will have an impact on one native vegetation community. This PCT may be associated with a TEC protected under the BC Act. See below Table 8-16 for details.

Table 8-16 State listed vegetation communities and associated BC Act TECs

PCT - ID	PCT	Associated BC Act listed TEC name*	Probable TEC Status*
5	River Red Gum Herbaceous – Grassy Very Tall Open Forest Wetland	Not listed under the BC Act	NA

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 39 listed species under the BC Act were recorded within the vicinity of the alignment.

##### Federally listed biodiversity constraints

- > NSW BioNet Atlas (OEH, 2019c) – a search for threatened species, populations and ecological communities was undertaken on 25/11/2019 with 13 listed species under the *EPBC Act* within the vicinity of the alignment.
- > A search of PMST (DOEE, 2019) was undertaken on 25/11/2019. The following MNES have been identified within 10km of this option.
  - Four Wetlands of International Importance all of which are located approximately 400km – 800km downstream of Option 6 alignment.
  - PMST results identified 28 threatened species and 11 migratory species within 10 km of Option 6.
- > No federally listed TEC within this the vicinity of this option.
- > According to the Gundagai LEP, Option 6 alignment passes through land that is mapped as sensitive land on the Natural Resources Sensitivity Biodiversity Map.

##### Important conservation tenures

- > Areas of Outstanding Biodiversity Value (AOBV): AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. Areas of declared critical habitat under the TSC Act have become the first AOBVs in NSW with the commencement of the new BC Act. A search of the Critical habitat register NSW Office of Environment and Heritage (OEH, 2019a) was conducted on 22/11/2019 and no areas of critical habitat/AOBVs are located within proximity of this option.
- > Option 6 does not impact on any listed NPWS reserves and national parks.
- > A search of the Biobanking Public Register (NSW OEH, 2019) was used to search for Biobanking agreements, expressions of interest and statements within the Cootamundra - Gundagai LGA. No Biobanking sites were located within the vicinity of this option.

#### 8.9.5.2 Heritage

##### 8.9.5.2.1 Historic Heritage

##### Local Heritage

There are two heritage items identified under the Gundagai LEP 2011 in proximity to the proposed option.

- > I20: War Memorial Nangus – located on the outskirts of the town of Nangus
- > I14 Nangus Station Group – located east of the option

Both of the abovementioned locally listed heritage items will not be impacted by the proposed option (OEH, 2019).

### State Heritage

There are no State Heritage Register listed heritage items within proximity of Option 6.

### Federal Heritage

- > A search of the Australian Government's Australian Heritage Database (DoEE, 2019) identified 15 federally listed heritage items within the Cootamundra - Gundagai LGA.
- > The PMST search undertaken on 25/11/2019 found that no World Heritage Properties or National Heritage Places were identified within 10 km of the pipeline route.

#### 8.9.5.2.2 Aboriginal Heritage

A search of the AHIMS register (NSW OEH, 2019d) on 25/11/2019 identified 23 Aboriginal sites and 0 (zero) Aboriginal places within the locality of Option 6. The search does not identify the precise locations of the sites and Aboriginal heritage constraints would be subject to confirmation during future project stages.

A search of the Native Title Register and Native Title Claims Register (Native Title Tribunal, 2019) conducted on 25/11/2019 returned no records within the Cootamundra – Gundagai LGA.

#### 8.9.5.3 Hydrology, Water Quality and Groundwater

The hydrological, water quality and groundwater related features associated with this option are shown on the Hydrology figure in Appendix B.

- > This option would draw water from indicative bore locations south of Nangus village. The bore locations are indicative and proposed shown in Appendix B. A more detailed investigation would be necessary to determine their exact locations during future stages of this project.
- > Option 6 only crosses one drainage stream which has been classified as a minor waterway and a class of 3 under the Strahler stream order system. The southern extent of the alignment and final indicative bore location come within 200 m of the Murrumbidgee River which has been given a higher order classification (DPI Water, 2017).
- > The Murrumbidgee River is mapped as Key Fish Habitat (DPI Water, 2017). An indicative bore location crosses over a drainage watercourse which is directly associated with the Murrumbidgee River.
- > While works will be within 40 m of these watercourses, a controlled activity approval under the WM Act is not required as the works would be undertaken by a public authority.
- > The requirements for a Water Access Licence and Works Approval are discussed in Section 9.7.4.
- > Creek crossings would need to be designed to be sensitive to the biodiversity values present at site.
- > Groundwater Dependent Ecosystems (GDE) are aquatic and terrestrial ecosystems which are sustained, to a degree, by groundwater. Option 6 does not directly impact on GDE's, however, the proposed alignment does cross a drainage channel which is directly associated with the Murrumbidgee River which has been classified as having high potential GDE (BOM, 2019).
- > This option would cross areas mapped as 'sensitive land' according to Gundagai LEP 2011.
- > Option 6 does not impact on any existing bores in its proposed locations. It is not expected that the option would have any impact on existing bores as the locations of infrastructure could be set to avoid them.
- > Option 6 involves the extraction of water from the Gundagai Alluvial Groundwater Source.

#### 8.9.5.4 Soil and Contamination

- > Soils present within the area are shown on the Soils figure in Appendix B.
- > Option 6 traverses multiple different soil classes including:
  - Kurosols

- Rudosols (Aluvial)

> Soil is not mapped as saline land in the DPE (2019) mapping.

A search of the OEH Contaminated Land Record and the POEO Act Public Register of Licences was undertaken on 24/11/2019. The search highlighted 22 locations where a POEO License has been issued in the LGA of Cootamundra - Gundagai. The listed locations of issued licences are not impacted by Option 6. There are no known contaminated sites listed on the OEH Contaminated Land Register in the vicinity of Option 6. All of these locations are outside of Option 6 alignment. There were no sites listed that were relevant to this option. There are no locations of contaminated lands according to OEH, 2019. This does not mean there is no contaminated land on site as not all contaminated areas have been recorded and constraints would need to be confirmed in future project stages.

#### 8.9.5.5 Socio-economic, Land Use and Zoning

- > The majority of Option 6 is covered by RU1 – Primary Production land zoning. As the alignment enters the township of Nangus the zoning changes to RU5 – Village (see the land use and zoning map in Appendix B).
- > The option traverses across private properties in multiple locations.
- > The PMST search identified 1 potential area of Commonwealth Land protected under the EPBC Act within 10 km of this option. The precise location of this land parcel will need to be confirmed in future investigations with impacts to these areas avoided and/or minimised where possible. If the project is likely to have a significant impact on Commonwealth land it may require referral to DoEE under the EPBC Act.
- > Socio-economic considerations relevant to this option include:
  - Potential adverse impacts on private properties during construction.
  - Positive impacts associated with securing a water supply for Nangus.

#### 8.9.5.6 Cumulative Impacts

The potential for cumulative impacts was considered through review of the Major Projects Register which identifies major projects proposed (including State Significant Development (SSD) and State Significant Infrastructure (SSI) projects) either under assessment or approved. The register was searched for Cootamundra - Gundagai LGA. One major project was identified (the Adjungbilly Wind Farm), however the project is not in close proximity to this option and is therefore unlikely to generate cumulative impacts.

The Cootamundra – Gundagai Regional Council DA Tracking portal for Cootamundra - Gundagai LGA was accessed on 25 November 2019 to check for any development that may impact on the proposed pipeline option. The search included results from January 2019 through to June 2019 and concluded that there are no relevant DA Applications that will have an influence on the proposed project.

It is noted that this search was not comprehensive and local developments should be checked as part of future project stages.

#### 8.9.5.7 Summary of Environmental Constraints & Approval Pathway

##### Summary

The key environmental constraints related to Option 6 are the biodiversity and heritage constraints identified above. A more detailed assessment of the final infrastructure locations during future stages of the development will allow for avoidance or minimisation of potential impacts identified above. This proposed option would be directly extracting groundwater from the Gundagai Alluvial Groundwater Source. Further investigation would be necessary to determine appropriate bore locations and extraction would need to be within the limits specified in the *Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012*. Impacts on other matters can generally be managed through careful construction management processes developed at future construction stages of development. Impacts to private property will also need to be minimised where possible with appropriate consultation with interested stakeholders and impacted community members where necessary.

The location and extent of all constraints, but in particular the biodiversity and heritage constraints, will need to be confirmed in future stages of the project through on-ground surveys and research. Significant impacts to biodiversity can trigger the need for an Environmental Impact Statement (EIS) under Part 5, Division 5.1, Subdivision 3 of the EP&A Act. Significant impacts to Commonwealth listed threatened entities or Commonwealth land can trigger the need for a referral to the Federal Government and assessment under the EPBC Act. If an EIS becomes necessary due to unavoidable impacts, the project approval timeframes

and budgets allocated could be substantially increased. From this high level desktop constraints analysis, the groundwater extraction option could be developed to avoid or minimise such impacts, it is considered unlikely that the proposed alignment would have a significant impact on biodiversity and/or Commonwealth matters. This would need to be confirmed during future stages of the project as the constraints analysis is high level and the design is at a preliminary stage.

### Initial approval pathway advice

The project will need assessment under the EP&A Act. SEPPs guide the approval pathways under the EP&A Act.

The initial approval pathway will be assessed under the State Environmental Planning Policy (Infrastructure) 2001 (ISEPP). The pipelines and associated ancillary structures are considered a “water reticulation system”. Under Clause 125(1) of ISEPP, development for the purpose of a water reticulation system (including reservoirs) may be carried out by or on behalf of a public authority without consent on any land. As the project would be undertaken by GWCC or CGRC (both public authorities) the proposal would be permissible without consent.

Under Clause 125(3A) of ISEPP, development for the purpose of water treatment facilities may be carried out by or on behalf of a public authority without consent on land in a prescribed zone. The proposed location of the Water Treatment Plant for Option 6 is on land in a prescribed zone and is therefore permissible without consent. Under Clause 125(5) of ISEPP, a reference to development for the purpose of water supply system of any kind includes a reference to development for a number of purposes including groundwater investigation works, groundwater bore stations, borefields, minewater works and the like. The definition of a ‘water supply system’ includes a water reticulation system which is what has been proposed in this option. Therefore, it is currently anticipated that the applicable approval pathway is via a Review of Environmental Factors under Part 5 of the EP&A Act.

Option 6 involves the extraction of water directly from the Gundagai Alluvial Groundwater Source. This activity is controlled under the *Water Sharing Plan for the Murrumbidgee River Water Source 2016* (NSW Government, 2018). A new Water Access Licence would be required for the extraction under the Water Sharing Plan, as discussed in Section 9.7.4 above. An application would need to be made to the NRAR for approval, and would require endorsement by DPIE.

Clause 14(1) of the State and Regional Development SEPP states that development for the purpose of water storage or water treatment facilities that has a capital investment value of more than \$30 million would be subject to a more intense approvals pathway which may trigger the need for an Environmental Impact Statement.

The approval pathway will need to be confirmed and will be dependent on confirmation of pipeline alignment and potential impacts which will be confirmed at later stages of the project. This will involve specialist studies and on-ground surveys to confirm environmental constraints, confirmation of land use and applicability of Part 5 provisions, confirmation of capital investment value and consideration of ‘significant impacts’ on the environment which could trigger the need for an EIS.

### 8.9.6 Cost Estimate

The estimated capital cost for Option 6 is \$8.76 million, excluding GST. A detailed breakdown of this estimate is provided in Appendix E. See Section 5.1 for a description of the inclusions and methodology for cost estimates.

### 8.9.7 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1) and a discussion on the risks related to each parameter are given in Table 8-17.

Table 8-17 Option 6 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	6	<ul style="list-style-type: none"> <li>Yield and security of the aquifer are currently unknown. Aquifer relies on recharge from the Murrumbidgee River and local rainfall/runoff.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	10	<ul style="list-style-type: none"> <li>The proposed treatment system will meet the requirements of the ADWG and the draft HBTs.</li> <li>Potential risks in maintaining treatment performance at a small facility with low staffing level.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	10	<ul style="list-style-type: none"> <li>The proposed treatment system will meet the requirements of the ADWG.</li> <li>Potential risks in maintaining treatment performance at a small facility with low staffing level.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	3	<ul style="list-style-type: none"> <li>Risk of damage to bores located near the Murrumbidgee River during flood conditions.</li> <li>Complex WTP (reverse osmosis) required due to water quality. Higher risk of operational failure than pipeline options.</li> <li>Potential for groundwater extraction to impact water level in existing bores.</li> <li>Resourcing risk for obtaining suitably qualified staff to operate a reverse osmosis plant.</li> <li>Brine management will remain an ongoing risk: <ul style="list-style-type: none"> <li>Potential for leakage or breach of containment.</li> <li>Alternative disposal routes will be required for emergency conditions.</li> </ul> </li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	5	<ul style="list-style-type: none"> <li>Risk of finding suitable groundwater resources in terms of yield and quality.</li> <li>Moderate risk related to procuring suitably qualified construction contractors that can meet program requirements. Construction delays have been observed in treatment plant construction in recent projects in NSW.</li> <li>Land acquisition delays are a potential risk.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	3	<ul style="list-style-type: none"> <li>Additional site investigations (exploratory drilling) to confirm the viability of the groundwater source in terms of yield and quality.</li> <li>Impacts of flooding unknown.</li> <li>Geotechnical conditions unknown.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	7	<ul style="list-style-type: none"> <li>Potential direct impacts to the Gundagai Alluvial Groundwater Source to be investigated further.</li> <li>Avoidance of impacts to known state and federally listed TEC's and threatened species is likely to be possible.</li> <li>Waterway crossings will need to be sensitively designed to have minimal impact on the waterways.</li> <li>Impacts to indigenous heritage and a more accurate and verified survey of the land is needed for future project development.</li> <li>A new WAL will be required for extraction of groundwater. Risk remains around this approval.</li> <li>A new works approval will be required from NRAR for construction of bores.</li> </ul>
	<b>Total</b>	100%	6.0	

## 8.10 Option 7: Do nothing

### 8.10.1 Description

For the 'do nothing' option, the current situation is maintained. No reticulated water is supplied to Nangus, and residents will continue to make their own water supply arrangements, as described in Section 2.

### 8.10.2 Hazards Related to Rainwater and Groundwater Supplies

The hazards related to the existing use of rainwater tanks and groundwater for water supply are outlined below.

#### 8.10.2.1 Rainwater Tanks

NSW Health (<https://www.health.nsw.gov.au/environment/water/Pages/rainwater.aspx>) and enHealth (2011) provide guidance on the use of rainwater tanks for drinking water supply to individual households.

In NSW around 7.3% of households use rainwater tanks as the main source of drinking water. Rainwater collected from roof catchments is generally considered safe to drink, and the risk of illness is considered low provided that the roof, gutters, tank, piping and surrounds (i.e. overhanging trees) are properly maintained. However, maintenance is generally observed to be poor. Proper maintenance is essential to ensure the supply remains safe to drink.

The greatest risk to human health comes from microbiological pathogens which may be present. Pathogens may come from two primary sources:

- > Faecal matter from birds, lizards, mice, rats possums and other animals.
- > Dead insects and other animals in gutters or in the tank.

Thermotolerant coliforms and *E. coli* are commonly identified in domestic rainwater tanks, which implies enteric (intestinal) pathogens may often be present. However, research involving testing for individual pathogens has generally shown low levels of detection.

Studies of gastrointestinal illness rates for people drinking from rainwater tanks vs. drinking from a supply complying with the ADWG have found little evidence for increased illness rates. This may be partly due to acquired immunity to pathogens in people that drink rainwater.

Rainwater can present a higher risk to immunologically compromised people.

Chemical hazards in rainwater can generally come from:

- > Off-site sources, such as pesticides, industrial emissions, traffic emissions and windblown particulate.
- > On-site sources such as materials used in roof, gutter and tank construction

Proper maintenance is key to reducing the potential for chemical hazards to exist in the supply. For example, sediments that collect in the base of rainwater tanks can contain significant concentrations of chemicals, including lead, and sediment removal is required to manage these risks.

#### 8.10.2.2 Groundwater

It is understood that some residents may use bore water for drinking. The level of treatment of this water, if any, that individual residents undertake is not known.

The aquifer underlying Nangus is shallow and unconfined (see Appendix D). Shallow aquifers are at greater risk of pathogen contamination from septic tanks and animal wastes, as well as chemical contamination from agricultural runoff and other sources. Available data on the local aquifer also shows that the water may have higher levels of salinity, reducing its palatability (see Appendix D).

NSW Health recommends that groundwater sources undergo testing to determine its microbiological and chemical quality and its suitability to be used as a drinking water source. enHealth (2011) recommends that groundwater from shallow aquifers should not be used as a drinking water source unless it has been recently tested for microbial and chemical quality (e.g. arsenic, nitrate, fluoride, health-related heavy metals, petroleum hydrocarbons and other organic chemicals).

### 8.10.3 Multi-criteria Analysis and Risk Assessment

MCA scoring (as per the template in Table 5-1), and a discussion on the risks related to each parameter are given in Table 8-18.

Table 8-18 Option 7 – Multi-Criteria Analysis

No.	Criteria	Weighting	Score	Discussion
1	<b>Security of Supply</b> Consider the security of the water supply and the impact/risks of prolonged drought.	20%	0	<ul style="list-style-type: none"> <li>No improvement in security of supply.</li> <li>Potential that security of supply for resident's rainwater tanks would decrease over time due to the impact of climate change.</li> </ul>
2	<b>Water Quality - Health</b> Consider the reliability and risks to water quality with regard to health criteria.	15%	0	<ul style="list-style-type: none"> <li>Continued use of rainwater tanks and, in particular, groundwater from the shallow aquifer presents a higher risk to health than from a reticulated supply which will meet the requirements of the ADWG.</li> </ul>
3	<b>Water Quality - Aesthetic</b> Consider the reliability and risks to water quality with regard to asthenic criteria.	10%	0	<ul style="list-style-type: none"> <li>Improperly maintained rainwater systems can result in aesthetic issues.</li> <li>Groundwater supplies may have lower palatability due to high salinity levels.</li> </ul>
4	<b>Operational Risk</b> Consider the consequence of failure with regards to operator safety, community safety, scheme complexity, time needed to reinstate supply and resourcing risk.	15%	10	<ul style="list-style-type: none"> <li>No operational risk as no water supply system is installed.</li> </ul>
5	<b>Constructability</b> Consider the ability to construct each option, including safety, availability of materials, availability of suitably qualified contractors, ground conditions, impact on existing services, access etc.	15%	10	<ul style="list-style-type: none"> <li>No constructability risks as no works are proposed.</li> </ul>
6	<b>Project Definition Risk</b> Consider risk associated with level of definition and potential for currently unknown issues to impact schedule and budget.	10%	10	<ul style="list-style-type: none"> <li>No project definition risks as no works are proposed.</li> </ul>
7	<b>Heritage, Environment and Approvals</b> Consider environmental and heritage impacts and risks and the risk associated with obtaining approvals.	15%	10	<ul style="list-style-type: none"> <li>No heritage, environment or approvals risks as no works are proposed.</li> </ul>
	<b>Total</b>	100%	5.5	

## 9 Conclusions and Recommendations

Nangus does not currently have a reticulated water supply, and residents provide their own water supply, typically from roof water, bottled water, bore water or water carting. Seven options for provision of potable water services to Nangus were investigated, including:

- > Option 1: Pipeline from Gundagai water supply
- > Option 2: Pipeline from GWCC water supply – from Oura Road
- > Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement
- > Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route
- > Option 5: Murrumbidgee River extraction and treatment
- > Option 6: Groundwater extraction and treatment
- > Option 7: Do nothing

These options were assessed and compared based on capital cost and a multi-criteria analysis. Estimated capital costs are provided in Table 9-1 and a summary of the MCA scoring is provided in Table 9-2.

Pipeline Options 2, 3 and 4 have similar capital costs, within the level of accuracy of a feasibility assessment. Pipeline Option 1 is significantly more expensive, largely due to the additional length of the pipeline. Options 5 and 6, involving surface and groundwater treatment respectively, are significantly more expensive than any of the pipeline options.

Option 2 scored highest in the MCA. This pipeline option scored higher than the other pipelines mostly due to lower construction risks, lower operational risk and the higher level of project definition that is possible at this stage of the project development.

Pipeline options 1, 2 and 4 scored higher than the surface and groundwater treatment options. Option 7 (do nothing) scored lowest in the MCA.

At the current stage of project development, Option 2 is the preferred option.

It is noted that significant capital outlay will be required to service Nangus. This options analysis is based on a supply for 100 ET. The current number of potential water supply connections is 33 (including occupied dwellings and non-residential developments), with approximately 36 vacant lots in the village. The financial viability of servicing Nangus has not yet been assessed. When financial analysis is carried out in later stages of project development, consideration should be given to the risks related to population projections and sensitivity to different growth rates in the short, medium and long term, as this may impact the financial viability of the project.

Table 9-1 Capital Cost Summary

Option	Estimated Capital Cost (ex. GST)
Option 1: Pipeline from Gundagai water supply	\$4,590,000
Option 2: Pipeline from GWCC water supply – from Oura Road	\$3,260,000
Option 3: Pipeline from GWCC water supply – from Tenandra Reservoirs following existing easement	\$3,070,000
Option 4: Pipeline from GWCC water supply – from Tenandra Reservoirs following new route	\$3,040,000
Option 5: Murrumbidgee River extraction and treatment	\$9,120,000
Option 6: Groundwater extraction and treatment	\$8,760,000
Option 7: Do nothing	\$0

Table 9-2 Multi-criteria Analysis Summary

Criteria	Weighting	Option						
		1	2	3	4	5	6	7
Security of Supply	20%	10	10	10	10	10	6	0
Water Quality - Health	15%	8	9	9	9	9	9	0
Water Quality - Aesthetic	10%	10	10	10	10	9	9	0
Operational Risk	15%	7	9	7	7	6	3	10
Constructability	15%	7	9	5	6	6	5	10
Project Definition Risk	10%	7	9	6	6	5	3	10
Heritage, Environment and Approvals	15%	7	8	5	8	6	7	10
Total MCA Score	100%	8.1	9.2	7.5	8.1	7.5	6.0	5.5

## 10 References

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- Atom Consulting (2017) *Goldenfields Water Drinking Water Management System*
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<https://www.health.nsw.gov.au/environment/water/Pages/Groundwater.aspx>
- WSAA (2011) *WSA03-2011: Water Supply Code of Australia*, Third Edition, Version 3.1
- WSAA (2015) *WSA202-2015-1.2 Manual for the Application of Health-Based Targets for Drinking Water Safety*

APPENDIX

A

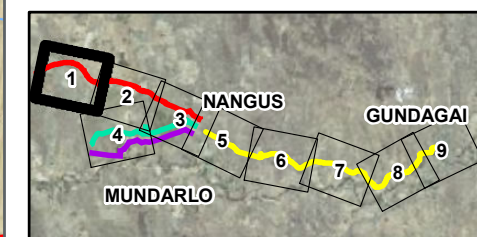
PIPELINE OPTION ROUTE MAPS

## Pipeline Options Page 1

NANGUS, NSW

### Legend

- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- GWCC Existing Water Mains
- 10m Contours (LPI)
- Major Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFS-I-SS, 2017)



1:15,000 Scale at A3

0 150 300 450 600  
m



 Cardno

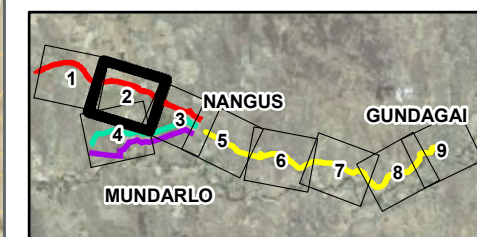
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-20 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Pipeline Options Page 2

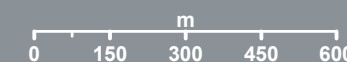
NANGUS, NSW

### Legend

- Reservoir Option 2
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- 10m Contours (LPI)
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSI-SS, 2017)



1:15,000 Scale at A3

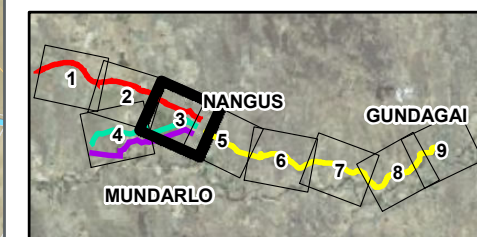


 **Cardno**

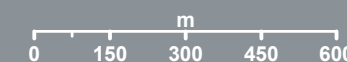
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-20 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Legend

- Reservoir Option 2
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Reticulation
- 10m Contours (LPI)
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DfSI-SS, 2017)

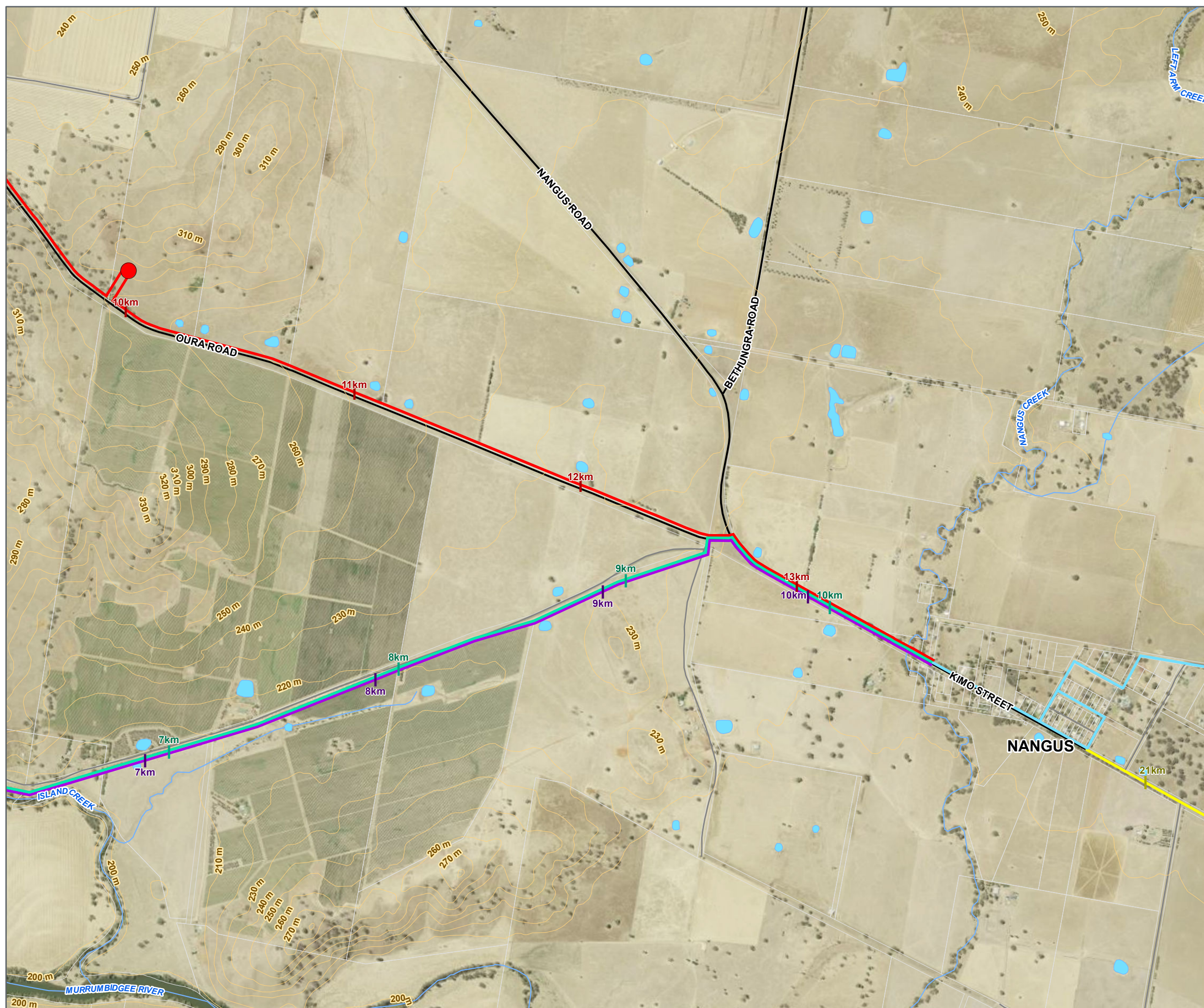


1:15,000 Scale at A3















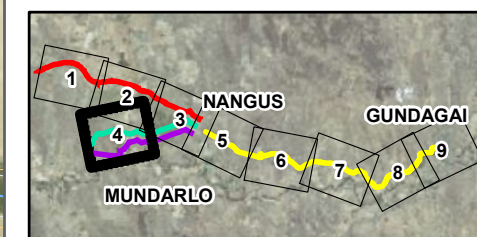
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Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
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Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DfSI (2017)

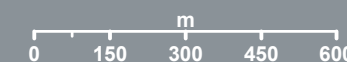


## Legend

-  Reservoir Options 3 and 4
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  GWCC Existing Water Mains
-  10m Contours (LPI)
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)
-  Cadastre (DFSI-SS, 2017)



1:15,000 Scale at A3



 **Cardno**

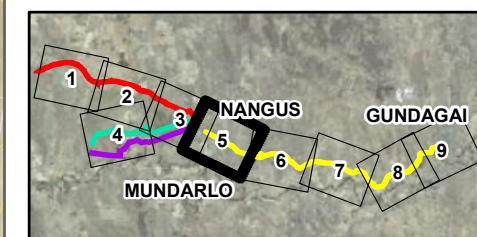
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Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Pipeline Options Page 5

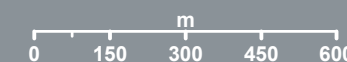
NANGUS, NSW

### Legend

- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Reticulation
- 10m Contours (LPI)
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSIS-SS, 2017)



1:15,000 Scale at A3














 Cardno

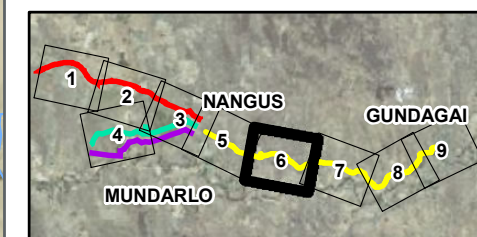
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Date: 2019-11-20 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Pipeline Options Page 6

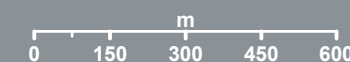
NANGUS, NSW

### Legend

-  Reservoir Option 1
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  10m Contours (LPI)
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)
-  Cadastre (DfSI-SS, 2017)



1:15,000 Scale at A3














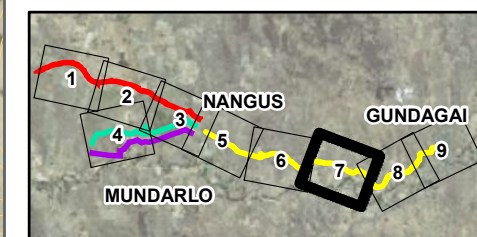
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Aerial Imagery supplied by DfSI (2017)

## Pipeline Options Page 7

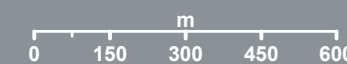
NANGUS, NSW

### Legend

-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  10m Contours (LPI)
-  Major Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)
-  Cadastre (DfSI-SS, 2017)

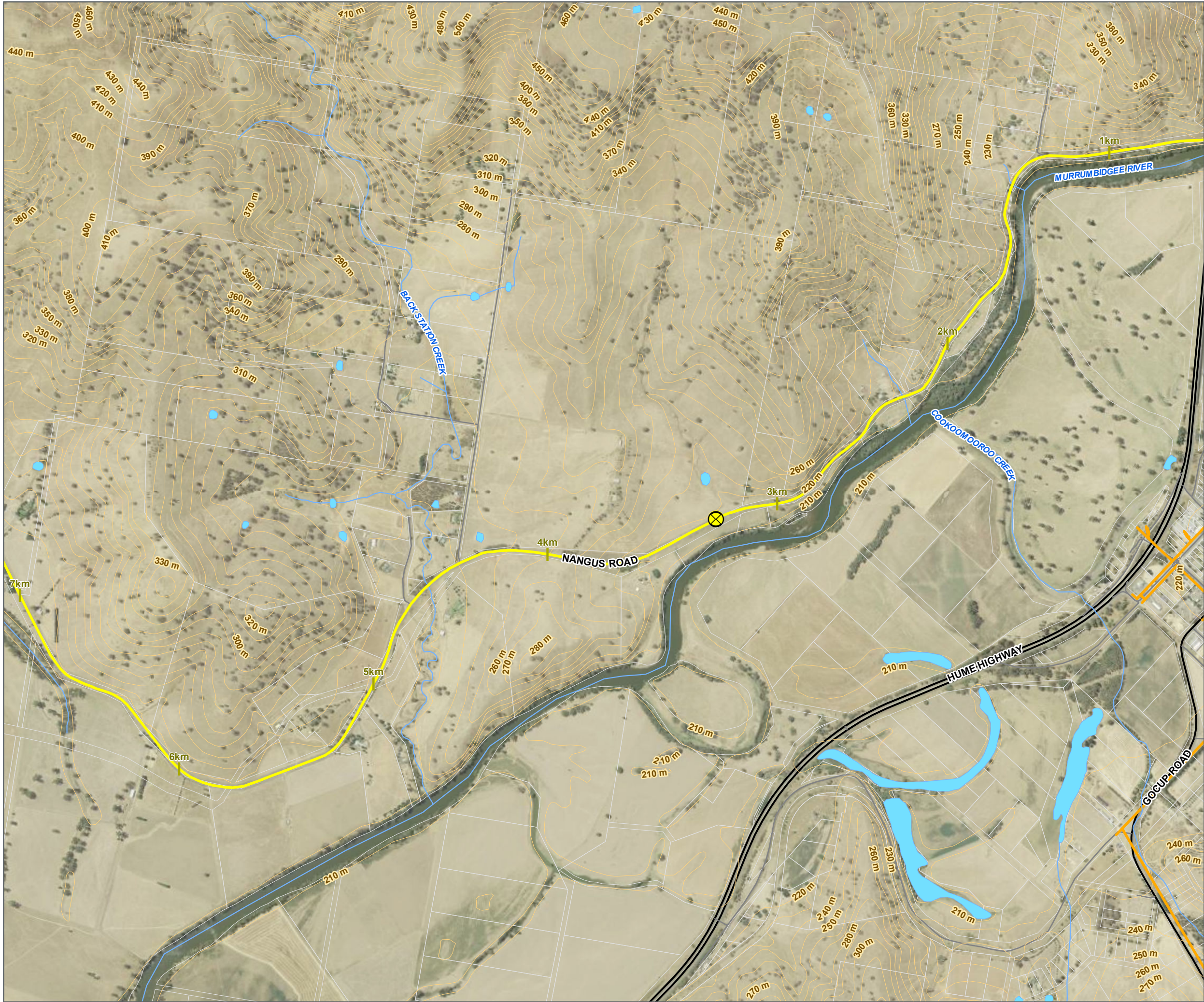


1:15,000 Scale at A3















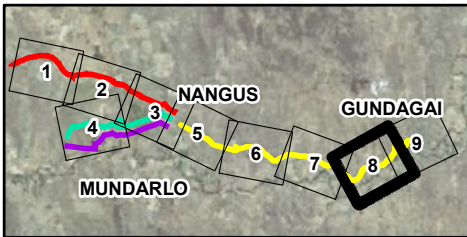
 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-20 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DfSI (2017)



Legend

-  Booster Pump Station (Option 1)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  10m Contours (LPI)
-  CGRC Existing Water Mains
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)
-  Cadastre (DFSI-SS, 2017)



1:15,000 Scale at A3



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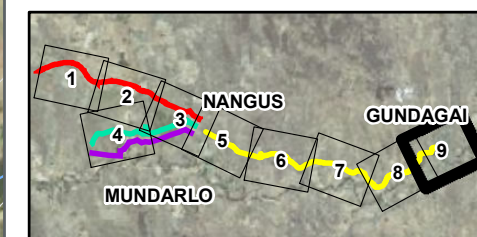
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Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Pipeline Options Page 9

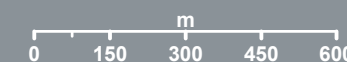
NANGUS, NSW

### Legend

- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- 10m Contours (LPI)
- CGRC Existing Water Mains
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)
- Cadastre (DFSI-SS, 2017)



1:15,000 Scale at A3



 **Cardno**

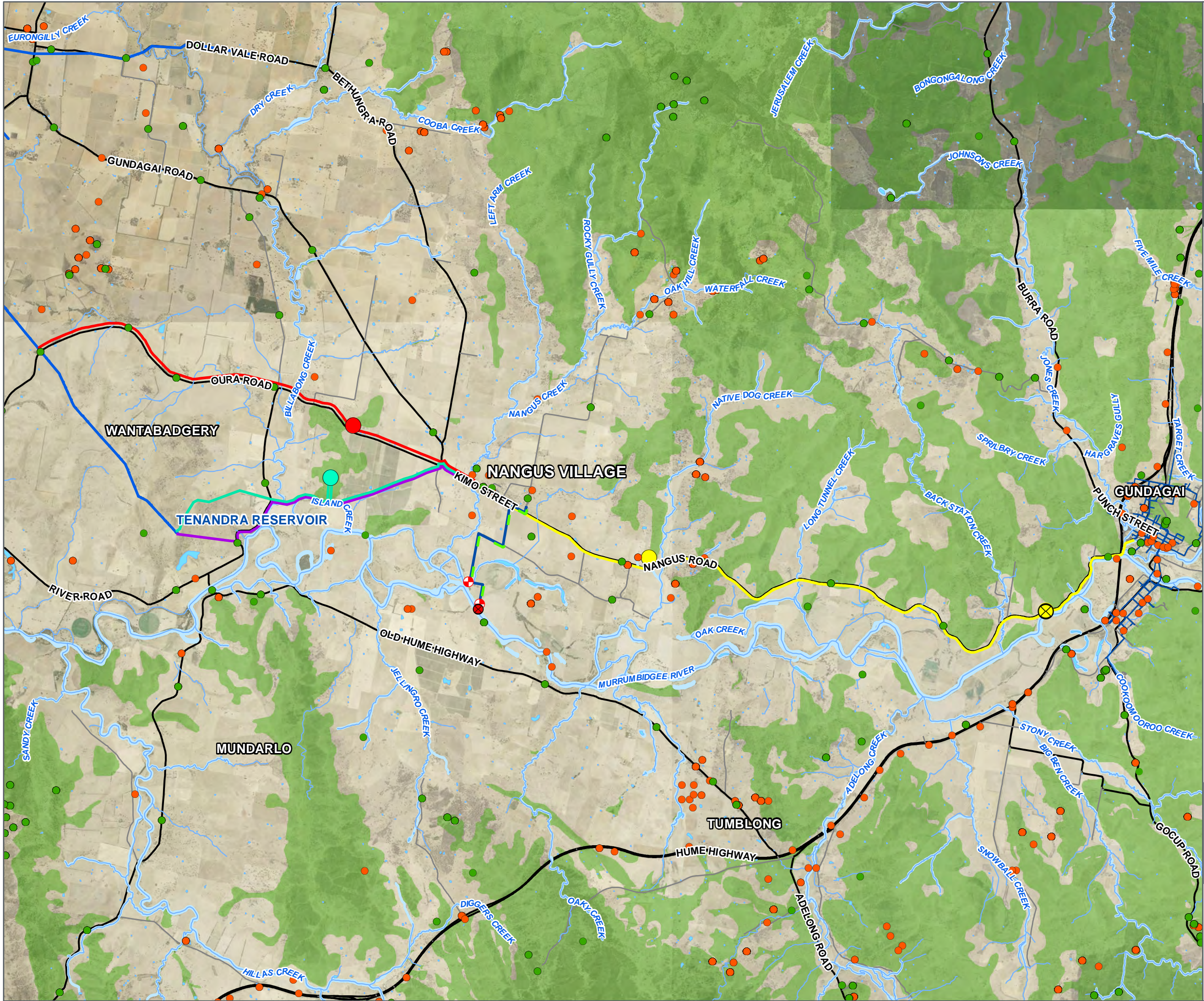
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Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-020-PipelineOptionsDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)



APPENDIX

# B

ENVIRONMENTAL CONSTRAINTS



Biodiversity

NANGUS, NSW

Legend

- Fauna Sightings (Bionet, 2019)
- Flora Sightings (Bionet, 2019)
- Indicative River Intake and Pump Station Option 5
- ✕ Indicative Bore Location Option 6
- ✕ Booster Pump Station (Option 1)
- Reservoir Option 1
- Reservoir Option 2
- Reservoir Options 3 and 4
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Raw Water Pipeline Option 5
- Proposed Raw Water Pipeline Option 6
- GWCC Existing Water Mains
- CGRC Existing Water Mains
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Key Fish Habitat (DPI Water, 2017)
- Terrestrial Biodiversity (DPE, 2019)
- Waterbodies (LPI)











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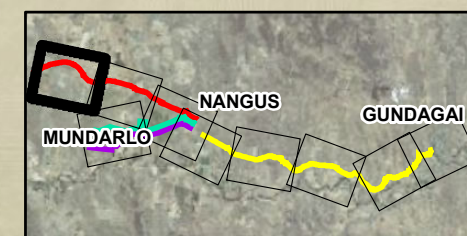
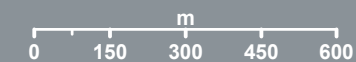
## Biodiversity Page 1

NANGUS, NSW

### Legend

-  Fauna Sightings (Bionet, 2019)
-  Flora Sightings (Bionet, 2019)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  GWCC Existing Water Mains
-  Major Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)

1:15,000 Scale at A3



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

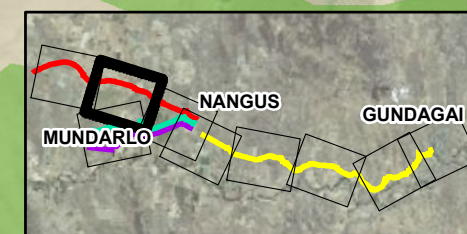
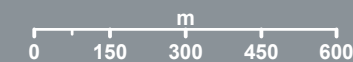
## Biodiversity Page 2

NANGUS, NSW

### Legend

- Reservoir Option 2
- Fauna Sightings (Bionet, 2019)
- Flora Sightings (Bionet, 2019)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Key Fish Habitat (DPI Water, 2017)
- Terrestrial Biodiversity (DPE, 2019)
- Waterbodies (LPI)

1:15,000 Scale at A3



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Biodiversity Page 3

NANGUS, NSW

### Legend

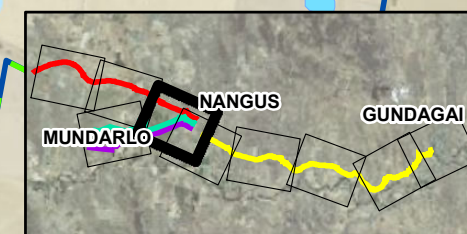
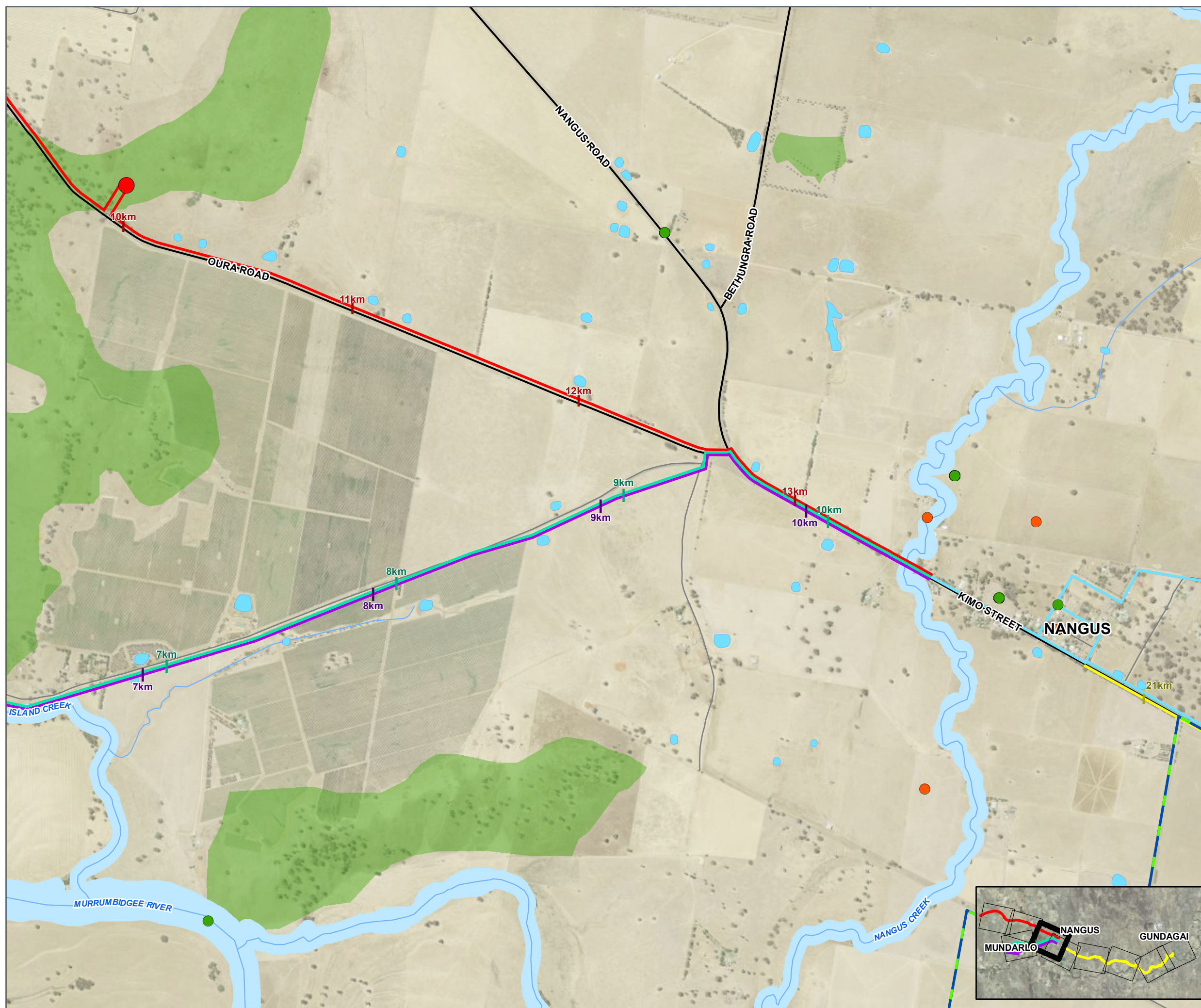
- Reservoir Option 2
- Fauna Sightings (Bionet, 2019)
- Flora Sightings (Bionet, 2019)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Raw Water Pipeline Option 5
- Proposed Raw Water Pipeline Option 6
- Proposed Reticulation
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Key Fish Habitat (DPI Water, 2017)
- Terrestrial Biodiversity (DPE, 2019)
- Waterbodies (LPI)

1:15,000 Scale at A3

0 150 300 450 600  
m

 **Cardno**















Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

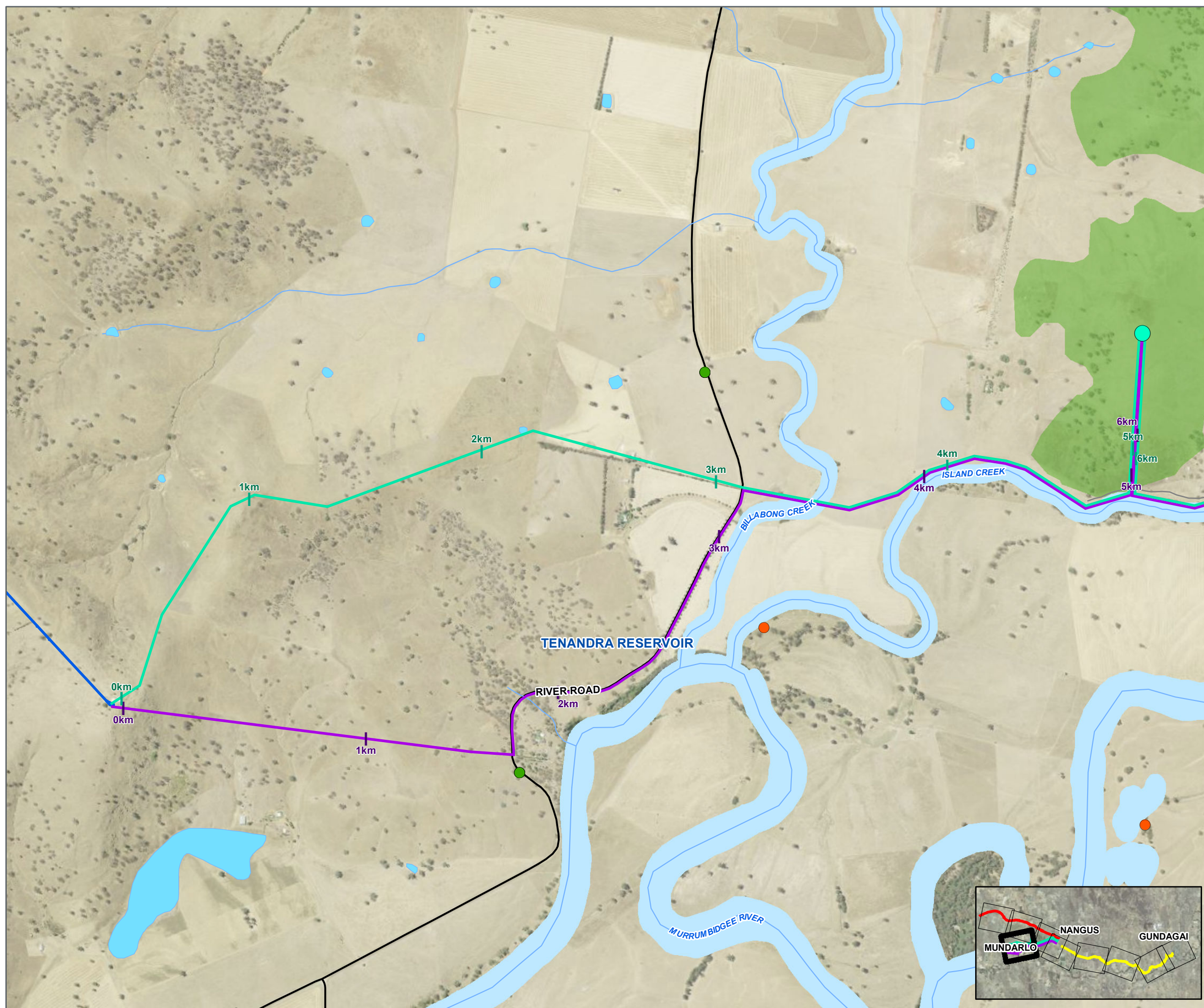


## Biodiversity Page 4

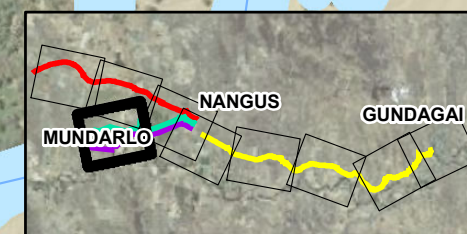
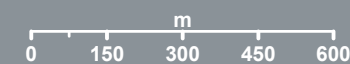
NANGUS, NSW

### Legend

-  Reservoir Options 3 and 4
-  Fauna Sightings (Bionet, 2019)
-  Flora Sightings (Bionet, 2019)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  GWCC Existing Water Mains
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Key Fish Habitat (DPI Water, 2017)
-  Terrestrial Biodiversity (DPE, 2019)
-  Waterbodies (LPI)



1:15,000 Scale at A3






















 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

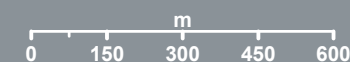
# Biodiversity Page 5

NANGUS, NSW

## Legend

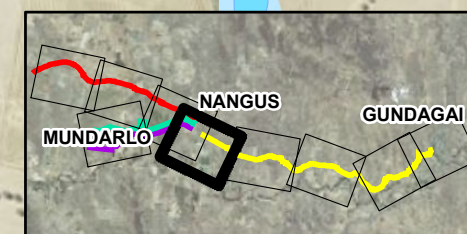
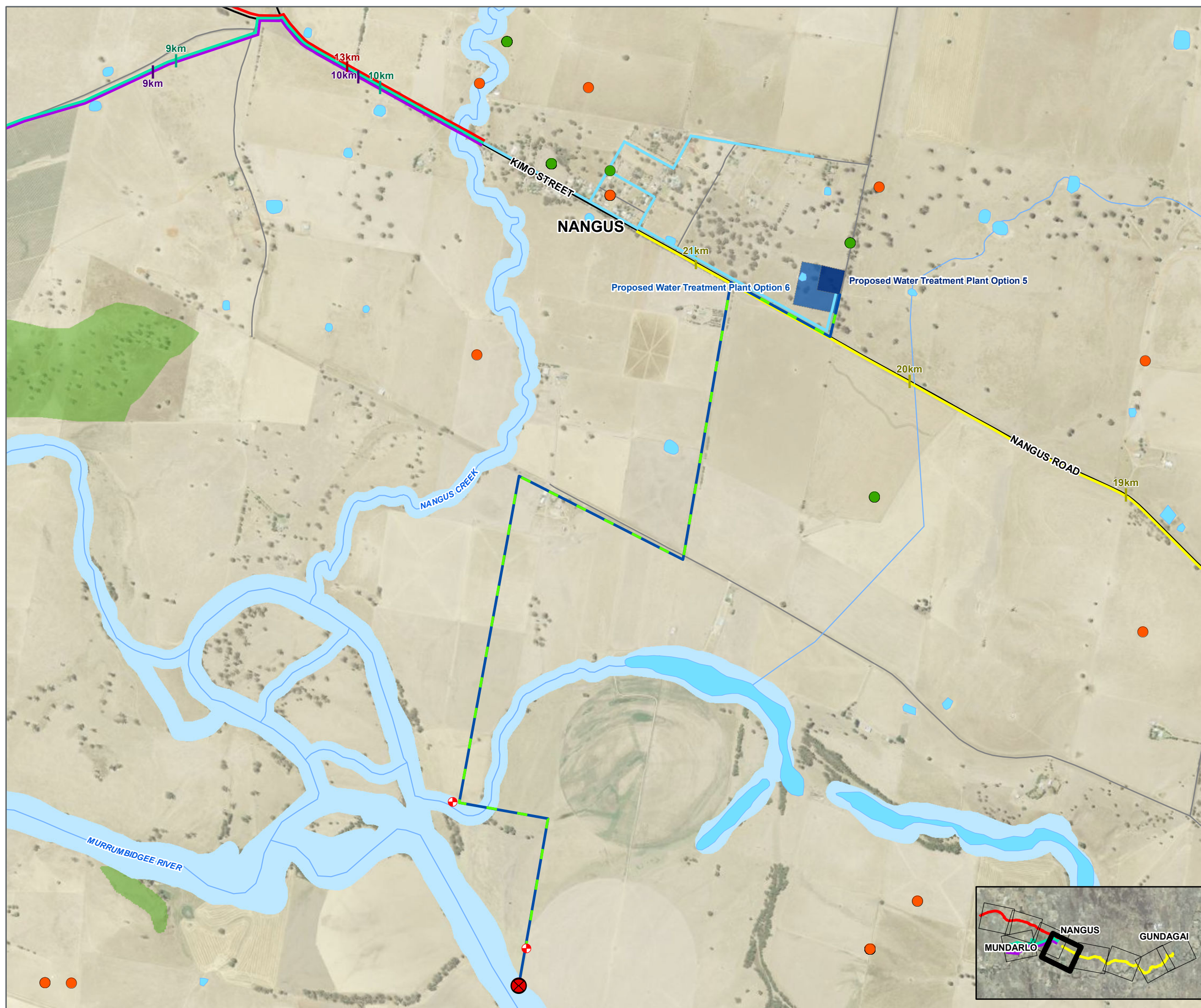
-  Indicative River Intake and Pump Station Option 5
-  Fauna Sightings (Bionet, 2019)
-  Flora Sightings (Bionet, 2019)
-  Indicative Bore Location Option 6
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  Proposed Raw Water Pipeline Option 5
-  Proposed Raw Water Pipeline Option 6
-  Proposed Reticulation
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Proposed Water Treatment Plant Option 5
-  Proposed Water Treatment Plant Option 6
-  Key Fish Habitat (DPI Water, 2017)
-  Terrestrial Biodiversity (DPE, 2019)
-  Waterbodies (LPI)

1:15,000 Scale at A3



 **Cardno**














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Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)



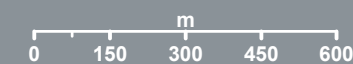
# Biodiversity Page 6

NANGUS, NSW

## Legend

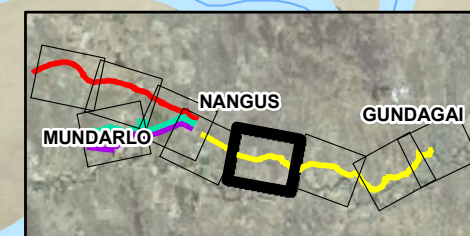
-  Reservoir Option 1
-  Fauna Sightings (Bionet, 2019)
-  Flora Sightings (Bionet, 2019)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Key Fish Habitat (DPI Water, 2017)
-  Terrestrial Biodiversity (DPE, 2019)
-  Waterbodies (LPI)

1:15,000 Scale at A3



 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

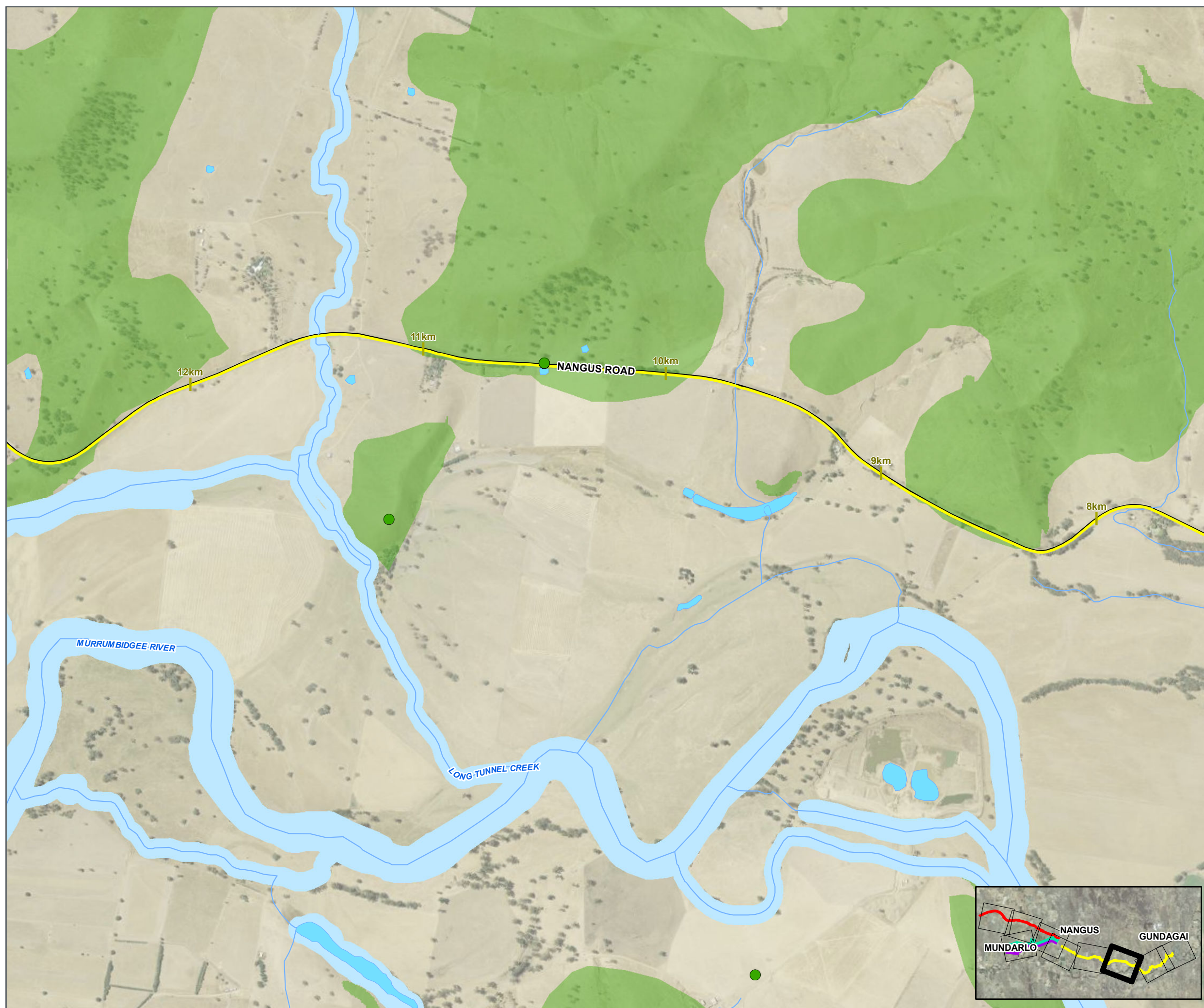


## Biodiversity Page 7

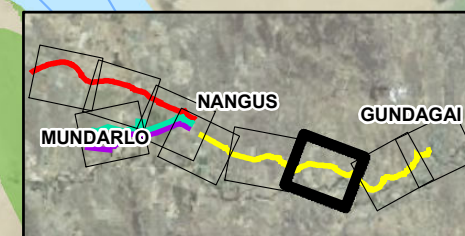
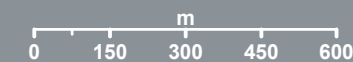
NANGUS, NSW

### Legend

- Flora Sightings (Bionet, 2019)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Major Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Key Fish Habitat (DPI Water, 2017)
- Terrestrial Biodiversity (DPE, 2019)
- Waterbodies (LPI)



1:15,000 Scale at A3

















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Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)

## Biodiversity Page 8

NANGUS, NSW

### Legend

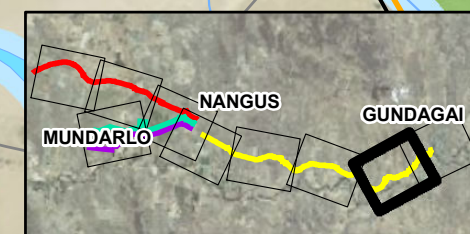
-  Booster Pump Station (Option 1)
-  Fauna Sightings (Bionet, 2019)
-  Flora Sightings (Bionet, 2019)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  CGRC Existing Water Mains
-  Major Road (LPI)
-  Local Road (LPI)
-  Major Watercourses (DPI Water, 2017)
-  Key Fish Habitat (DPI Water, 2017)
-  Terrestrial Biodiversity (DPE, 2019)
-  Waterbodies (LPI)

1:15,000 Scale at A3



 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)



## Biodiversity Page 9

NANGUS, NSW

### Legend

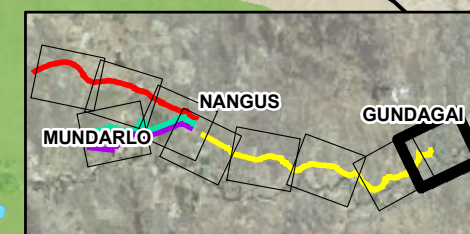
- Fauna Sightings (Bionet, 2019)
- Flora Sightings (Bionet, 2019)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- CGRC Existing Water Mains
- Major Road (LPI)
- Local Road (LPI)
- Major Watercourses (DPI Water, 2017)
- Key Fish Habitat (DPI Water, 2017)
- Terrestrial Biodiversity (DPE, 2019)
- Waterbodies (LPI)

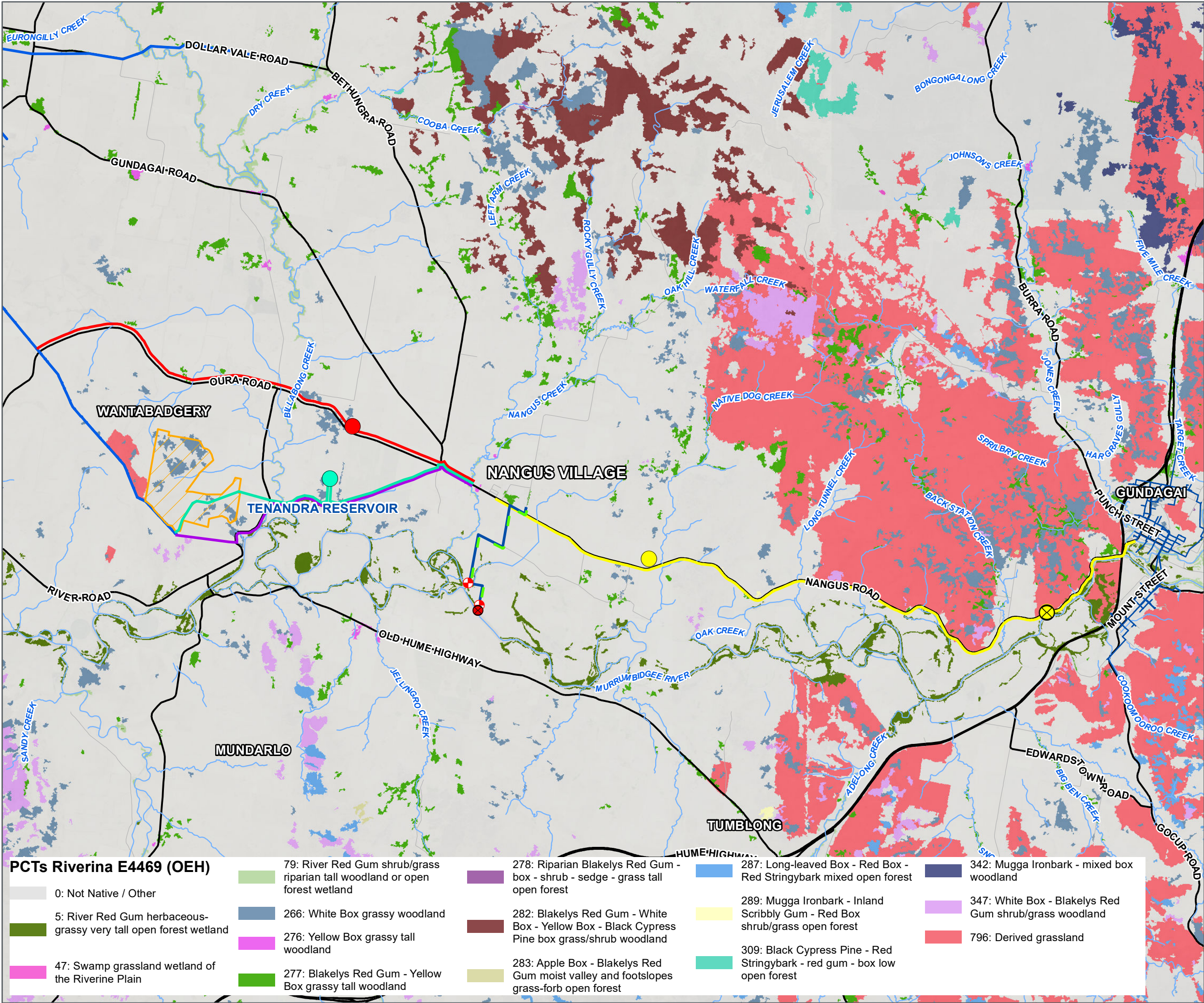
1:15,000 Scale at A3

0 150 300 450 600  
m

 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2019-11-29 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-014-BiodiversityDDP.mxd 02  
Aerial Imagery supplied by DFSI (2017)





## Vegetation

NANGUS, NSW

### Legend

- Indicative River Intake and Pump Station Option 5
- Indicative Bore Location Option 6
- Booster Pump Station (Option 1)
- Reservoir Option 1
- Reservoir Option 2
- Reservoir Options 3 and 4
- Major Road (NSW SS)
- Local Road (NSW SS)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Raw Water Pipeline Option 5
- Proposed Raw Water Pipeline Option 6
- GWCC Existing Water Mains
- CGRC Existing Water Mains
- Major Watercourses (DPI Water, 2017)
- Approximate Stewardship Zone (P1-Z1)

1:100,000 Scale at A3



Cardno

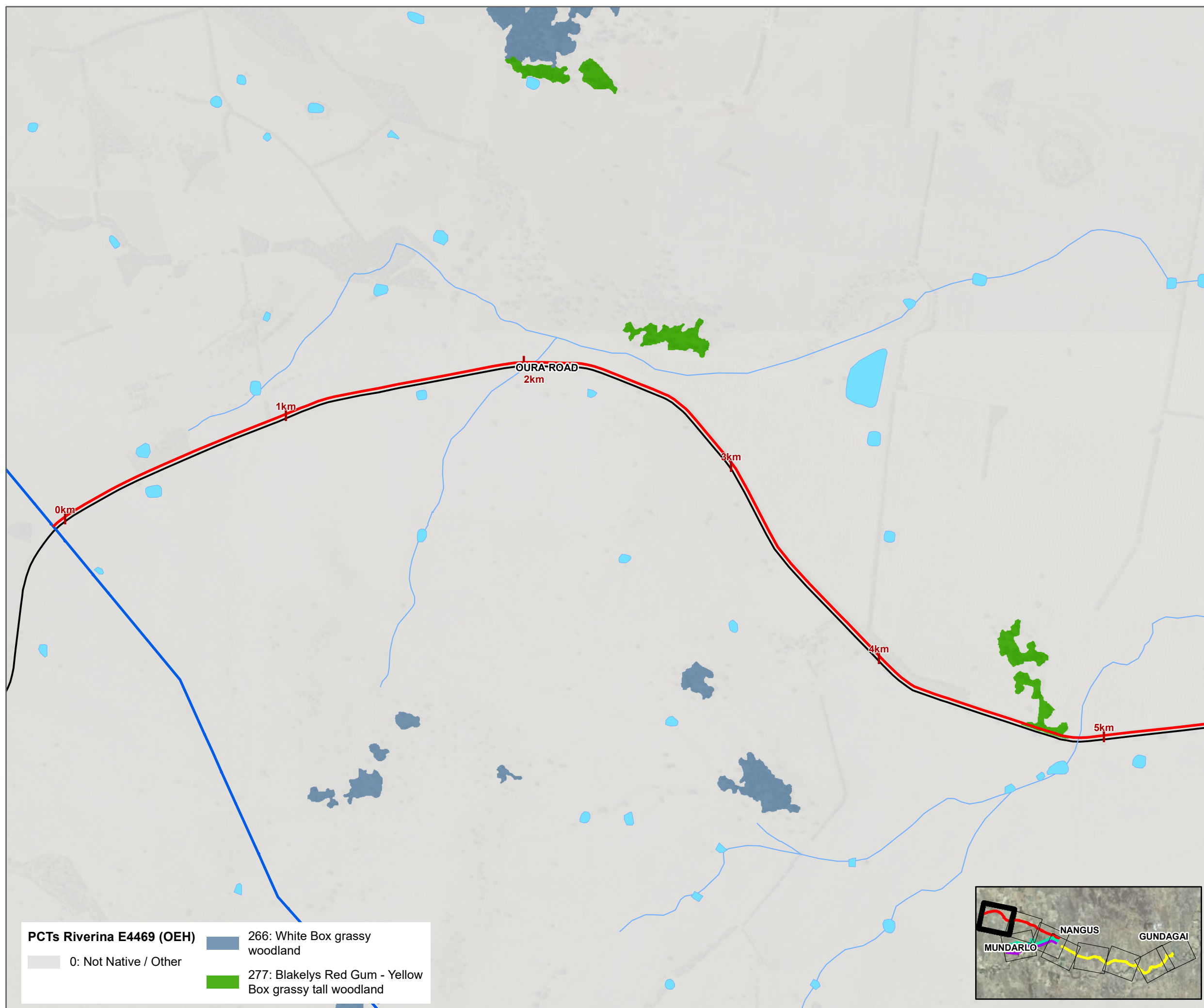
Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2020-02-14 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-008-Vegetation1.mxd 03  
Aerial Imagery supplied by DFSI (2017)  
PCT names have been shortened to fit legend

## Vegetation Page 1

NANGUS, NSW

### Legend

- Major Road (NSW SS)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- GWCC Existing Water Mains
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)



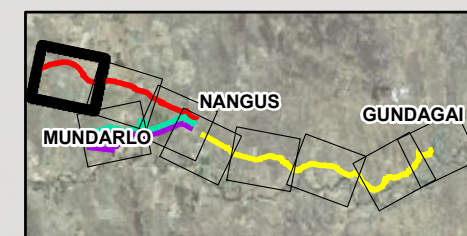
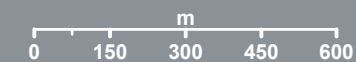
### PCTs Riverina E4469 (OEH)

0: Not Native / Other

266: White Box grassy  
woodland

277: Blakelys Red Gum - Yellow  
Box grassy tall woodland

1:15,000 Scale at A3



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
Date: 2020-02-14 | Project: 82020043-01  
Coordinate System: GDA 1994 MGA Zone 55  
Map: 8202004301-01-GS-015-VegetationDDP.mxd 03  
Aerial Imagery supplied by DFSI (2017)  
PCT names have been shortened to fit legend

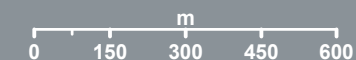
## Vegetation Page 2

NANGUS, NSW

### Legend

- Reservoir Option 2
- Major Road (NSW SS)
- Local Road (NSW SS)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Approximate Stewardship Zone (P1-Z1)
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)

1:15,000 Scale at A3



 **Cardno**

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
 Date: 2020-02-14 | Project: 82020043-01  
 Coordinate System: GDA 1994 MGA Zone 55  
 Map: 8202004301-01-GS-015-VegetationDDP.mxd 03  
 Aerial Imagery supplied by DFSI (2017)  
 PCT names have been shortened to fit legend

### PCTs Riverina E4469 (OEH)

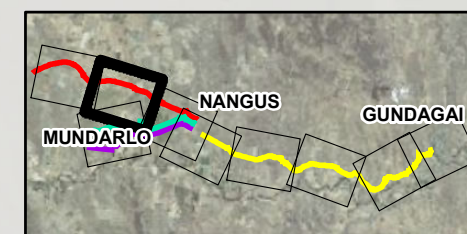
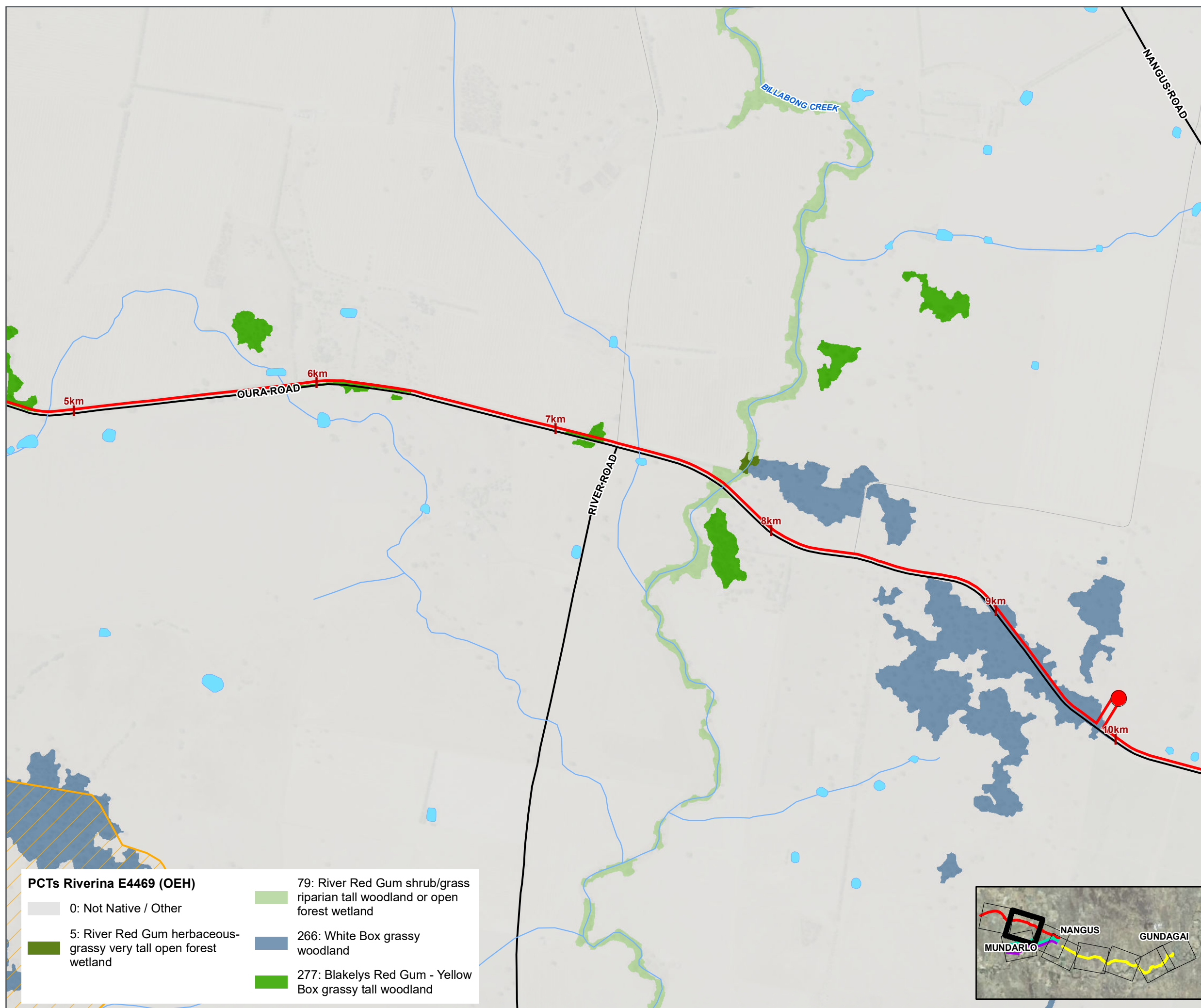
0: Not Native / Other

5: River Red Gum herbaceous-grassy very tall open forest wetland

79: River Red Gum shrub/grass riparian tall woodland or open forest wetland

266: White Box grassy woodland

277: Blakelys Red Gum - Yellow Box grassy tall woodland



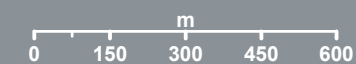
## Vegetation Page 3

NANGUS, NSW

### Legend

- Reservoir Option 2
- Major Road (NSW SS)
- Local Road (NSW SS)
- Pipeline Option 1 (21.5km)
- Pipeline Option 2 (13.7km)
- Pipeline Option 3 (10.5km)
- Pipeline Option 4 (10.6km)
- Proposed Raw Water Pipeline Option 5
- Proposed Raw Water Pipeline Option 6
- Proposed Reticulation
- Major Watercourses (DPI Water, 2017)
- Waterbodies (LPI)

1:15,000 Scale at A3



 Cardno

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
 Date: 2020-02-14 | Project: 82020043-01  
 Coordinate System: GDA 1994 MGA Zone 55  
 Map: 8202004301-01-GS-015-VegetationDDP.mxd 03  
 Aerial Imagery supplied by DFSI (2017)  
 PCT names have been shortened to fit legend

### PCTs Riverina E4469 (OEH)

■ 0: Not Native / Other

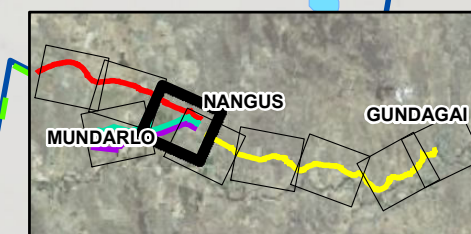
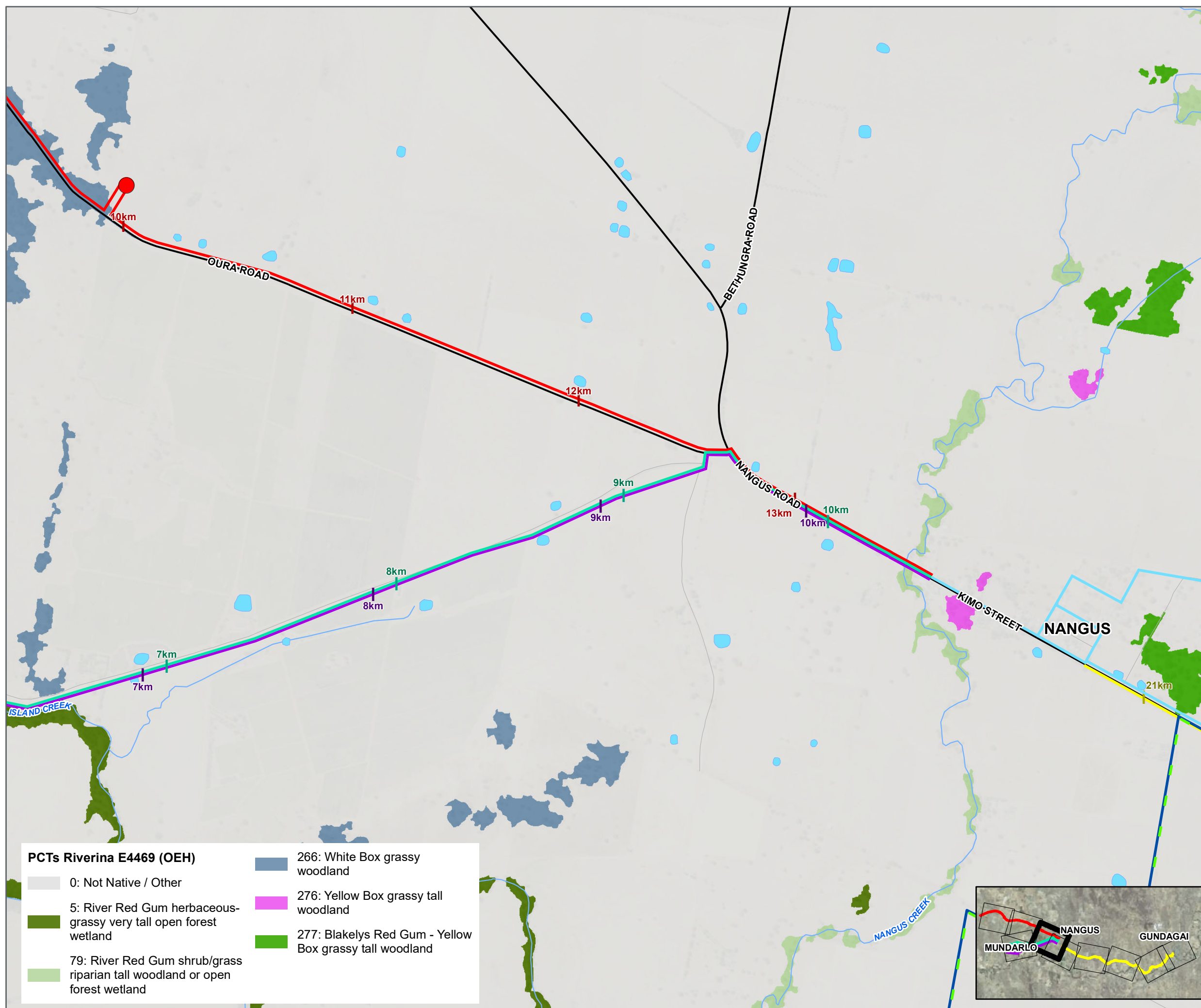
■ 5: River Red Gum herbaceous-grassy very tall open forest wetland

■ 79: River Red Gum shrub/grass riparian tall woodland or open forest wetland

■ 266: White Box grassy woodland

■ 276: Yellow Box grassy tall woodland












■ 277: Blakelys Red Gum - Yellow Box grassy tall woodland



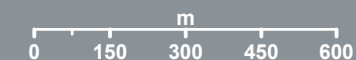
## Vegetation Page 4

NANGUS, NSW

### Legend

-  Reservoir Options 3 and 4
-  Major Road (NSW SS)
-  Local Road (NSW SS)
-  Pipeline Option 1 (21.5km)
-  Pipeline Option 2 (13.7km)
-  Pipeline Option 3 (10.5km)
-  Pipeline Option 4 (10.6km)
-  Approximate Stewardship Zone (P1-Z1)
-  GWCC Existing Water Mains
-  Major Watercourses (DPI Water, 2017)
-  Waterbodies (LPI)

1:15,000 Scale at A3





 Cardno


Map Produced by Cardno NSW/ACT Pty Ltd (WOL)  
 Date: 2020-02-14 | Project: 82020043-01  
 Coordinate System: GDA 1994 MGA Zone 55  
 Map: 8202004301-01-GS-015-VegetationDDP.mxd 03  
 Aerial Imagery supplied by DFSI (2017)  
 PCT names have been shortened to fit legend


### PCTs Riverina E4469 (OEH)

 0: Not Native / Other

 5: River Red Gum herbaceous-grassy very tall open forest wetland

 79: River Red Gum shrub/grass riparian tall woodland or open forest wetland

 266: White Box grassy woodland

 347: White Box - Blakelys Red Gum shrub/grass woodland

