

10 Ecology

10.1 Assessment objectives

The DGRs for the Cobbora Coal Project that relate specifically to biodiversity are:

- accurate estimates of any vegetation clearing;
- a detailed assessment of the potential impacts of the Project on any terrestrial and aquatic threatened species, populations, ecological communities or their habitats;
- a detailed description of the measures that would be implemented to avoid or mitigate impacts to biodiversity;
- a comprehensive offset strategy to ensure that the Project maintains or improves the biodiversity values of the region in the medium to long term (in accordance with NSW and Commonwealth policies);
- consideration of how the proposal may impact upon lands covered by the Brigalow and Nandewar Community Conservation Area Act 2005 (B&N Act); and
- Commonwealth environmental assessment requirements, including:
 - general information regarding the controlled action;
 - description of the controlled action;
 - description of the existing environment;
 - description of relevant impacts of the controlled action;
 - proposed safeguards and mitigation measures; and
 - offsets.

10.2 Assessment method

Terrestrial and aquatic ecological assessments were undertaken to characterise the biodiversity of the PAA and determine the potential occurrence and impacts to threatened species, populations and communities. The terrestrial ecology assessment was undertaken by EMM and is included as Appendix H. The aquatic ecology assessment was undertaken by Cardno Ecology Lab and is included as Appendix I. The results of the assessments are summarised in this chapter.

The assessments were in accordance with the following regulations, methods and guidance documents as specified in the DGRs:

- *Draft Guidelines for Threatened Species Assessment under Part 3A of the Environmental Planning and Assessment Act 1979* (DEC and DPI 2005);
- Department of Land and Water Conservation *NSW State Groundwater Dependent Ecosystem Policy* (DLWC 2004);

- NSW Fisheries Policy and Guidelines – *Aquatic Habitat Management and Fish Conservation* (DPI 1999);
- NSW Fisheries Policy and Guidelines – *Fish Friendly Waterway Crossings* (DPI 2003);
- State Environmental Planning Policy (SEPP) No. 44 – Koala Habitat protection;
- Department of Environment and Climate Change *Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna: Amphibians* (DECC 2012);
- Department of Planning *EIA Guideline Series: Aquatic Ecology in Environmental Impact Assessment* (DoP 2003); and
- *Australia, New Zealand Environment Conservation Council Guidelines for Upland Rivers in South-eastern Australia* (ANZECC 2000).

10.2.1 Terrestrial ecology

Relevant literature, databases and vegetation mapping were reviewed to characterise the ecological attributes of the Project assessment area (PAA). The reviewed information was used to inform and design detailed field surveys to identify threatened species, populations and communities and their habitat within the PAA, in accordance with the guidelines in Section 10.2.

Biodiversity was surveyed in the PAA between 2009 and 2012 (Table 10.1). The survey period spanned all seasons and occurred in both dry and wet periods. This maximised the chances of recording species occurring within the PAA.

Table 10.1 Summary of terrestrial biodiversity surveys within the PAA

Taxa group	Survey method	Survey timing
Flora	Preliminary vegetation surveys	Winter and spring 2009
	Plot surveys	Spring 2009 and 2011
	Rapid vegetation assessments	Spring 2009 and 2011
	Targeted threatened flora searches	Summer–autumn 2010, spring–summer 2011
Fauna	Habitat assessments and searches for signs	Spring 2009, summer–autumn 2010, spring–summer 2011
Amphibians	Water body searches	Spring 2009 and spring–summer 2011
Reptiles	Active search	Summer 2011
	Nocturnal search	Summer 2011
Birds	Timed diurnal search	Winter and spring 2009, summer and autumn 2010, winter and summer 2011
Microchiropteran bats	Anabat detection	Spring 2009 and 2011
	Harp trapping	Spring 2011
Non-flying mammals	Arboreal hair tubes	Spring–summer 2011
	Ground hair tubes	Spring 2009, summer 2011
	Koala spot assessment	Summer 2011
	Infrared camera surveys	Spring 2009, summer 2011
Nocturnal birds and mammals	Call broadcasting and spotlighting	Spring and summer 2009, spring and summer 2011

i Flora surveys

Flora were surveyed to identify and characterise the vegetation types occurring in the PAA and identify threatened species, populations and ecological communities present or potentially occurring in the PAA.

Flora surveys and vegetation mapping consisted of:

- reviewing vegetation mapping projects previously undertaken within the PAA;
- aerial photograph interpretation;
- field validation of spatial vegetation patterns using rapid assessments;
- quantitative plot-based surveys (400 m²) of each vegetation type; and
- targeted flora searches for rare and/or threatened flora using formal transect surveys and the random meander method.

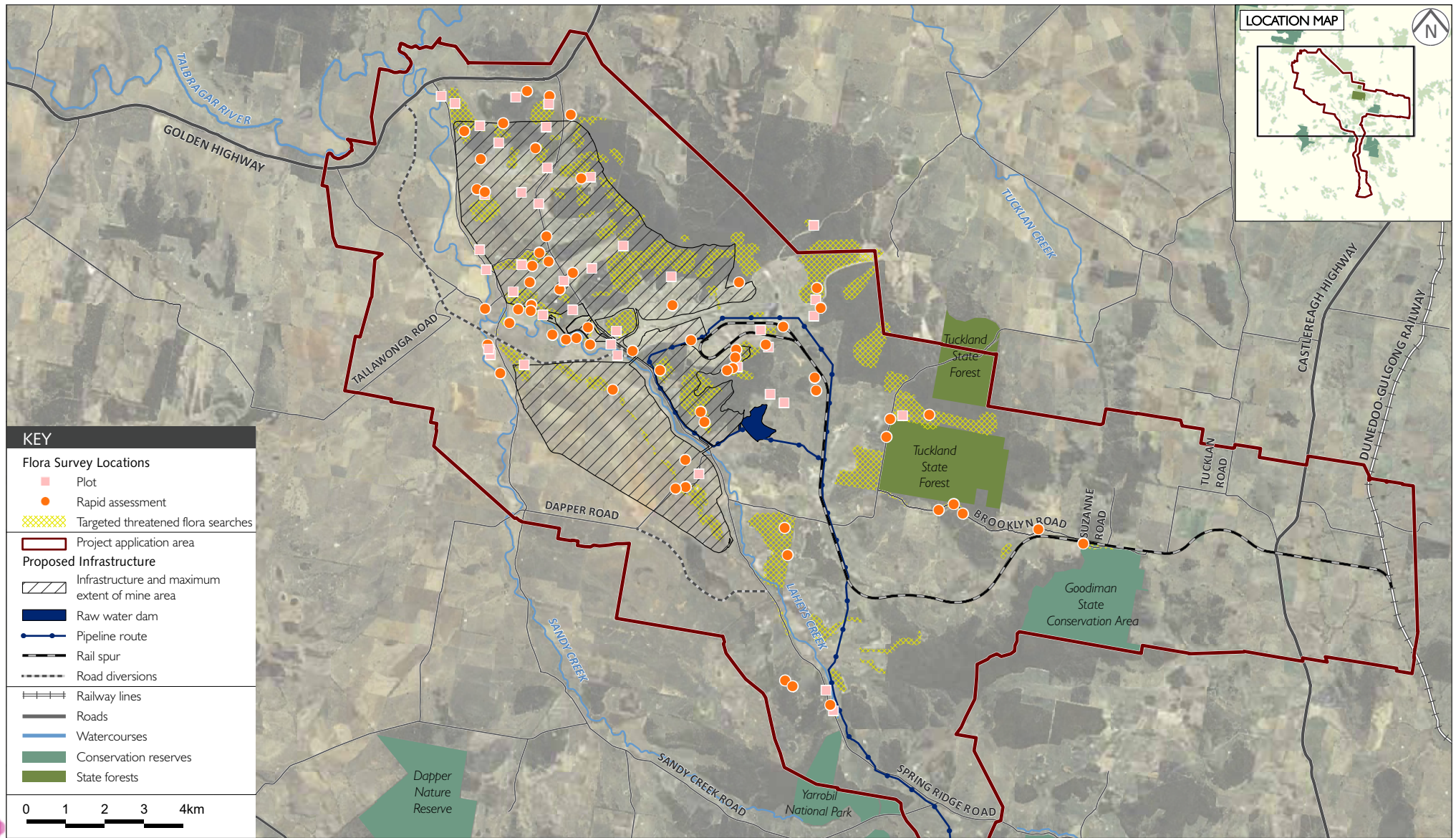
The locations of flora survey sites within the PAA are provided in Figure 10.1. Vegetation plots were placed in areas indicative of each vegetation type present to appropriately represent the composition and condition of the vegetation present. The number of plots surveyed complied with requirements according to site stratification (DEC and DPI 2005). Plot data was used to identify threatened ecological communities in accordance with SEWPaC and OEH identification guidelines.

ii Fauna surveys

Fauna were surveyed to determine the faunal assemblages occurring in the PAA and identify threatened species and populations present, or potentially occurring, in the PAA. Habitat for threatened fauna species was identified based on mapped vegetation types, landscape position and species records for the area. Methods used to identify fauna of the PAA included:

- review database records and existing literature;
- assess fauna habitats;
- active diurnal and nocturnal searches for reptiles and amphibians;
- diurnal and nocturnal bird surveys and call broadcasting;
- microbat echolocation detection, trapping and roost surveys;
- sample mammal hair, infrared camera surveys, spotlighting and koala (*Phascolarctos cinereus*) spot assessments; and
- active searches for tracks, scats and signs of use.

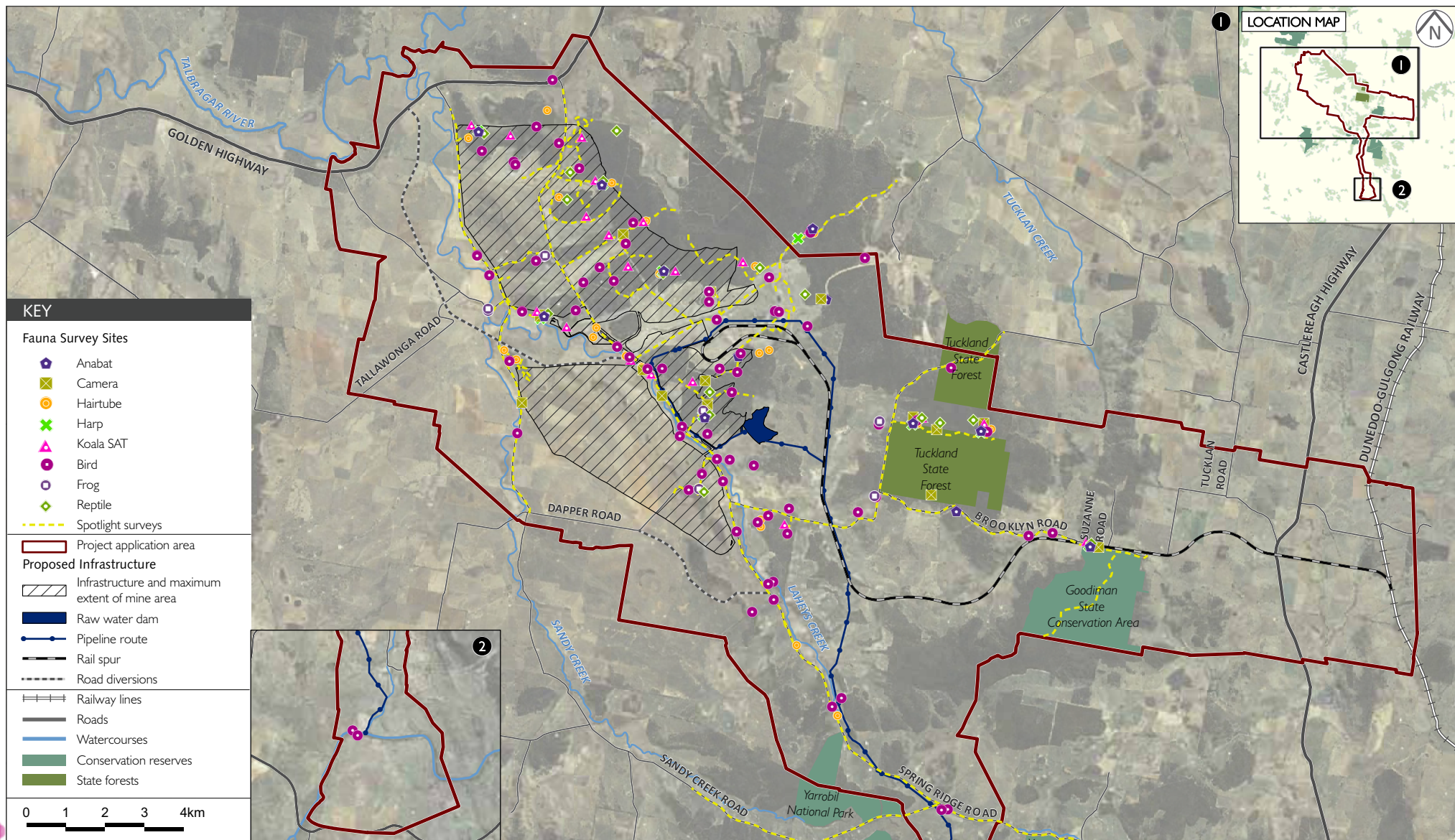
The locations of fauna survey sites are provided in Figure 10.2. Survey effort for threatened fauna generally met or exceeded applicable guidelines. However, Elliot and cage trapping were not used. The mammal species targeted by surveys were considered to be detectable using other methods, including sampling hair, analysing scat, infrared cameras, spotlighting and call playback, which had recorded the target species in nearby reserves (NPWS 2000).



Flora Survey Sites

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Figure 10.1



Fauna Survey Sites

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Figure 10.2

10.2.2 Aquatic ecology

i Aquatic surveys

Aquatic surveys of waterways were undertaken to determine the aquatic habitats and species occurring in the PAA and identify threatened aquatic species, populations and ecological communities present or potentially occurring in the PAA. An overview of the aquatic ecology survey effort is provided in Table 10.2.

Table 10.2 Summary of aquatic biodiversity surveys within the PAA

Survey method	Survey locations (waterways)	Survey timing
Aquatic habitat assessment	Talbragar River, Sandy Creek, Laheys Creek, Lambing Yard Creek, Cudgegong River, Tallawang Creek, Blackheath Creek, Fords Creek, Patricks Creek and Mebul Creek	Spring 2009, spring and summer 2011
Macroinvertebrate sampling	Talbragar River, Sandy Creek, Laheys Creek, Cudgegong River, Mebul Creek, Tallawang Creek	Spring 2009, spring and Summer 2011
Water quality	Talbragar River, Sandy Creek, Laheys Creek, Cudgegong River, Tucklan Creek, Mebul Creek, Tallawang Creek	Spring 2009, spring and summer 2011
Fish sampling	Talbragar River, Sandy Creek, Laheys Creek, Cudgegong River, Mebul Creek, Tallawang Creek	Spring 2009, spring and summer 2011

Stream characterisation and aquatic habitat were assessed to determine the condition and level of disturbance. Habitat descriptors included:

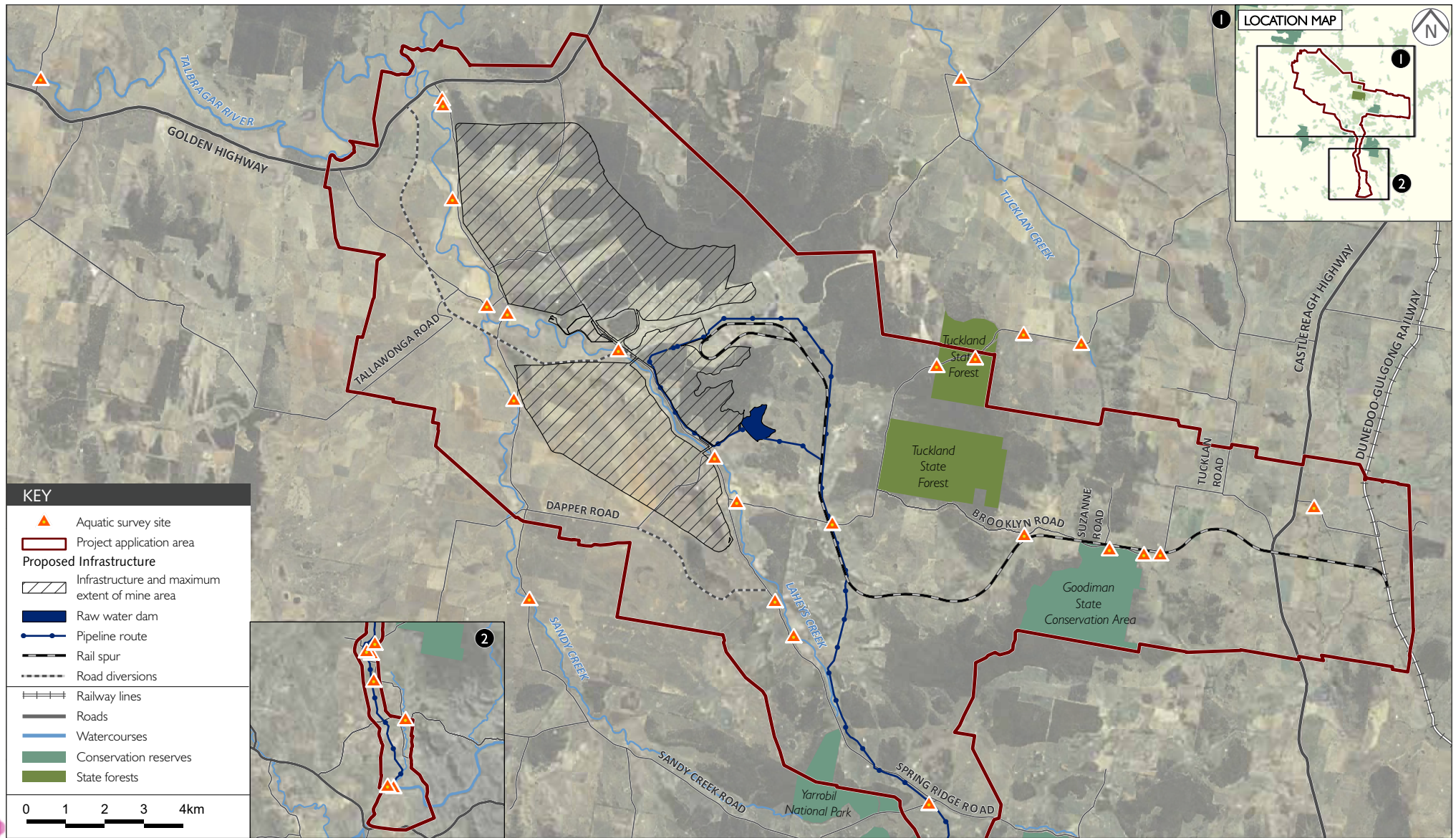
- geomorphological characteristics of the waterway;
- land use along the waterway (eg industries associated with the river and recreational uses);
- riparian vegetation and in-stream vegetation (eg presence/absence, native or exotic, condition and percent cover); and
- channel substratum type (eg rock, sand, gravel or alluvial substrata).

Water quality was tested during the aquatic survey. Results were compared with the ANZECC guidelines for upland rivers in south-eastern Australia to determine the health of the waterways for aquatic species and habitat.

Macro-invertebrates were sampled in pool edge habitat in accordance with the AusRivAS protocol (Turak et al. 2004). Samples collected in the field were identified in the laboratory. Results were incorporated into the AusRivAS predictive model and compared with freshwater macro-invertebrate assemblages from undisturbed reference sites to provide a basis to assess the health of the streams.

Bait traps and seine nets were used to sample fish and large mobile macro-invertebrates, and electro-fishing was used at suitable sites. Plankton nets were used to sample fish eggs and larvae.

The locations of aquatic survey sites are provided in Figure 10.3.



Aquatic Survey Sites

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Figure 10.3

10.2.3 Groundwater dependent ecosystems

The occurrence of groundwater dependent ecosystems (GDEs) within the PAA was determined in accordance with the *NSW State Groundwater Dependent Ecosystem (GDE) Policy* (DLWC 2002). Potential groundwater availability to terrestrial and aquatic ecosystems was identified using topographic maps, field survey results, vegetation data, results from groundwater pump tests and groundwater modelling. Where groundwater was considered to be available, potential GDEs were classified and assessed.

10.3 Existing environment

10.3.1 Regional and local setting

i Terrestrial

The PAA is on the boundary of the South West Slopes and Brigalow Belt South bioregions, which are characterised by diverse and varied habitat types and an array of flora and fauna assemblages. The Brigalow Belt South Bioregion lies on the transition zone between eastern, western and northern biotic elements and is an important area for biodiversity as it contains unique assemblages of fauna and flora (NPWS 2000).

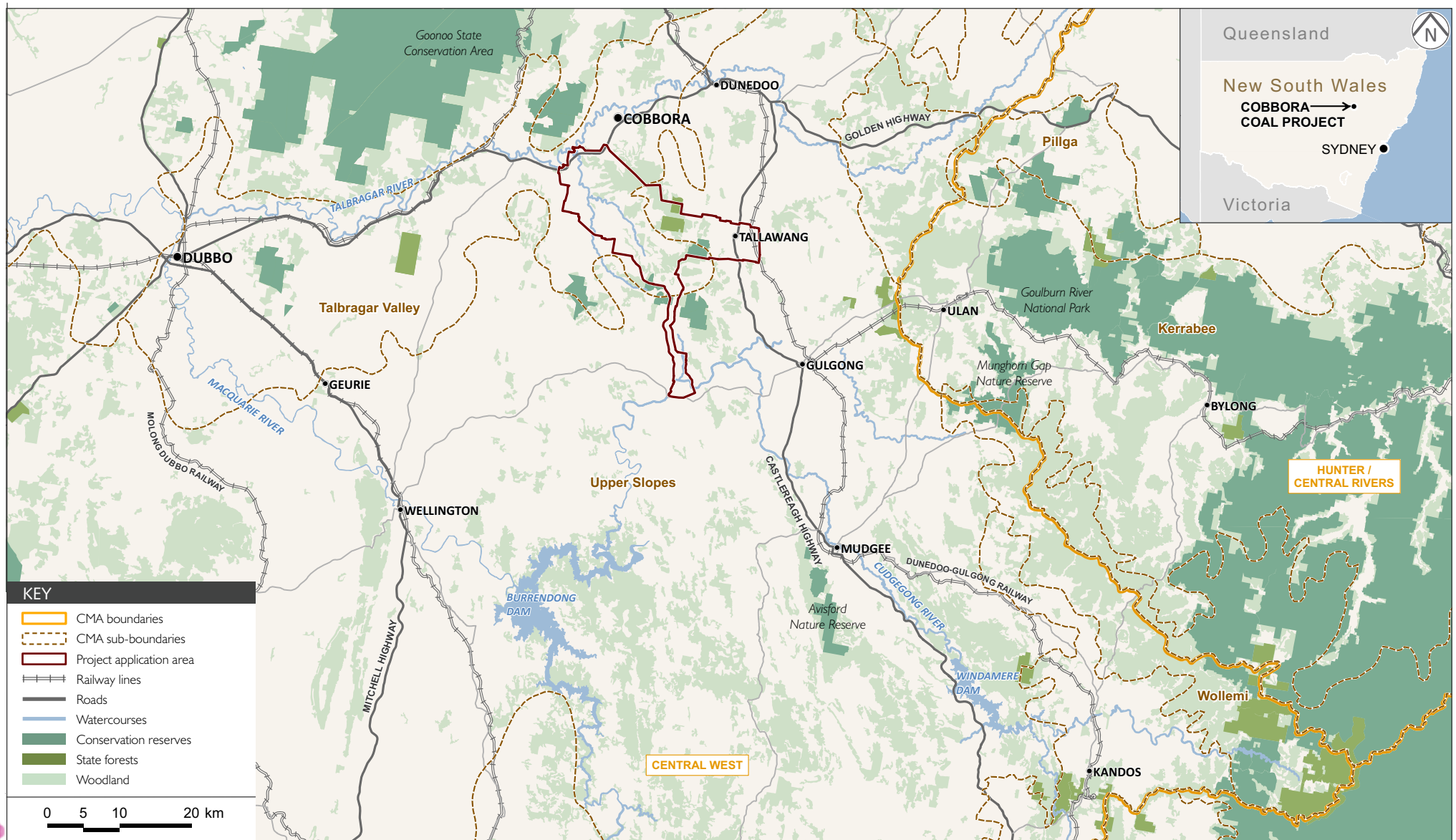
The PAA is within the Central West Catchment Management Area. The landform changes from tablelands to plains in this region and there is a decrease in rainfall in an east-west gradient, creating an ecological transition area where a number of species converge (Bauer and Goldney 2000). In particular, the eastern part of the region contains the highest diversity of vertebrate fauna species in the region (Goldney et al. 2007). However, the region has a history of agricultural land use, with about 60% of woody native vegetation estimated to have been cleared (Benson et al. 2010). This past disturbance has been linked with a vertebrate species decline in the region (Bauer and Goldney 2000).

An estimated 10% of remnant native vegetation in the Brigalow Belt South Bioregion is within protected areas (Goldney et al. 2007). There are three protected areas in the PAA; Yarrobil National Park (NP), Goodiman State Conservation Area (SCA) and Tuckland State Forest, which constitute 10% of the total PAA area (Figure 10.4). Large reserves in the area, but outside the PAA include Cobbora SCA, Goonoo SCA and Dapper Nature Reserve. Threatened species recorded within these large protected areas include the malleefowl (*Leipoa ocellata*), glossy black-cockatoo (*Calyptorhynchus lathami*), Pilliga mouse (*Pseudomys pilligaensis*), koala, eastern pygmy-possum (*Cercartetus nanus*), squirrel glider (*Petaurus norfolcensis*), barking owl (*Ninox connivens*), Ingram's zieria (*Zieria ingramii*) and Ausfeld's wattle (*Acacia ausfeldii*).

ii Aquatic

The Project area is in the Macquarie River subcatchment. There are two river systems in the PAA: the Talbragar drains the northern part of the PAA, and the Cudgegong drains the south along the pipeline corridor (Figure 10.4).

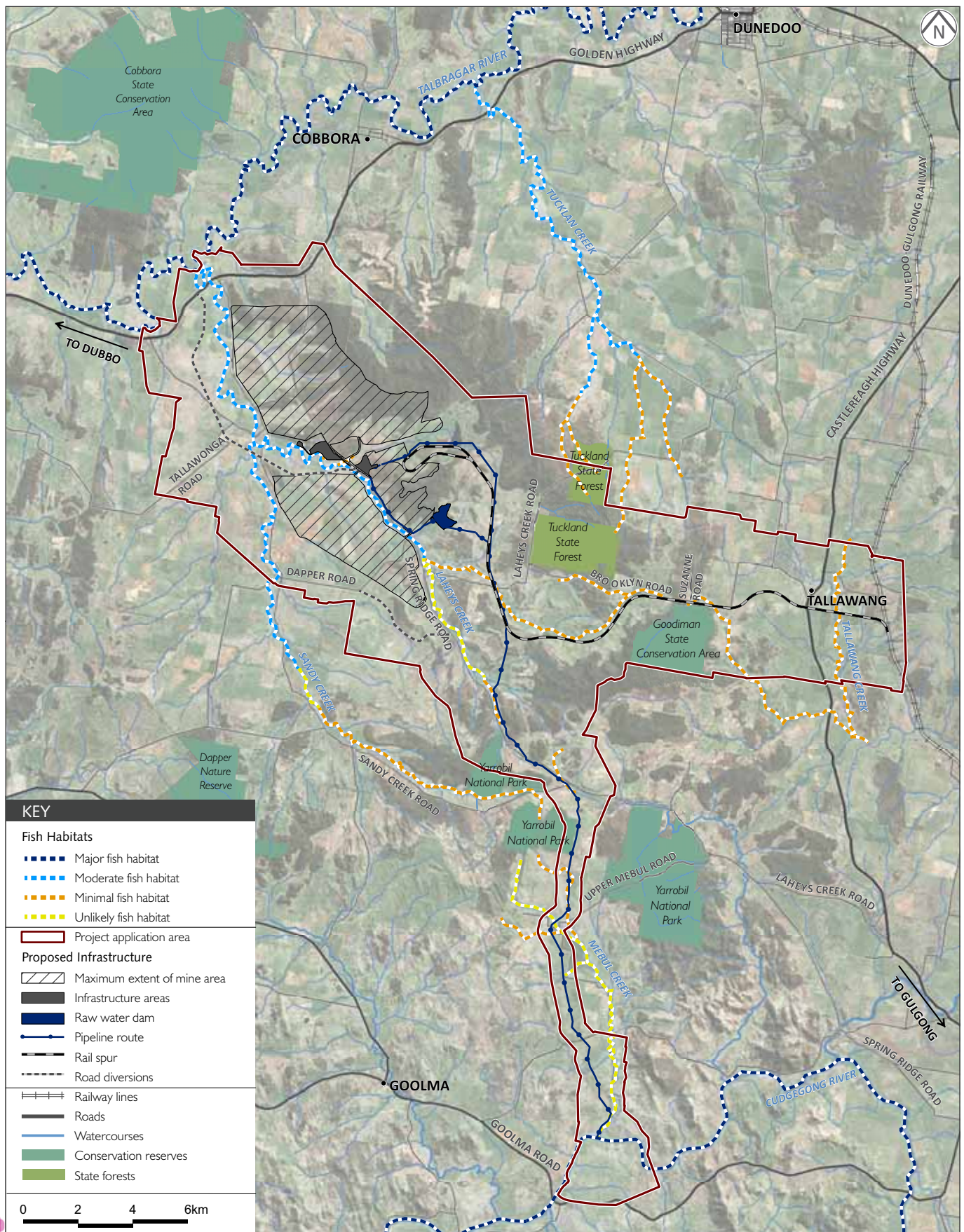
The natural flow regime of the Macquarie River system, including the Cudgegong River, has been disrupted by dams, weirs and the extraction of water. This has altered seasonal patterns and variability of flows, which has reduced the number of large flooding events and the time between inundations. The Talbragar is an unregulated river as it does not contain water storages and is not operated for the purpose of satisfying water requirements. However, extraction and interception of runoff have altered the natural flow regime of the Talbragar.



Biodiversity Setting

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Figure 10.4



Waterway Classes for Fish Habitat within the PAA

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Figure 10.5

The main drainage systems within the PAA are Sandy Creek and Laheys Creek. Minor systems occur in the east (Tuckland Creek and Tallawang Creek) and the south (Mebul Creek) (Figure 10.5).

The upstream reaches of Sandy and Laheys creeks are relatively steep, dominated by bedrock, transitioning to a sand substratum 'chain of ponds' reach in the Talbragar floodplain (Appendix E 'Surface water assessment'). Laheys Creek flows into Sandy Creek, converging between the footprint of Mining Area A and Mining Area B. Sandy Creek then discharges into the Talbragar River about 3 km downstream of the PAA's northern boundary.

The Talbragar River, Sandy Creek and Laheys Creek are naturally ephemeral waterways that cease to flow during dry periods (Appendix E 'Surface water assessment'). Flows in the Talbragar River are characterised by a seasonal pattern with lower flows over summer and autumn, and flood events throughout winter and spring (Appendix E 'Surface water assessment').

10.3.2 Ecological communities

i Vegetation

The Project area has been highly disturbed by agricultural land uses, including intensive grazing, firewood collection and pasture improvement. Remnant and regenerating woodland vegetation, including that within protected areas, only covers 36% of the PAA. In general, remnant vegetation in the PAA is confined to roadside verges and areas of steeper topography. The remaining area (64%) is made up of agricultural areas dominated by pasture grassland.

Eighteen vegetation types were recorded within the PAA and the. The most common are (see Figure 10.6):

- Grasslands (Native Pasture and Introduced Pasture/Disturbed);
- Blue-leaved Ironbark Woodland;
- Regrowth (representative of the Blue-leaved Ironbark Woodland community);
- Grey Box Woodland;
- Slaty Gum Woodland;
- Cypress Pine Woodland;
- Red Stringybark Woodland;
- Box Gum Grassy Woodland; and
- Dwyer's Red Gum Woodland.

Three threatened ecological communities (TECs) were identified in the PAA (see Figure 10.6):

- Box Gum Grassy Woodland (incorporating the Box Gum Grassy Woodland, Blakely's Red Gum Woodland and Rough-barked Apple Woodland vegetation types), listed as 'White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland critically endangered ecological community' under the EPBC Act and 'White Box Yellow Box Blakely's Red Gum Woodland endangered ecological community' under the TSC Act; Inland Grey Box Woodland (comprising the mapped Grey Box Woodland vegetation type) listed as 'Grey Box (*Eucalyptus microcarpa*) Grassy Woodlands and Derived Native Grasslands of South-Eastern Australia endangered ecological community' under the EPBC Act and 'Inland Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Penplain, Nandewar and Brigalow Belt South Bioregions endangered ecological community' under the TSC Act; and
- Fuzzy Box Woodland (comprising the Fuzzy Box Woodland type) listed as 'Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions endangered ecological community' under the TSC Act.

In general, box woodlands, including those listed as TECs, occur on the floodplains in the PAA. These areas have been heavily disturbed through cropping, pasture improvement and intensive grazing regimes, with remnant vegetation in these areas often occurring in small patches that had not been substantially disturbed by agricultural activities. This includes along the major creeks and their floodplain, and the roadside verges.

Red gum woodlands occur on flat topography at the foot of gentle and steep slopes. Cypress woodlands occur on gentle midslopes to steep upper slopes, while ironbark/stringybark woodlands occur on gentle midslopes to steep upper slopes. These areas usually contain large rocky sandstone or granite outcrops, while those dominated by ironbark contain sandstone or lateritic outcropping. Feral herbivores and firewood collection appear to have disturbed these vegetation types.

Grasslands occur in the lower lying more fertile parts of the PAA. The grasslands are either poor condition and low diversity native pastures or improved pastures dominated by exotic species. Native pasture areas were not representative of vegetation communities that would have occurred prior to clearing and agricultural activities, and were not considered to be consistent with the definition of any derived native grassland listed under the TSC Act or the EPBC Act.

ii Aquatic communities

The aquatic biota within the PAA (below 500 m AHD) and adjacent reaches of the Talbragar River forms part of the endangered Lowland Darling River aquatic ecological community listed under the *Fisheries Management Act 1993* (FM Act). The Lowland Darling River aquatic ecological community is characterised by a diverse biotic assemblage, including 21 native fish species and hundreds of native invertebrates (including insects, crustaceans, molluscs, sponges and worms).

10.3.3 Groundwater dependent ecosystems

Murray et al. (2003) define GDEs as requiring the input of groundwater to maintain their current composition and functioning. Potential GDEs recorded in the PAA include:

- terrestrial vegetation; and
- base flows in streams.

i Terrestrial vegetation

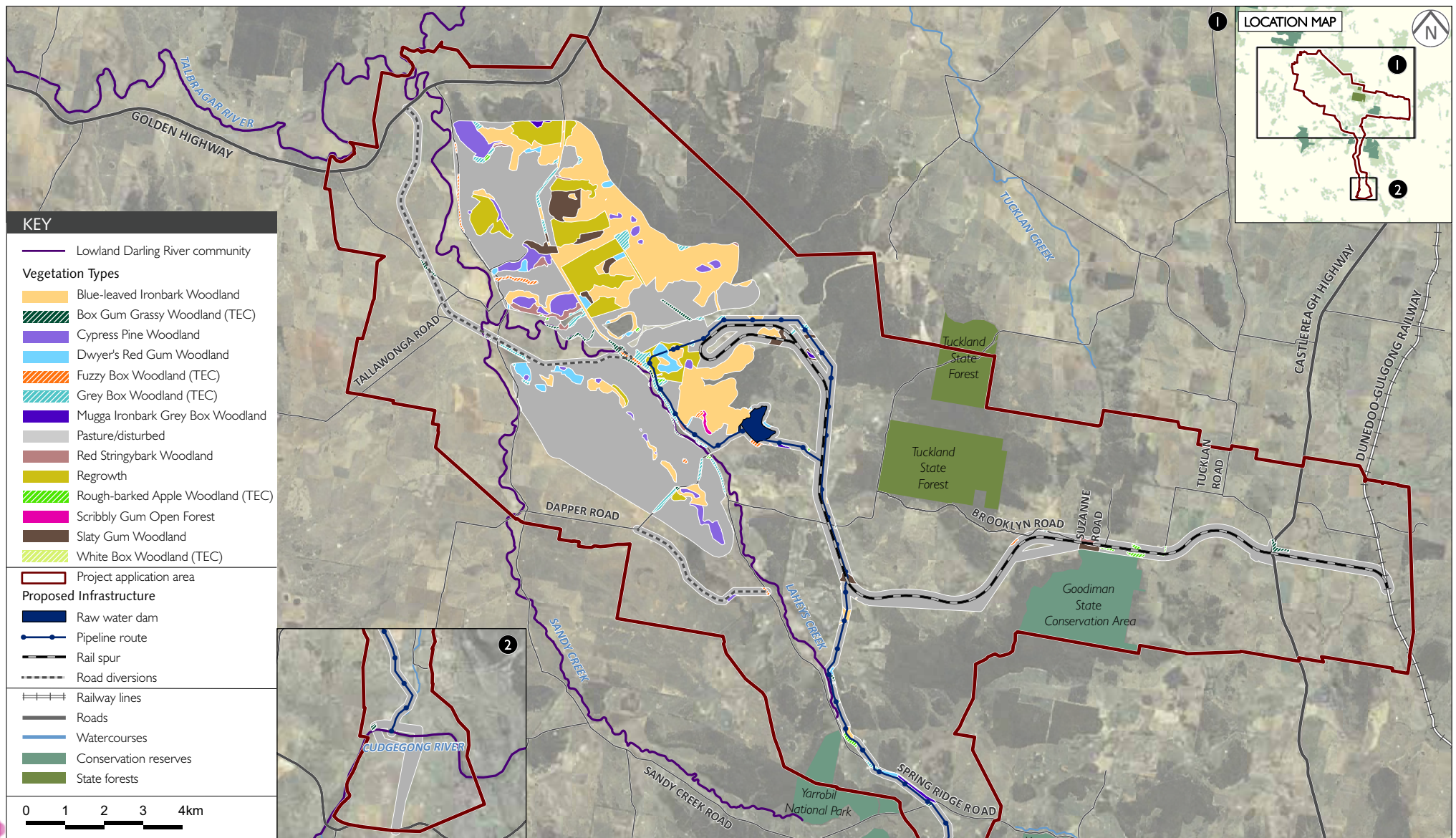
Rain-fed springs were identified at the intersection of the basalt hilltops in the south of the PAA and the northern side of the Talbragar River (Appendix D 'Groundwater assessment'). The vegetation associated with these areas is likely to depend on groundwater availability. These areas occur outside the Project footprint and depend on the rain-fed aquifers associated with the basalt hilltops.

Ground and surface water interactions are likely to occur along the riparian zones of the PAA where alluvial sediments retain shallow groundwater systems fed by rainwater infiltration (Figure 10.7). Groundwater modelling has identified that these may provide baseflow to deep pools in the creeks and rivers (Appendix D 'Groundwater assessment'), with groundwater potentially available to deep-rooted terrestrial vegetation.

Modelling of the distribution of alluvial sediments where the water table may be within tree rooting depth (within 3 m of the surface) does not correlate with any specific vegetation types. Only 4.5 ha of the wooded vegetation occurs in such areas, with more than six vegetation communities represented. The vegetation within the riparian zone of the PAA is not typically known for groundwater dependence with dominant species including yellow box (*Eucalyptus melliodora*), fuzzy box (*Eucalyptus conica*), Blakely's red gum (*Eucalyptus blakelyi*) and rough-barked apple (*Angophora floribunda*). These communities also occur elsewhere within the PAA where alluvium is deep or absent. Any groundwater use by terrestrial vegetation in riparian areas is therefore assumed to be opportunistic rather than dependent where alluvial sediments occur.

ii Base flow in streams

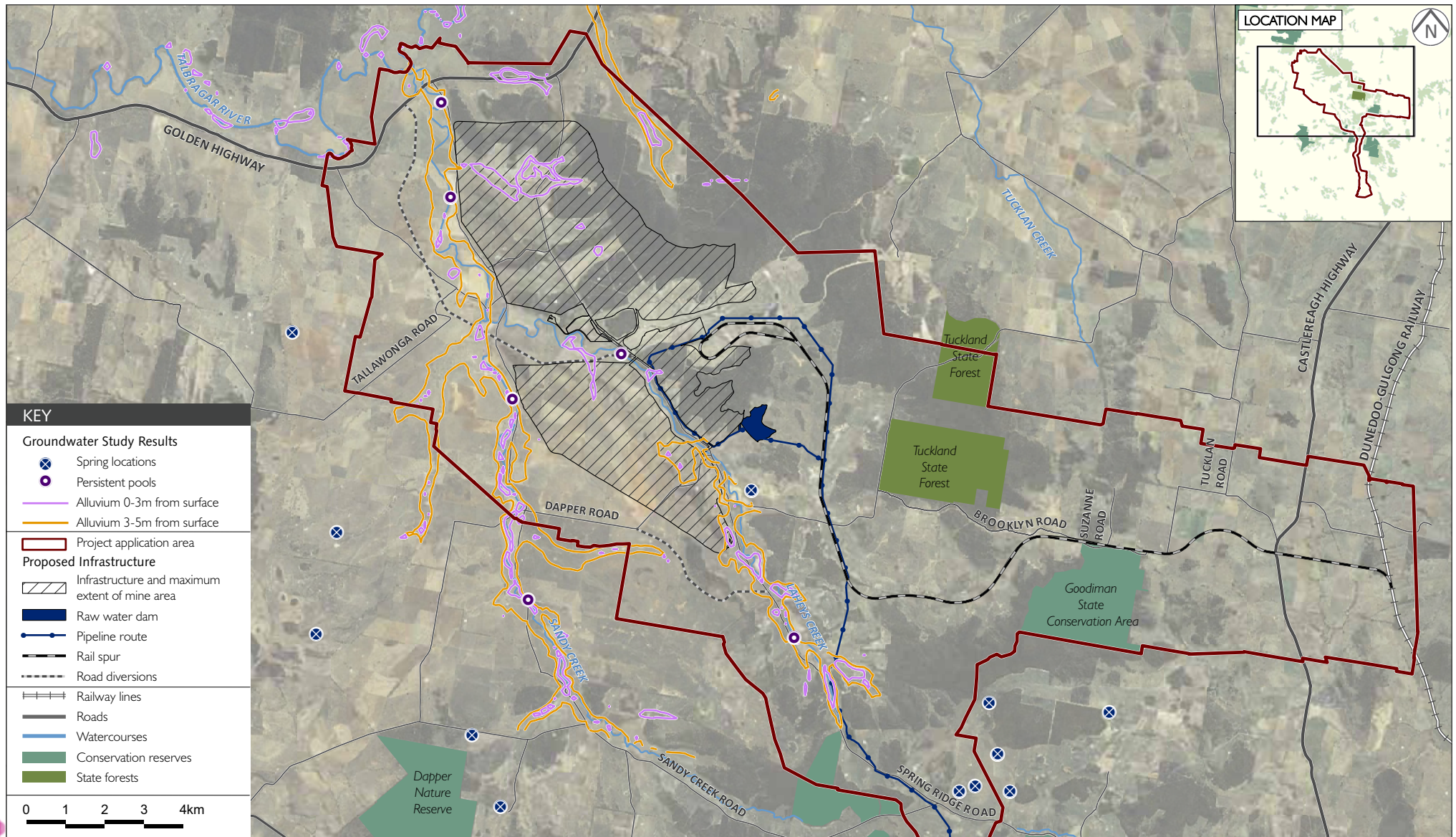
Groundwater from the PAA flows towards the Talbragar River, contributing to baseflow (Appendix E 'Surface water assessment'). Under typical conditions, baseflow is low and insufficient to create a continuously flowing river. However, the groundwater contribution to the waterways of the PAA may be important to the persistence of pool 'refugia' during periods of low rainfall. The species that inhabit persistent pools are therefore likely to be dependent on groundwater in times of low water flows.



Vegetation Types and Threatened Ecological Communities

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Figure 10.6



Source: PB (2012)

Location of Potential GDEs based on Depth to Alluvium and Persistent Pools

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Figure 10.7

10.3.4 Flora

Four threatened flora species were recorded in the PAA (Figure 10.8). These species, along with their conservation status and details of occurrence are listed in Table 10.3.

Table 10.3 Threatened flora species recorded within the PAA

Species	Status		Details of occurrence
	TSC Act	EPBC Act	
Ausfeld's wattle <i>Acacia ausfeldii</i>	V	-	Recorded along roadsides, along Brooklyn Road in Goodiman State Conservation Area within Blue-leaved Ironbark and Slaty Gum Woodland, and along Spring Ridge Road and Sandy Creek Road in Mugga Ironbark Grey Box Woodland. A large sub-population was recorded in regrowth vegetation, where it was the dominant species, adjacent to Goodiman SCA. The sub-population in this area was estimated at 55,000 individuals, based on 10 m by 10 m plots recording 100 plants. It is estimated that 56,000 plants occur within the study area.
Ingram's zieria <i>Zieria ingramii</i>	E	E	Recorded on gentle slopes and relatively flat topography in Blue-leaved Ironbark Woodland, Red Stringybark Woodland or less commonly in Dwyer's Red Gum Woodland; 1,255 individual plants in 15 sub-populations were recorded.
<i>Homoranthus darwinioides</i>	V	V	Two sub-populations were recorded as more than 427 individuals in Dwyer's Red Gum Woodland, Blue-leaved Ironbark Woodland and surrounding regrowth. <i>H. darwinioides</i> was most abundant where the canopy was sparse. In the regrowth areas, it occurred as large solitary plants on open ground amongst dense patches of Sifton Bush.
<i>Tylophora linearis</i>	V	E	Nine individuals were recorded in two sub-populations in Blue-leaved Ironbark and Red Gum Woodlands.

Note: 1. TSC Act – Threatened Species Conservation Act 1995 (NSW), EPBC Act – Environment Protection and Biodiversity Conservation Act 1999 (Cth), V – vulnerable, E – endangered.

The majority of flora species recorded within the PAA were native. Of the 257 species recorded, 18% were exotic (Appendix H 'Terrestrial ecology assessment'). Of the exotic species recorded, four are listed as noxious weeds:

- St John's wort (*Hypericum perforatum*);
- African boxthorn (*Lycium ferocissimum*);
- common prickly pear (*Opuntia stricta*); and
- blackberry (*Rubus fruticosus* sp. *aggregata*).

10.3.5 Fauna habitat

The PAA provides a range of habitat resources for fauna species, including hollow-bearing trees, fallen timber, flowering trees and shrubs, woody fruits and seeds, rocky outcrops and bush rock, persistent waterholes and large artificial water sources.

While the PAA has been subject to clearing for agriculture and ongoing firewood collection, hollow-bearing tree density was typical of undisturbed woodlands within box woodlands, ironbark/stringybark woodlands and red gum woodlands (NSWSC 2007).

Winter flowering species including mistletoes occur throughout the PAA providing important foraging resources for fauna, particularly birds. The woody fruits of the buloke (*Allocasuarina luehmanni*) provide a significant resource for the glossy black-cockatoo. Native grass seeds provide important foraging habitat for the diamond firetail (*Stagnopleura guttata*).

Rock outcropping occurs throughout the PAA, providing fauna shelter and roosting sites, particularly for bats. These areas also provide important habitat for reptile species.

Although Sandy Creek, Laheys Creek and the Talbragar River are often dry, they provide aquatic habitat when flowing. In-channel habitat recorded included macrophyte beds, submerged woody debris, deep pools, and a variety of substrata such as bedrock, sand bars, gravel beds, boulders, cobble and pebbles. Persistent pools in these waterways form refuges for aquatic fauna. Other (mainly upper) sections of waterways were extremely degraded and were classed as containing 'unlikely' to 'minimal' fish habitat (see Figure 10.5). Several large dams in the PAA provide habitat for frogs, some fish species and water resources for terrestrial fauna.

10.3.6 Fauna

i Terrestrial fauna

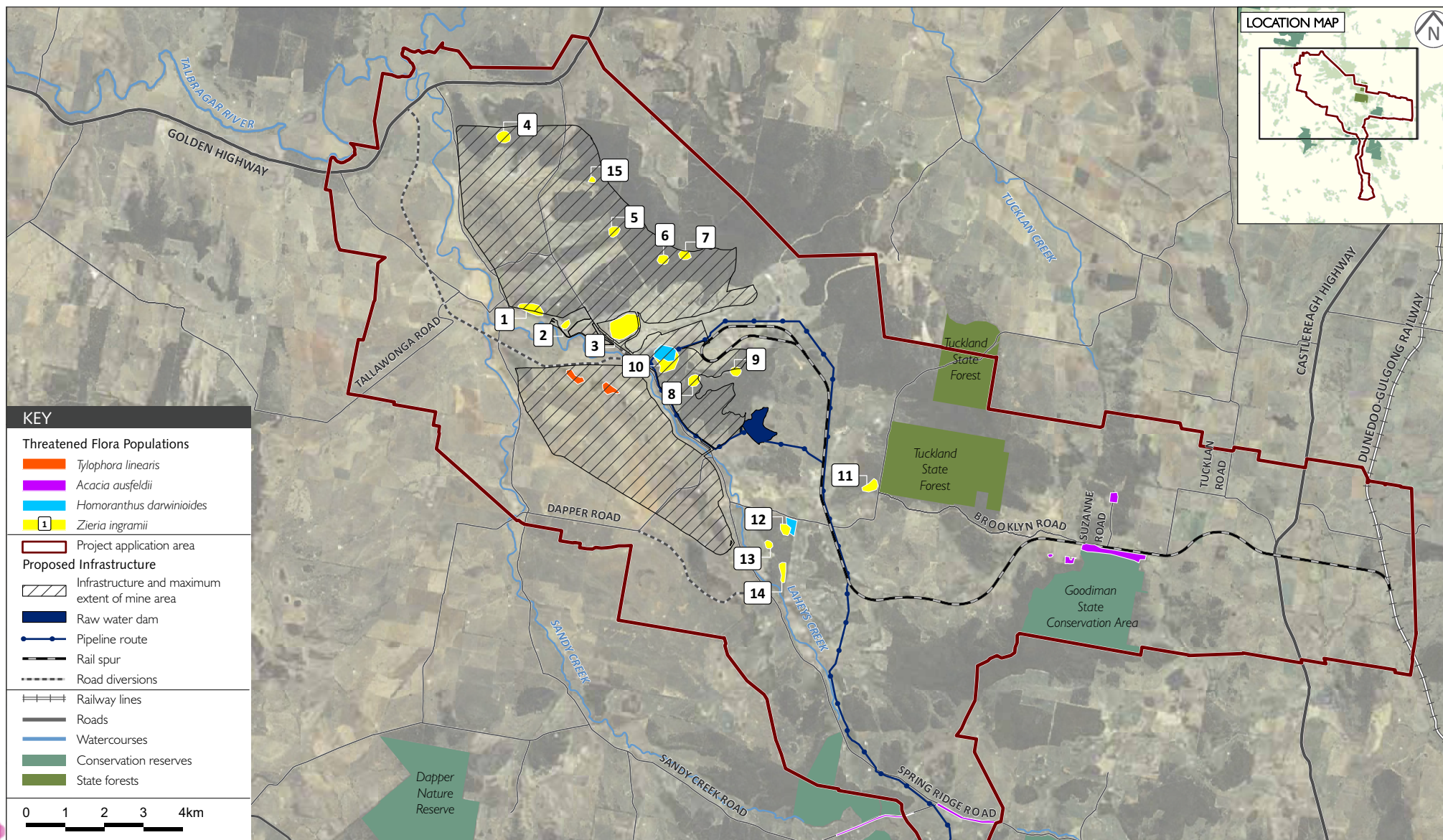
Amphibian diversity in the PAA is high for the region when compared with other studies (Goldney et al. 2007), with 17 species recorded in the PAA. This may have been because the surveys were undertaken in a wet period in 2011. Frogs were abundant in the many farm dams within the PAA, and were less abundant in riparian zones. This may be because suitable breeding conditions occur in the still water of dams, while frequent flash flooding was occurring in the creeks during the survey.

In general, reptile diversity in the PAA (a total of 25 reptile species were recorded) is moderate when compared with other regional studies (Goldney et al. 2007). Reptile abundance at the site is low, with only a few individuals of most species recorded in the PAA.

No threatened amphibian or reptile species were recorded in the PAA. Potentially suitable habitat occurs within the PAA for Sloane's froglet (*Crinia sloanei*) and the pale-headed snake (*Hoplocephalus bitorquatus*) (Table 10.4).

A total of 168 bird species were recorded within the PAA. This represents 67% of species known to occur within the Dubbo area (Hosking et al. 2010) and 77% of the species recorded within the Cobbora 1:100,000 map sheet by Birds Australia (2011). Thus, bird diversity within the PAA is relatively high when compared with local registers, but more moderate when compared with larger regional studies (Goldney et al. 2007).

Woodland birds identified within the study area comprised a mixture of those typically found on the eastern side of the Great Dividing Range, and those most often recorded in the Pilliga to the west of the PAA. As such, the PAA represents a transitional zone for woodland bird species.



Threatened Flora Populations of the PAA

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Figure 10.8

Seventeen bird species listed as threatened under the TSC Act were recorded. The most commonly recorded threatened species were the brown tree creeper (*Climacteris picumnus victoriae*), speckled warbler (*Chthonicola sagittata*) and varied sittella (*Daphoensitta chrystoptera*). Less commonly recorded species included the hooded robin (*Melanodryas cucullata*), glossy black-cockatoo, diamond firetail and grey-crowned babbler (*Pomatostomus temporalis*). A number of additional threatened bird species that were not recorded in the PAA were considered likely to occur (Table 10.4). Such species have been recorded recently nearby or are known to use habitat within the region similar to that provided within the PAA. Two species are also listed under the EPBC Act (Figure 10.9 and Table 10.4). In addition, three migratory bird species listed under the EPBC Act were recorded.

Non-flying mammal diversity was low in the PAA, with 21 species recorded. Almost half of these are pest species. Macropods were the most diverse and numerous mammal species recorded in the PAA.

No threatened mammal species were recorded in the PAA. Potential habitat occurs for several threatened mammal species that are known to occur sporadically throughout the region, including the squirrel glider (*Petaurus norfolkensis*), spotted-tail quoll (*Dasyurus maculatus*) and eastern pygmy-possum (*Cercartetus nanus*) (Table 10.4).

The occurrence of koala habitat was assessed in accordance with SEPP 44. The assessment identified two feed tree species listed on Schedule 2 of SEPP 44, white box (*Eucalyptus albens*) and river red gum (*E. camaldulensis*). Both species are considered rare in the PAA. Additional feed trees listed for the Western Slopes and Plains Koala Management Area (DECCW 2008b) were identified in the PAA. However, surveys failed to find any signs of koala use. Given the presence of feed tree species, it is assumed the koala could occur in low numbers in the PAA.

Bat activity levels and species diversity are high in the PAA. Cave-roosting and tree-roosting bat species were recorded within the PAA. Sixteen bat species were recorded, five of which are listed as threatened under the TSC Act (Figure 10.9) (Table 10.4). Two of these species, the large-eared pied bat (*Chalinolobus dwyeri*) and the southern long-eared bat (*Nyctophilus corbeni*) are also listed as threatened under the EPBC Act.

Table 10.4 Threatened fauna species recorded or likely to occur within the PAA

Species	Status		Recorded within the PAA
	TSC Act	EPBC Act	
Amphibians			
Sloane’s froglet (<i>Crinia sloanei</i>)	V	-	No – moderate potential for occurrence
Reptiles			
Pale-headed snake (<i>Hoplocephalus bitorquatus</i>)	V	-	No – moderate potential for occurrence
Birds			
Australasian bittern (<i>Botaurus poiciloptilus</i>)	E	E	Yes
Barking owl (<i>Ninox connivens</i>)	V	-	Yes
Black-breasted buzzard <i>Hamirostra melanosternon</i>	V	-	No – moderate potential for occurrence
Black-chinned honeyeater (eastern subspecies) <i>Melithreptus gularis gularis</i>	V	-	No – moderate potential for occurrence
Blue-billed duck (<i>Oxyura australis</i>)	V	Mi	Yes
Brolga (<i>Grus rubicund</i>)	V	-	No – moderate potential for occurrence

Table 10.4 Threatened fauna species recorded or likely to occur within the PAA (Cont'd)

Species	Status		Recorded within the PAA
	TSC Act	EPBC Act	
Brown treecreeper (<i>Climacteris picumnus victoriae</i>)	V	-	Yes
Bush stone-curlew (<i>Burhinus grallarius</i>)	E	-	No – high potential for occurrence
Cattle egret (<i>Ardea ibis</i>)	-	Mi	Yes
Diamond firetail (<i>Stagnopleura guttata</i>)	V	-	Yes
Flame robin (<i>Petroica phoenicea</i>)	V	-	No – moderate potential for occurrence
Freckled duck (<i>Stictonetta naevosa</i>)	V	-	No – moderate potential for occurrence
Gilbert's whistler (<i>Pachycephala inornata</i>)	V	-	No – moderate potential for occurrence
Glossy black-cockatoo (<i>Calyptorhynchus lathami</i>)	V	-	Yes
Great egret (<i>Ardea alba</i>)	-	Mi	Yes
Grey-crowned babbler (<i>Pomatostomus temporalis</i>)	V	-	Yes
Hooded robin (<i>Melanodryas cucullata</i>)	V	-	Yes
Little eagle (<i>Hieraaetus morphnoides</i>)	V	-	No – moderate potential for occurrence
Little lorikeet (<i>Glossopsitta pusilla</i>)	V	-	Yes
Masked owl (<i>Tyto novaehollandiae</i>)	V	-	Yes
Malleefowl (disused nests) (<i>Leipoa ocellata</i>)	E	E, Mi	Yes
Painted honeyeater (<i>Grantiella picta</i>)	V	-	No – moderate potential for occurrence
Powerful owl (<i>Ninox strenua</i>)	V	-	Yes
Rainbow bee-eater (<i>Merops ornatus</i>)	-	Mi	Yes
Regent honeyeater (<i>Anthochaera phrygia</i>)	CE	E	No – high potential for occurrence
Scarlet robin (<i>Petroica boodang</i>)	V	-	No – moderate potential for occurrence
Speckled warbler (<i>Chthonicola saggitata</i>)	V	-	Yes
Spotted harrier (<i>Circus assimilis</i>)	V	-	No – moderate potential for occurrence
Square-tailed kite (<i>Lophoictinia isura</i>)	V	-	No – high potential for occurrence
Superb parrot (<i>Polytelis swainsonii</i>)	V	V	Yes
Swift parrot (<i>Lathamus discolor</i>)	E	E	No – moderate potential for occurrence
Turquoise parrot (<i>Neophema pulchella</i>)	V	-	Yes
Varied sitella (<i>Daphoenositta chrysoptera</i>)	V	-	Yes
White-fronted chat (<i>Epthianura albifrons</i>)	V	-	Yes
Bats			
Eastern bent-wing bat (<i>Miniopterus schreibersii oceanensis</i>)	V	-	Yes
Eastern cave bat (<i>Vespadelus troughtoni</i>)	V	-	No – high potential for occurrence
Large-eared pied bat (<i>Chalinolobus dwyeri</i>)	V	V	Yes
Little pied bat (<i>Chalinolobus picatus</i>)	V	-	Yes
Southern long-eared bat (<i>Nyctophilus corbeni</i> (syn. <i>timoriensis</i>))	V	V	Yes
Yellow-bellied sheath-tail bat (<i>Saccolaimus flaviventris</i>)	V	-	Yes

Table 10.4 Threatened fauna species recorded or likely to occur within the PAA (Cont'd)

Species	Status		Recorded within the PAA
	TSC Act	EPBC Act	
Non-flying mammals			
Eastern pygmy-possum (<i>Cercartetus nanus</i>)	V	-	No – moderate potential for occurrence
Koala (<i>Phascolarctos cinereus</i>)	V	V	No – moderate potential for occurrence
Spotted-tailed quoll (<i>Dasyurus maculatus</i>)	V	V	No – moderate potential for occurrence
Squirrel glider (<i>Petaurus norfolkensis</i>)	V	-	No – moderate potential for occurrence

Note: 1. TSC Act – Threatened Species Conservation Act 1995 (NSW), EPBC Act – Environment Protection and Biodiversity Conservation Act 1999 (Cth), V – vulnerable, E – endangered, Mi – migratory.

iii Aquatic fauna

Water quality in Sandy Creek, Laheys Creek and the Talbragar River was poor during low and high flow events, sampled during the aquatic surveys in 2009 and 2011 respectively. Salinity and turbidity were often above the ANZECC reference trigger values for aquatic ecosystems during the survey, whilst dissolved oxygen was below the lower ANZECC trigger value.

The AusRivAS protocol found that the aquatic macro-invertebrate assemblages present indicate moderate pollution or local habitat degradation of the major creeks. Sampling of macroinvertebrates revealed a number of taxa that are sensitive to low dissolved oxygen levels were absent and the assemblages represent a more lake-like rather than riverine environment. This is likely to be due to the lack of surface water flow at the time of sampling, even under high flow conditions (after heavy rainfall). A desktop review identified 28 fish species that could occur within the PAA, with seven being introduced and six listed as threatened under the FM Act. Eight fish species were recorded during the field assessment. These were the introduced carp (*Cyprinus carpio*), goldfish (*Carassius auratus*), redfin perch (*Perca fluviatilis*), mosquitofish (*Gambusia holbrooki*), and the indigenous native carp gudgeon (*Hypseleotris* spp.), golden perch (*Macquaria ambigua ambigua*), Australian smelt (*Retropinna semoni*) and freshwater catfish (*Tandanus tandanus*). Invasive fish species had the highest abundance, diversity and distribution.

The Murray-Darling population of freshwater catfish are listed as endangered under the FM Act. Two individuals were observed in small pools, one in Laheys Creek and one downstream of the confluence of Sandy Creek and Laheys Creek (Figure 10.9). The species has been previously recorded from the Talbragar River and the PAA is considered part of a remnant sub-population in the Macquarie River catchment.

Potential habitat for the trout cod (*Maccullochella macquariensis*) and Murray cod (*Maccullochella peelii peelii*), which are listed in the EPBC Act, occurs within the PAA. Potential habitat also occurs for the southern purple-spotted gudgeon (*Mogurnda adspersa*), western population of the olive perchlet (*Ambassis agassizii*) and the silver perch (*Bidyanus bidyanus*), which are listed in the FM Act. None of these species were observed during the field assessments and there are no records for their occurrence in the PAA. This absence may reflect a lack of previous sampling within the region, as local historical accounts (by long-term residents) occur for the Murray cod and silver perch in the Talbragar River. Given the regional degradation of waterways as a result of water extraction, upstream diversions and nearby land practices, it is possible the waterways of the PAA no longer support viable populations of these species.

Trout cod, Murray cod and silver perch are known to inhabit the Macquarie River downstream of the Talbragar River, with the latter species known to migrate long distances upstream to spawn. Therefore, despite regional habitat degradation, it is possible these species use waterways in the PAA during peak flow events over spring and early summer.

Trout cod have been stocked in the Macquarie River at Dubbo but it is unknown if these have established a reproducing population. However, as they have small home ranges and do not go on large-scale spawning migrations, it is unlikely they have become established in the PAA. The unregulated Talbragar River represents potential (though marginal) habitat for the trout cod, should their population increase. Similarly, although it is unlikely that the southern purple-spotted gudgeon inhabit the PAA (a new population was recently discovered in the upper Macquarie River catchment), the persistent pools within the Talbragar River (or its tributaries) constitute potential habitat for the species.

10.4 Environmental management

The following section provides a description of avoidance measures already implemented as part of the Project design, and management measures that will be implemented during its construction and operation.

10.4.1 Avoidance

Design changes to avoid sensitive ecological features in the PAA include:

- the diversion of creeks to accommodate the mine has been avoided by reducing and reconfiguring the mining area, which has minimised;
 - clearing riparian vegetation,
 - impacts to large areas of terrestrial and aquatic TECs, and
 - impacts to threatened species habitat, particularly for the freshwater catfish population;
- removing a proposed coal conveyor and thereby minimising clearing requirements (particularly a large sub-population of Ingram's zieria) and maintaining a wildlife corridor that will be further enhanced as part of biodiversity offset strategy (see Section 10.7);
- infrastructure and emplacement areas have been moved to avoid impacts to a large sub-population of Ingram's zieria;
- road diversions have been designed to avoid clearing roadside vegetation, where possible, which consist mainly of TECs;
- waterway crossings will include two bridges, one over Sandy Creek and one over Laheys Creek, designed and constructed according to NSW Fisheries guidelines to ensure that native fish species can navigate road crossings;
- sediment and mine water dams will capture and treat runoff from the mine areas, ensuring water quality is not compromised in surrounding aquatic systems; and
- intake screening in the Cudgegong River water extraction site will minimise the potential for impacts on fish, larvae and eggs.