



CHAPTER **5.1**
BIODIVERSITY

5.1 Biodiversity

5.1.1 Overview

The assessment of terrestrial biodiversity impacts for Exploratory Works was undertaken by EMM (Appendix F), whilst Cardno assessed impacts to aquatic biodiversity (Appendix G).

The primary focus of this assessment process has been avoidance and minimisation of impacts through iterative design. Project ecologists have been a key part of the design process, providing information on biodiversity as it was identified and working with the design team to avoid and minimise impacts, where possible

The NSW *Biodiversity Conservation Act 2016* (BC Act) is the legislation responsible for the conservation of biodiversity in NSW. The BC Act, together with the NSW Biodiversity Conservation Regulation 2017, established the Biodiversity Offsets Scheme (BOS), which in turn established the biodiversity assessment method (BAM, OEH 2017). The biodiversity surveys, analysis and assessment for Exploratory Works have been undertaken in line with the requirements of the BAM. The aquatic assessment has been undertaken in line with the FM Act. For full and detailed information about the biodiversity and aquatic assessments and the survey methods used, refer to Appendix F and G.

As described in Section 3.3, a referral was prepared and lodged with the Commonwealth Department of Energy and Environment (DoEE) under the EPBC Act. The Commonwealth Minister's delegate determined on 10 July 2018 that Exploratory Works is not a controlled action, meaning that it does not require further assessment and approval under the EPBC Act before it can proceed.

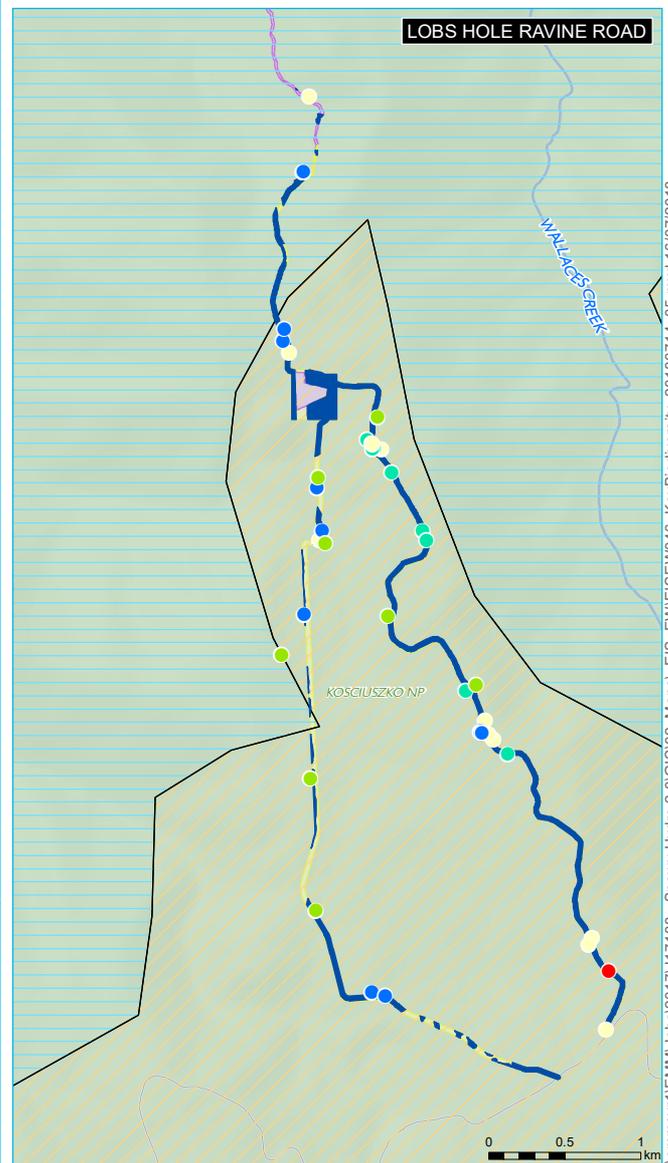
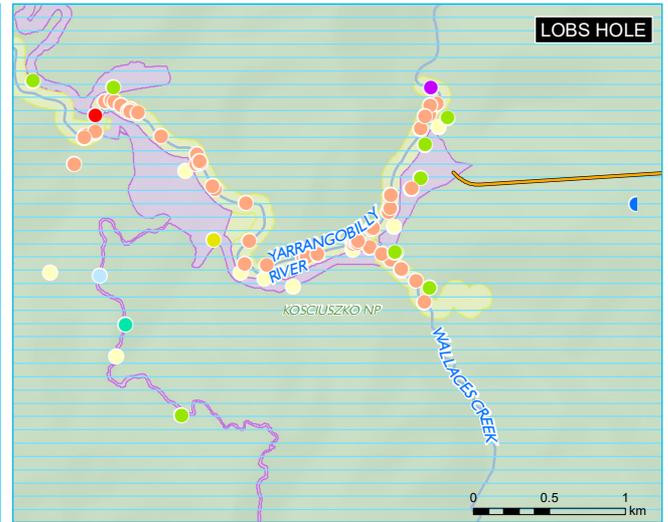
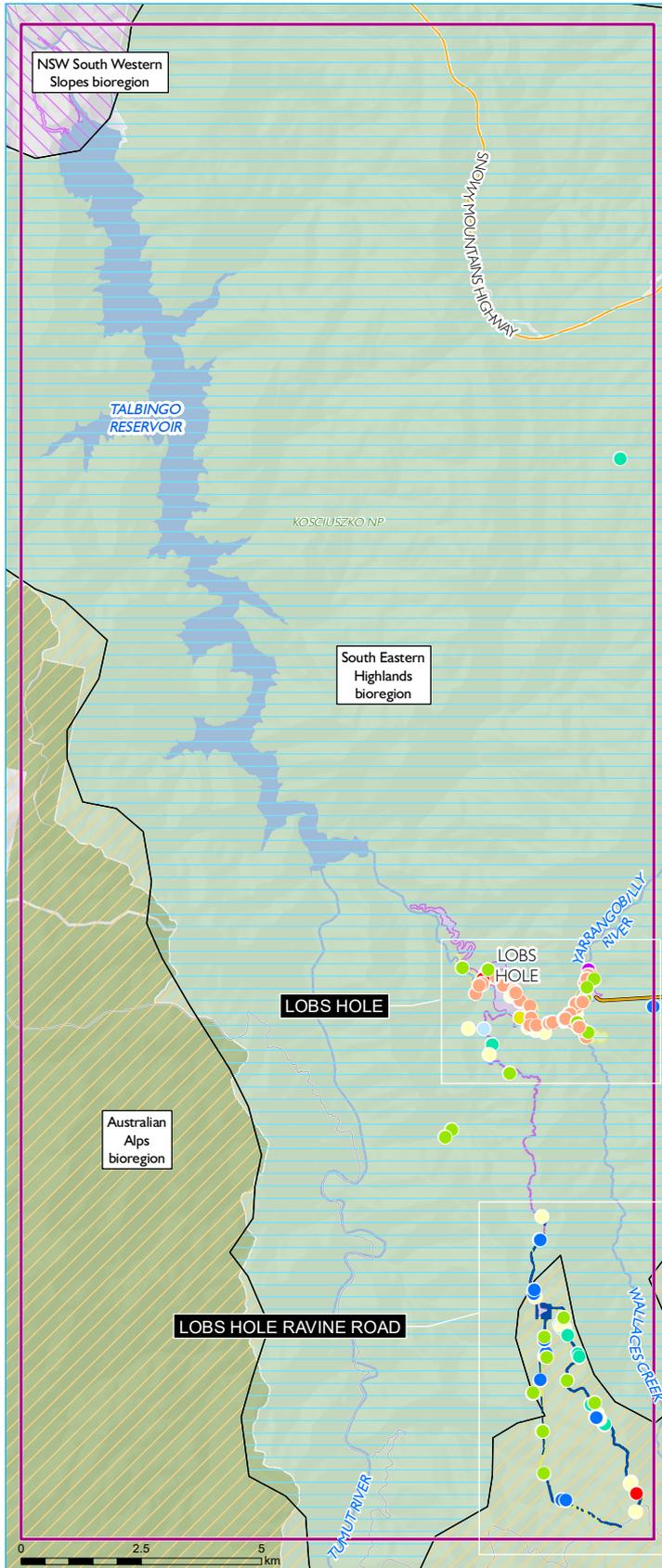
5.1.2 Existing environment

i Landscape features

Three Interim Biogeographic Regionalisation of Australia (IBRA) regions and subregions fall within the Exploratory Works project area (see Figure 5.1):

- NSW South Western Slopes IBRA region and Inland Slopes IBRA subregion (Talbingo barge ramp at the northern end of Talbingo Reservoir);
- Australian Alps IBRA region and Snowy Mountains IBRA subregion (the southern end of Lobs Hole Ravine Road); and
- South Eastern Highlands IBRA region and Bondo IBRA subregion (the majority of works, including access roads and activities in Lobs Hole).

The Exploratory Works project area is within the Murrumbidgee River catchment in the Australian Alps. The Murrumbidgee catchment is bordered by the Great Dividing Range to the east, the Lachlan Catchment to the north and the Murray Catchment to the south, covering an area of 84,000 square kilometres (km²). The major waterbodies and watercourses within the project area are Talbingo Reservoir, Yarrangobilly River and Wallaces Creek (see Figure 5.1). Smaller named third order tributaries of the Yarrangobilly River include Stable Creek, Lick Hole Creek and Cave Gully, which flow into the river from the south.



Source: EMM (2018); DFSI (2017); GA (2015)

KEY

- | | | |
|--------------------------|----------------------------------|----------------------------|
| Threatened fauna species | ● Smoky Mouse | — Local road |
| ● Booroolong Frog | ■ Smoky Mouse potential habitat | — Watercourse |
| ● Diamond Firetail | IBRA bioregion | ■ Waterbodies |
| ● Eastern Pygmy-possum | ▨ Australian Alps | ▨ Disturbance footprint |
| ● Flame Robin | ▨ NSW South Western Slopes | ▨ Avoidance footprint |
| ● Gang-gang Cockatoo | ▨ South Eastern Highlands | ▨ Kosciuszko National Park |
| ● Masked Owl | ▨ Exploratory Works project area | ▨ State forest |
| ● Murray Crayfish | — Exploratory tunnel | |
| ● Scarlet Robin | — Main road | |

GDA 1994 MGA Zone 55

Key biodiversity features

Snowy 2.0
Environmental Impact Statement
Exploratory Works
Figure 5.1

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ii Native vegetation

a. Overview

KNP is largely vegetated across its 673,543 ha area, with intact remnant vegetation extending into a further 1.6 million ha across the Australian Alps. The extent of vegetation across KNP provides a high degree of habitat connectivity. The wooded areas provide high connectivity for terrestrial and arboreal mammals, birds, and reptiles. The various waterways provide suitable river corridors for aquatic and semi-aquatic species (such as fish and amphibians) and species which use linear features (such as birds and bats) to navigate.

Native vegetation across the project area is described based on three key areas:

- Lobs Hole Ravine Road; vegetation along the upper (southern) extent of Lobs Hole Ravine Road is largely intact, with minimal disturbance evident. Vegetation comprises tall montane forests with large trees and a shrubby understorey. Weed invasion is minimal and limited to road edges. The lower reaches of Lobs Hole Ravine Road, generally below 1,200 m, comprise dry sclerophyll forests with a shrubby to grassy understorey. In some areas disturbance due to past land use is evident and significant, while in other areas there is minimal disturbance. Weediness varies, depending on past land use, and is heavy in some areas.
- Lobs Hole; first used in the early 1800s for the movement of stock, Lobs Hole has since been the site of prospecting, mining, grazing, settlement, refuge from the winters of Kiandra, gardening and agriculture. From the 1860s to approximately 1917, it was the site of a copper mine. Lobs Hole is now a public camping area with a boat ramp which is used to access the southern reaches of Talbingo Reservoir. These activities and past land uses have resulted in significant amounts of clearing and disturbance of vegetation in the area, and have modified native vegetation and fauna habitats. Native vegetation has re-established itself in the area; however, Blackberry, a weed of national significance, is at the point of infestation within the area, particularly in gullies and along the Yarrangobilly River.
- Northern end of Talbingo Reservoir; the area around the proposed barge access infrastructure at the northern end of Talbingo Reservoir has been subject to clearing and disturbance associated with the construction of the dam wall and Tumut 3 power station. Large areas have been cleared and are largely devoid of native vegetation. However, some areas of moderate quality vegetation are in the project area.

b. Plant community types

Plant community types (PCTs) are a NSW classification used to identify plant communities. Vegetation mapping identified nine PCTs within the project area (see Table 5.1). These nine PCTs include 28 vegetation zones. Of these zones, 17 show significant levels of existing disturbance, four show some degree of impact, and seven are considered representative of relatively intact vegetation of high quality.

Table 5.1 Plant Community Types mapped within the Exploratory Works project area

Plant community type	Vegetation formation	Area (ha)	Condition / Integrity	Ancillary Code
PCT 285 – Broad-leaved Sally grass – sedge woodland on valley flats and swamps in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	5.41	Moderate to Good	Poor
PCT 296 – Brittle Gum – Peppermint open forest of the Woomargama to Tumut region, NSW South Western Slopes Bioregion	Dry Sclerophyll Forest (Shrubby sub-formation)	42.51	Moderate to Good. One area Low	Poor to High. One area derived grassland
PCT 300 – Ribbon Gum - Narrow-leaved (Robertsons) Peppermint montane fern - grass tall open forest on deep clay loam soils in the upper NSW South Western Slopes Bioregion and western Kosciuszko escarpment	Wet Sclerophyll Forests (Grassy sub-formation)	8.12	Moderate to Good	Medium to High. One area derived grassland
PCT 302 - Riparian Blakely's Red Gum - Broad-leaved Sally woodland - tea-tree - bottlebrush - wattle shrubland wetland of the NSW South Western Slopes Bioregion and South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	10.38	Moderate to Good. One area Low	Poor to High. One area derived grassland
PCT 311 - Red Stringybark - Broad-leaved Peppermint - Nortons Box heath open forest of the upper slopes subregion in the NSW South Western Slopes Bioregion and adjoining South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrub/grass sub-formation)	7.17	Moderate to Good	Medium to High
PCT 643 - Alpine shrubland on scree, blockstreams and rocky sites of high altitude areas of Kosciuszko National Park, Australian Alps Bioregion	Alpine Complex	0.12	Low	-
PCT 729 - Broad-leaved Peppermint - Candlebark shrubby open forest of montane areas, southern South Eastern Highlands Bioregion and South East Corner Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	17.34	Moderate to Good	Poor to High. One area derived grassland

Table 5.1 Plant Community Types mapped within the Exploratory Works project area

Plant community type	Vegetation formation	Area (ha)	Condition / Integrity	Ancillary Code
PCT 999 - Norton's Box - Broad-leaved Peppermint open forest on footslopes, central and southern South Eastern Highlands Bioregion	Dry Sclerophyll Forests (Shrubby sub-formation)	0.64	Moderate to Good	High with one area derived grassland
PCT 1196 - Snow Gum - Mountain Gum shrubby open forest of montane areas, South Eastern Highlands Bioregion and Australian Alps Bioregion	Grassy Woodlands	2.73	Moderate to Good.	High with one area derived grassland

c. Threatened ecological communities

The nine PCTs listed in Table 5.1 have been reviewed against threatened ecological communities (TECs) listed under Commonwealth and NSW legislation. Three TECs were identified through geographic and habitat constraints as having potential to occur. However, following detailed desk and field studies, it was determined that none of these TECs occur in the project area.

d. Groundwater dependent ecosystems

A detailed assessment of potential groundwater impacts on groundwater dependent ecosystems (GDEs) is summarised in Appendix F. Three PCTs were identified as GDEs: *Broad-leaved Sally grass-sedge woodland (PCT 285)*, *Brittle Gum - Peppermint open forest (PCT 296)*, and *Riparian Blakeley's Red Gum – Broad-leaved Sally woodland (PCT 302)*. These PCTs are associated with the alluvial/colluvial areas along the Yarrangobilly River or associated tributaries.

The Yarrangobilly River is close to the exploratory tunnel, and may experience some minor associated groundwater effects from its construction. The groundwater study completed for Exploratory Works concluded that alluvial/colluvial aquifers along the Yarrangobilly River are expected to experience some reductions in baseflow (refer to Section 5.4). However, the level predicted is considered negligible and highly unlikely to affect GDEs. Further detail is provided in Appendix N.

iii Aquatic habitat

a. Yarrangobilly River and tributaries

Yarrangobilly River and Wallaces Creek are watercourses with substantial ecological value. The streams contain unconsolidated boulders, cobbles, pebbles and gravel with little evidence of siltation. Stream edges are well vegetated with riparian plants including several mature trees (including the weed blackberry along the Yarrangobilly River), which help stabilise banks, prevent sediment input and provide a source of food and habitat for aquatic plants and animals.

Nearby tributaries of Wallaces Creek (Lick Hole Creek and Sheep Station Creek) are ephemeral and provide aquatic habitat of lower value. In particular Sheep Station Creek was dry during field surveys. Only minimal flow was present in Lick Hole Creek. Cave Gully, a nearby tributary of Wallaces Creek, consisted of disconnected pools with no visible flow. These watercourses would provide very limited habitat for fish, but would provide more valuable refuge for aquatic macroinvertebrates and potentially burrowing crayfish. No natural or artificial barriers to fish passage were identified on the sections of Yarrangobilly River and Wallaces Creek within the project area. Although no aquatic plants were observed in the sections of watercourses surveyed this was not surprising given the fast flowing water and lack of fine sediment (which would discourage the establishment and growth of plants).

b. Talbingo Reservoir

Talbingo Reservoir provides aquatic habitat including some areas considered key fish habitat. In particular, extensive areas of wood debris (primarily submerged dead trees) and the non-native aquatic macrophyte *Elodea canadensis* (Canadian pondweed) along shallow edges and embayments. Only very small areas of *Elodea canadensis* and wood debris are present within the disturbance footprint for the Talbingo barge ramp, adjacent to the current spillway. This area includes unvegetated bare rock of low aquatic ecological value. Wood debris and elodea is present within the disturbance footprint for the Middle Bay barge ramp, as well as the adjacent shoreline. Aquatic habitat at potential subaqueous placement areas is likely to consist of soft sediment and wood debris, and provide food sources for macroinvertebrates and fish.

iv Threatened species

a. Threatened terrestrial flora surveys results

Three species of threatened flora were identified as having potential to occur within the project area based on background research. Following a candidate species assessment based on geographic and habitat constraints, only two species were considered to have potential to occur. However, no threatened flora species were recorded during targeted surveys for these species. All candidate threatened flora species are considered to have a low likelihood of occurrence with the project area following targeted surveys.

b. Threatened terrestrial fauna surveys results

Nineteen species of threatened fauna were identified as having potential to occur within the project area based on background research. Following a candidate species assessment based on geographic and habitat constraints, twelve species were considered to have potential to occur.

Ten threatened fauna species were recorded during targeted surveys within or adjacent to the project area; five ecosystem credit species and five species credit species (as defined under the BAM). These species are identified in Table 5.2.

Table 5.2 Threatened terrestrial fauna survey results

Common name	Scientific name	Conservation status in NSW (BC Act)	Commonwealth conservation status (EPBC Act)
Birds			
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	Vulnerable	Not listed
Diamond Firetail ¹	<i>Stagonopleura guttata</i>	Vulnerable	Not listed
Dusky Woodswallow ¹	<i>Artamus cyanopterus cyanopterus</i>	Vulnerable	Not listed
Flame Robin ¹	<i>Petroica phoenicea</i>	Vulnerable	Not listed
Scarlet Robin ¹	<i>Petroica boodang</i>	Vulnerable	Not listed
Varied Sittella ¹	<i>Daphoenositta chrysoptera</i>	Vulnerable	Not listed
Masked Owl	<i>Tyto novaehollandiae</i>	Vulnerable	Not listed
Mammals			
Eastern Pygmy-possum	<i>Cercartetus nanus</i>	Vulnerable	Not listed
Smoky Mouse	<i>Pseudomys fumeus</i>	Critically endangered	Endangered
Amphibians			
Booroolong Frog	<i>Litoria booroolongensis</i>	Endangered	Endangered

Notes: 1. ecosystem credit species (as defined by the BAM)

Further information regarding the key species (excluding ecosystem credit species) is given below and detailed information is provided in Appendix F. Species requiring compensatory measures are discussed as follows:

- Gang-gang Cockatoo** - Gang-gang Cockatoos were found to be common throughout the project area and observed foraging at several locations. It was most commonly observed in sub-alpine woodlands (such as at the upper section of Lobs Hole Ravine Road) and riparian areas at lower elevations (close to the Yarrangobilly River). Targeted nest searches were carried out across the project area. The species was not observed nesting but was observed investigating hollows on two occasions; once along the Yarrangobilly River and once along the upper section of Lobs Hole Ravine Road. Like other Cockatoos, Gang-gang Cockatoos nest in the trunks, limbs or dead spouts of tall, mature, living trees.
- Masked Owl** - this nocturnal predator was recorded at two locations during targeted surveys; on the Yarrangobilly River in Lobs Hole and along the upper section of Lobs Hole Ravine Road, near the intersection with Link Road. Both records were from the species being 'called in' as a result of call playback. Masked Owls typically nest in large, old, hollow eucalypts. Nesting hollows are larger than 40 cm wide and 100 cm deep. Suitable sized breeding trees and hollows are restricted to the two areas where the species was observed.
- Smoky Mouse** - extensive targeted surveys for the Smoky Mouse were carried out and identified the species at 12 locations in the project area (Figure 5.2). The species distribution is predominantly associated with a single vegetation community (PCT 1196) along the upper section of Lobs Hole Ravine Road, above 1,100 m elevation. In this area vegetation consists of tall forests dominated by Mountain Gum and Snow Gum, with a moderate to dense shrubby midstorey dominated by shrubs from the plant family Fabaceae (with some Epacridaceae and Mimosaceae), and dense groundcover with abundant sub-shrubs, logs and leaf litter.

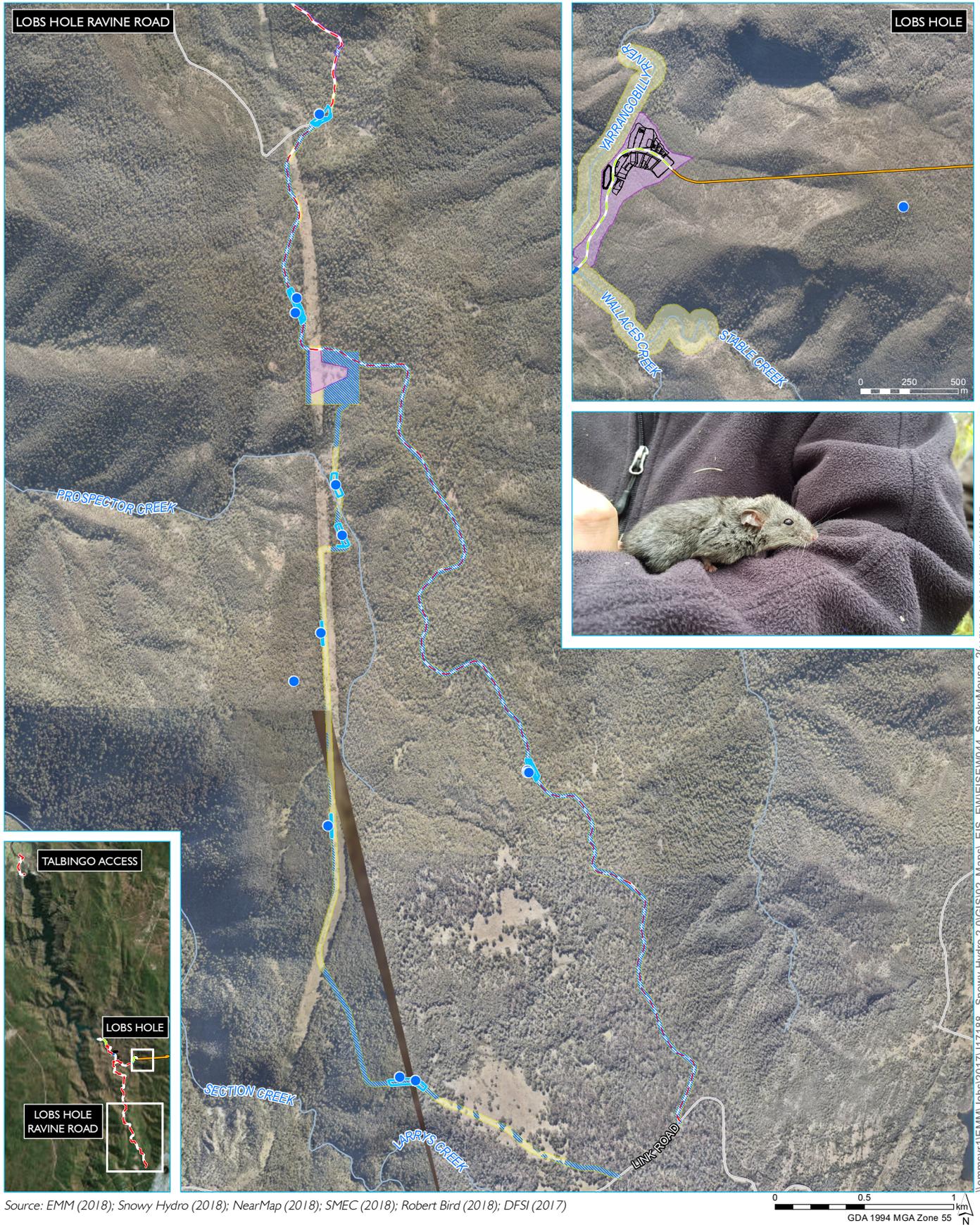
- **Eastern Pygmy-possum** - this species was recorded at several locations within the project area, from the upper section of Lobs Hole Ravine Road to Lobs Hole. It was found to inhabit a broad range of habitats with a suitably dense understorey with flowering Banksias; woodlands and heath were preferred. The species feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes and there is a strong association with Banksias and a dense, flowering understorey.
- **Booroolong Frog**. - This species was recorded within the project area along the Yarrangobilly River, from the FSL of Talbingo Reservoir to the upper reaches of the Yarrangobilly River, as well as along Wallaces Creek (see Figure 5.3). The Yarrangobilly River provides optimal breeding habitat for this species, with a series of cobble banks and bedrock structures along stream margins, with slow-flowing water. These areas are connected by larger, slow-flowing pools.

c. **Threatened aquatic fauna surveys results**

An assessment of the likelihood of occurrence of all threatened aquatic species identified five with potential to occur:

- Murray Crayfish (vulnerable in NSW) - has a high chance of occurring in Yarrangobilly River and Wallaces Creek;
- Trout Cod (endangered in NSW and Commonwealth listed) – stocking records in Talbingo Reservoir suggest it has a moderate chance of occurring;
- Macquarie Perch (endangered in NSW and Commonwealth listed) – stocking records in Talbingo Reservoir suggest it has a moderate chance of occurring both here and in the Yarrangobilly River; and
- Murray Cod (Commonwealth listed as vulnerable) and Silver Perch (vulnerable in NSW) – these species have been stocked in Blowering Dam and there is a possibility, albeit low, that they have also been introduced to Talbingo Reservoir.

Murray Crayfish was the only threatened aquatic species detected during surveys. During surveys of Yarrangobilly River and Wallaces Creek, Murray Crayfish were observed and were also detected in environmental deoxyribonucleic acid (DNA) sampling. Threatened Macquarie Perch, Trout Cod, Murray Cod and Silver Perch were not identified during field surveys or in environmental DNA samples taken in Talbingo Reservoir. It is not known whether any self-sustaining populations of these species are present. Suitable habitat for Macquarie Perch exists within Yarrangobilly River.



Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)

KEY

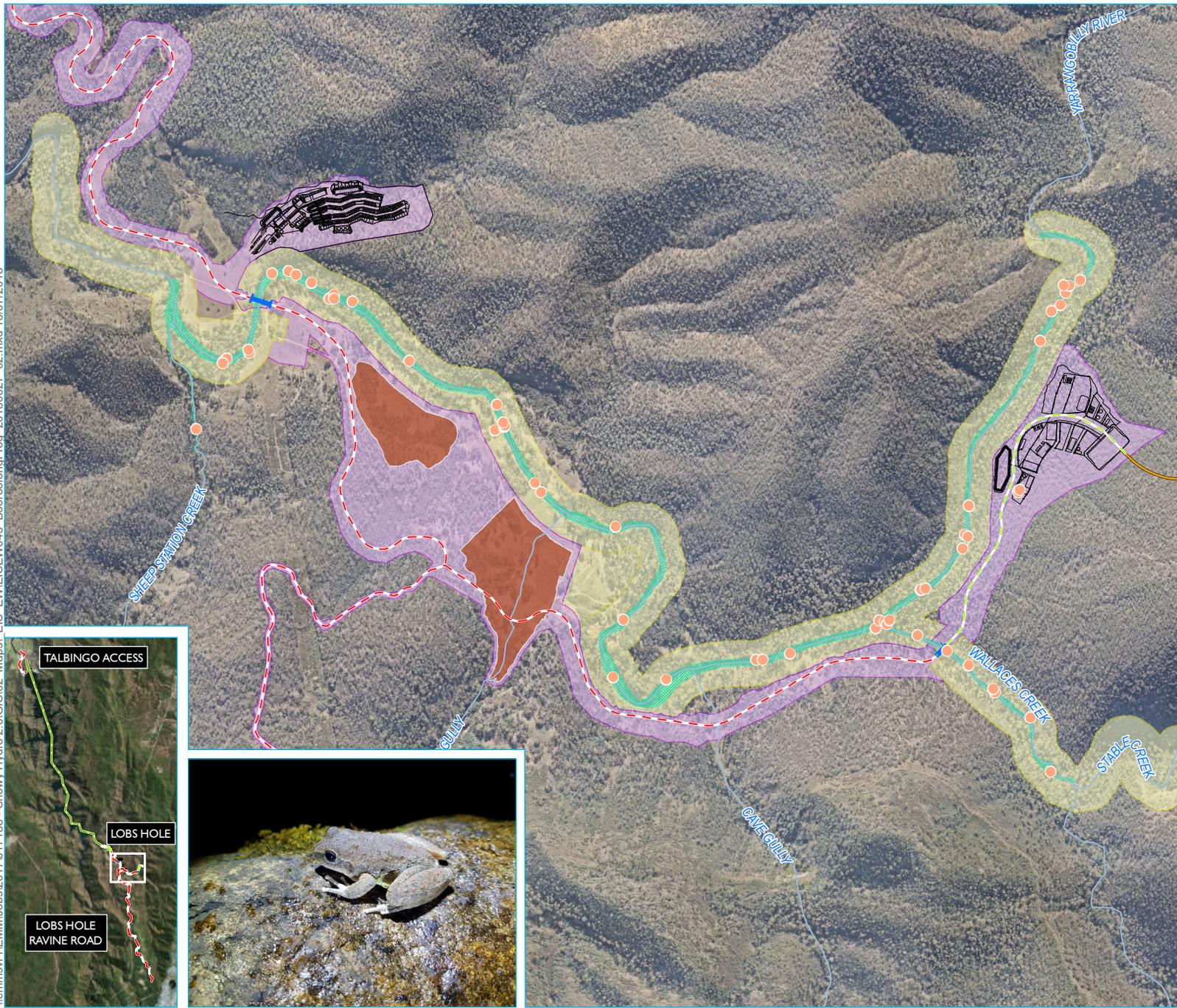
- - - Access road upgrade
- - - Access road extension
- Exploratory tunnel
- Portal construction pad conceptual layout
- Permanent bridge
- Local road or track
- Watercourse
- Smoky Mouse (12 recorded)
- ▨ Smoky Mouse potential habitat
- ▨ Smoky Mouse confirmed habitat
- ▨ Disturbance footprint
- ▨ Avoidance footprint

Smoky Mouse records and potential habitat

Snowy 2.0
Environmental Impact Statement
Exploratory Works
Figure 5.2

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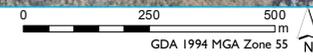
- KEY**
- - - Access road upgrade
 - - - Access road extension
 - Exploratory tunnel
 - Portal construction pad and accommodation camp conceptual layout
 - Permanent bridge
 - On land rock management
 - Watercourse
 - Booroolong Frog (56 recorded)
 - ▨ Booroolong Frog - breeding habitat
 - ▨ Booroolong Frog - potential dispersal and refuge habitat (avoidance area - 50 m from top of bank)
 - ▨ Disturbance footprint



Booroolong Frog records and potential habitat

Snowy 2.0
Environmental Impact Statement
Exploratory Works
Figure 5.3

Source: EMM (2018); Snowy Hydro (2018); NearMap (2018); SMEC (2018); Robert Bird (2018); DFSI (2017)



5.1.3 Assessment of impacts

i Avoidance and minimisation of impacts

A key focus of Snowy Hydro, EMM and the project design team has been to avoid and minimise impacts to biodiversity and key fish habitat. The process below has been followed to ensure impacts are avoided and minimised to the greatest extent possible, within the design and other limitations of the project:

- identification of biodiversity values through comprehensive surveys;
- communication of identified values to the project team;
- consultation between the design team and project ecologists to achieve best practice outcomes;
- consultation with key government stakeholders, in particular NPWS and OEH, to seek input and discuss measures proposed to avoid, minimise and mitigate impacts; and
- finalisation of measures to avoid, minimise and mitigate impacts.

Several threatened species and their habitat were key drivers for changes made to design, including Smoky Mouse, Booroolong Frog, Murray Crayfish and Macquarie Perch. The emphasis placed on the Smoky Mouse during design is because of its confirmed presence, its critically endangered conservation status, its specific and limited habitat range, and its susceptibility to impacts. Similarly the Booroolong Frog and Murray Crayfish are present in the Yarrangobilly River and have varied susceptibility to impacts. Macquarie Perch was not detected but potential key fish habitat exists in Yarrangobilly River, warranting consideration in design.

The following measures to avoid and minimise impacts have been implemented during the design process.

a. Upper Lobs Hole Ravine Road

The initial design was to upgrade the upper section of Lobs Hole Ravine Road to a dual lane access road, resulting in road widening and an estimated 4 to 5 ha of vegetation removal. Since the initial identification of Smoky Mouse (as well as Gang-gang Cockatoo, Eastern Pygmy-possum and Masked Owl) in this area, a number of alternatives to widening were considered. This resulted in a fundamental change in design, whereby a barge is proposed to be used to transport large and heavy materials and equipment to the site via the Middle Bay barge ramp. This has reduced the need to under the road and significantly reduced the amount of potential vegetation and threatened species habitat removal.

Upgrades will now be restricted to the existing surface, with some minor works and a lay down area. No clearing of habitat for Smoky Mouse (or any threatened species) will result from these minor upgrade works. Indirect impacts could occur due to fauna vehicle strikes if vehicles are moving during the night time when the Smoky Mouse and Eastern Pygmy-possum are active, or through the introduction of weeds or pathogens. To prevent this, the following controls will be implemented:

- vehicle movements on Lobs Hole Ravine Road will be limited to daytime only. Only emergency situations are expected to need night time movements;
- a 40 km/h speed limit (day time) will be imposed on Lobs Hole Ravine Road, with night time movements (if required) limited to 20 km/h;

- a weed and pathogen monitoring and trial program will be implemented; and
- wash-down stations will be built at suitable locations.

b. Lobs Hole

To transport equipment and materials from the Middle Bay barge access to construction areas, an upgrade of Lobs Hole Road and Mine Trail Road, adjacent to the Yarrangobilly River, is needed. Early in the design phase, a key measure to avoid impacts was to prohibit disturbance within a 50 m buffer from high bank of the Yarrangobilly River. In consultation with recognised government species experts, including from NPWS and OEH, it was determined that if works can be avoided within this buffer, direct impacts to Booroolong Frog and their habitat can be avoided, along with most indirect impacts.

Two bridges will be built to transport equipment and materials from the barge access to the portal construction area. Upgrades to the Mine Trail Road in the eastern section of Lobs Hole will use the existing track network to avoid impacts within the 50 m buffer zone. As a result, the proposed road upgrade will disturb the 50 m buffer zone at three discrete locations: the bridge over the Yarrangobilly River; the bridge over Wallaces Creek; and along Mine Trail Road in the eastern section of Lobs Hole Ravine. The bridge design for both locations will include a single span bridge. This has been recommended to minimise structures within the river or creek, to maintain fish passage and to avoid impacts to Macquarie Perch, if they are present.

c. Exploratory tunnel, portal and portal construction pad

The design of the portal construction pad originally occupied a much larger area. As part of the iterative design process, the portal construction pad has been significantly reduced in size to make best use of limited space, in consideration of the biodiversity of the area and minimising loss of native vegetation. The exploratory tunnel, portal and portal construction pad has been sited outside the Yarrangobilly River 50m buffer zone, avoiding direct impacts to habitat for the Booroolong Frog. Additionally, considerable design work has been undertaken to manage and minimise stormwater run-off in this area to avoid indirect impacts to the habitat for the Booroolong Frog and Murray Crayfish. Potential impacts to manage are limited to road works and potential for contamination of receiving waters due to accidental leaks and spills or fire water discharge.

d. Accommodation camp

During the siting of the accommodation camp, the biodiversity of Lobs Hole was considered. The accommodation camp needed to be in close proximity to the works area, but not adjacent, and outside of the flood zone. An existing cleared area to the south-west of the current location was considered; however, this area is within the flood zone and is not suitable for accommodation purposes. The current location was chosen as this area has been disturbed previously, with clearing of overstorey species and a disturbed ground layer still evident. The siting of the accommodation camp has also minimised the loss of native vegetation.

e. Excavated rock management

It is estimated that up to 750,000 m³ of bulked materials will be excavated during Exploratory Works. The excavated material will be placed in one of two rock emplacement areas at Lobs Hole; one to the east in Lick Hole Gully, and one to the west below and backing onto a steep escarpment. The rock emplacement areas have been sited in areas of low quality vegetation. These areas have previously been cleared, and consist largely of Low or Derived Grassland condition class vegetation, subject to significant weed invasion.

As discussed in Chapter 2, areas for subaqueous placement of excavated material have been determined through consideration of site selection criteria, including aquatic ecology. The placement of material below MOL is at depths that generally avoids high quality aquatic habitat associated with shallower environments in other areas of the reservoir.

Displacement of aquatic habitat in Talbingo Reservoir due to dredging and construction of barge access infrastructure and placement of dredged sediment and material excavated from the tunnel would largely be minimised and restricted to soft sediments. This habitat is abundant throughout the reservoir and the loss of a very small area is expected to have negligible impacts to aquatic ecology at this scale. Some habitat, such as wood debris, would be relocated to other areas of the reservoir to ensure there is no net-loss of this type of habitat.

f. Monitoring and adaptive management

Prior to undertaking vegetation clearing, pre-clearance inspections will confirm the biodiversity values identified in this EIS and appendices, including revision of the extent of clearing required for Exploratory Works. This information will be used to inform and refine the biodiversity strategy and offset requirements for Exploratory Works. Monitoring will focus on key threatened species (such as Smoky Mouse and Booroolong Frog), water quality monitoring, weed and pathogen and feral species monitoring.

ii Residual impact summary

Residual impacts following implementation of the avoidance and minimisation measures include:

- clearing of 95 ha of native vegetation; and
- impacts to 70.64 ha of threatened species habitat for five species credit species.

Impacts to threatened species habitat requiring offsets include:

- direct impacts on 0.9 ha of habitat for the Gang-gang Cockatoo;
- direct impacts on 66.6 ha of habitat for the Eastern Pygmy-possum;
- direct impacts on 2.04 ha of habitat for the Booroolong Frog;
- direct impacts on 0.2 ha of habitat for the Smoky Mouse; and
- direct impacts on 0.9 ha of habitat for the Masked Owl.

There will also be some permanent impacts to aquatic habitat in Talbingo Reservoir including to habitats within the dredging footprint, at the location of subaqueous rock placement, and along the route of the communication cable.

5.1.4 Mitigation measures

A summary of the mitigation and management measures that would be implemented to avoid and minimise impacts to biodiversity is provided in Table 5.2. These measures will be incorporated into the CEMP for Exploratory Works.

Table 5.3 Mitigation measures - Biodiversity

Impact	Reference #	Environmental management measures
Biodiversity		
Impact to biodiversity	ECO01	<p>The CEMP will include the following:</p> <ul style="list-style-type: none"> ● identification of guidelines relevant to construction, the matters they apply to and what is required to ensure compliance; · ● pre-disturbance inspection requirements to identify features of conservation significance and select appropriate management measures and environmental controls; ● standard precautions and mitigation measures in Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fisheries NSW 2013); ● tree assessment and management protocols consistent with <i>AS 4970-2009 Protection of trees on development sites</i>; ● terrestrial and aquatic weed, pest and pathogen prevention and management protocols, including washdown facilities at suitable locations.
	ECO02	Ground disturbance within the avoidance footprint (Yarrangobilly River and Smoky Mouse habitat) will be prohibited, and marked with environmental controls as an exclusion area.
Impacts to threatened species	ECO03	<p>A Threatened Species Management sub plan will be developed and implemented as part of the CEMP during construction. The sub plan will include:</p> <ul style="list-style-type: none"> ● pre-clearance procedures; ● an unexpected threatened species finds procedure; ● Murray Crayfish monitoring program (Talbingo Reservoir); ● Smoky Mouse monitoring program; and ● Booroolong Frog monitoring program.
	ECO04	<p>Vehicle traffic movements along Upper Lobs Hole Ravine Road will be:</p> <ul style="list-style-type: none"> ● limited to day time hours only (except for emergencies); and ● limited to 40km/h.
Impacts to fish eggs and larvae due to extraction of water from Talbingo Reservoir	ECO05	<p>The water pipeline intake will be designed to:</p> <ul style="list-style-type: none"> ● prevent/discourage adult fish from approaching or entering the intake ● locate the intake pump in deeper water where possible away from fish habitat such as woody debris and aquatic plants; and ● allow for pump start up procedures involving initial slow water velocity to reduce likelihood of aquatic biota being drawn into the pump.

Table 5.3 Mitigation measures - Biodiversity

Impact	Reference #	Environmental management measures
Impacts to fish passage	ECO06	The permanent bridges at Yarrangobilly River and at Wallaces Creek will be designed with consideration of Policy and Guidelines for Fish Habitat Conservation - Update 2013 (DPI 2013) and Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries 2003).
	ECO07	The temporary bridges at Yarrangobilly River and at Wallaces Creek will be designed and constructed to: <ul style="list-style-type: none"> ● adhere to guidelines for temporary structures in Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 update) (Fisheries NSW 2013) and recommended crossing design considerations in Fairfull and Witheridge (2003); and ● ensure any build-up of debris potentially obstructing fish passage will be removed.
	ECO08	Construction of the temporary bridge at Yarrangobilly River will avoid or minimise works during the migration time of Macquarie Perch (October to January).
Impact to aquatic ecology from erosion and sedimentation	ECO09	The water quality controls described in the Surface water assessment (Appendix M) and Aquatic ecology assessment (Appendix G) will be implemented will be implemented.
Impacts to aquatic habitat and biota during dredging and subaqueous placement	ECO10	The subaqueous placement monitoring program for Talbingo Reservoir (described in Appendix D of Appendix L) will be implemented and include measures relevant to aquatic ecology including: <ul style="list-style-type: none"> ● monitoring of water quality indicators including turbidity, pH and dissolved oxygen within and downstream of the construction area and, if a decline in water quality is detected, stop or scale back further works and revise control measures; ● removing wood debris from within the dredge footprint and subaqueous placement location and spreading it back into the reservoir in relatively shallow water (0-10 m) where fish are more likely to occur; ● mapping of aquatic habitats within and adjacent to the subaqueous placement areas to confirm the presence/absence of the aquatic habitats and vegetation within and adjacent to the placement area and minimise the disturbance of aquatic habitat where feasible; and ● minimising suspension of sediment and turbidity by using the methods described in the Barge Access Infrastructure Report (Appendix L).

i Biodiversity Offset Strategy

Offsets will be provided in line with the biodiversity offset framework. Impacts that are required to be offset are set out in Appendix F. Extensive consultation has been undertaken with NPWS and OEH, and other government agencies regarding the biodiversity offset for Exploratory Works. Throughout this process, the objective of the offset framework has been to ensure any offsets payment from the Exploratory Works achieve best value for the management of biodiversity values in KNP. Through these discussions a number of guiding principles have been developed to guide the development of the biodiversity offset strategy. These include measures /actions that:

- achieve direct conservation outcomes within KNP rather than out of park conservation;
- aim to provide a net improvement in the biodiversity values of KNP over time;
- target threatened species, ecological communities or protected matters being impacted by Exploratory Works;
- provide a measurable conservation gain for the threatened species, ecological communities or protected matters being impacted by Exploratory Works;
- focus on broader management of the KNP where a better conservation outcome may be achieved;
- seek to provide a whole of catchment benefit, providing measurable conservation gains for biodiversity in KNP;
- are informed by scientific advice and evidence, and will be transparent, effective and efficient; and
- Any payment for offsets is proposed to be made once, and will be proportional to the residual impacts after all measures to avoid, minimise and mitigate impacts have been considered. Consultation with key stakeholders is ongoing, and the offset strategy will be developed in consultation with these stakeholders. The biodiversity offset strategy will be finalised before any impacts from Exploratory Works occur.