

6. Environmental assessment

6.1 Biodiversity

This section provides an assessment of the potential impacts of the proposal on biodiversity and identifies safeguards and management measures to avoid or minimise these impacts. A detailed assessment of biodiversity impacts is presented in a Biodiversity Development Assessment Report (BDAR) (Appendix D).

6.1.1 Methodology

The methodology for the biodiversity assessment included a desktop assessment, habitat suitability assessment, field surveys and the assessment of biodiversity impacts.

Desktop assessment

A desktop assessment was undertaken in the first half of 2021 which included a review of the following relevant databases and previously undertaken assessments:

- The NSW BioNet Wildlife Atlas and Threatened Biodiversity data collection (DPIE, 2020a)
- The NSW BioNet Vegetation Classification data collection (DPIE, 2020b)
- The Bureau of Meteorology Atlas of Groundwater Dependent Ecosystems (BoM, 2020)
- DPI threatened species list (DPI, 2021)
- NSW Interim Biogeographic Regions of Australia (IBRA) regions and sub-regions – Version 7 (DAWE, 2021a)
- Southeast NSW Native Vegetation Classification and Mapping (VIS_ID 2230) based on Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands (Tozer, et al., 2010)
- Species Profile and Threats (SPRAT) Database (DAWE, 2021b)
- The Protected Matters Search Tool (DAWE, 2020)
- Species profiles from the Threatened Biodiversity Data Collection (DPIE (EES))
- Biodiversity Assessment Method (BAM) Calculator
- The NSW DPI weeds database (DPIE, 2020c)
- Directory of Important Wetlands (DAWE, 2019)
- Soils and geology database (eSPADE) (DPIE, 2020d)
- The Fisheries NSW Spatial Data Portal (DPI, 2020)
- Key Fish Habitat maps (DPI, n.d.)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey NPWS revocation area – Little Hartley (Niche, 2021a)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey NPWS revocation area – Medlow Bath to Blackheath (Niche, 2021b)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey Report 1 – Proposed tunnel portal locations (Niche, 2021c)
- Great Western Highway Upgrade – Katoomba to Lithgow, Preliminary Biodiversity Survey Report 2 – TfNSW surplus lands (Niche, 2021d)

- Great Western Highway Upgrade - Katoomba to Lithgow, Preliminary Biodiversity Survey Report 3 – Additional areas (Niche, 2021e)
- BioBanking agreement ID number: 424 Under the Threatened Species Conservation Act 1995 for Roads and Maritime Services for 40 Bends Road Biobank (OEH, 2017b)
- Great Western Highway Upgrade, Katoomba to Lithgow Preliminary Environmental Investigation (Transport for NSW, 2020)
- Great Western Highway Upgrade, Mount Victoria to Lithgow Alliance Forty Bends Upgrade – Review Of Environmental Factors Technical Paper 1 Biodiversity (RMS, SKM & PB, 2012)
- Mount Victoria to Lithgow Great Western Highway Upgrade Route Options Report (SKM, 2009).

Habitat suitability assessment

In order to identify species for targeted field surveys, a list of candidate species identified by the BAM Calculator known or considered likely to occur was refined based on the known geographic distribution and the suitability of habitat features present, including associated plant community types and soil and geological preferences. A habitat assessment was then undertaken to determine the likelihood for each of the listed candidate species to occur and, as such, require targeted field survey and assessment of potential impacts of the proposal.

Field surveys

Vegetation, flora and fauna field surveys were undertaken in March, April and May 2021 to target specific threatened species to validate the results of the desktop and habitat assessments. Survey effort is in accordance with current biodiversity assessment guidelines (OEH, 2017). A summary of the survey effort for the biodiversity assessment is shown in Table 6-1.

Table 6-1 Summary of biodiversity assessment field survey effort

Date	Method
15 to 16 March 2021	Fauna surveys including habitat assessment, diurnal bird surveys, nocturnal surveys (spotlighting and call playback) and deployment of detection devices. Remote cameras deployed targeting ground dwelling (Spotted-tailed Quoll) and arboreal mammals (Squirrel Glider, Greater Glider and Koala). Ultrasonic detectors deployed to survey for threatened microbat species.
7 to 8 April 2021	Fauna surveys including habitat assessment, diurnal bird surveys, inspection of culverts, nocturnal surveys (spotlighting and call playback), collection and re-deployment of detection devices. Remote cameras and ultrasonic detectors re-positioned to survey different locations within subject land.
14 to 15 April 2021	Flora surveys including six vegetation plots sampling Plant Community Types (PCTs): 731 and 1103.
12 to 13 May 2021	Fauna surveys including habitat assessment, diurnal bird surveys, collection and re-deployment of detection devices. Remote cameras and ultrasonic detectors re-positioned to survey different locations within subject land.
	Flora surveys including seven vegetation plots sampling PCTs: 731, 732, 963, 1103 and 1155.

Date	Method
20 to 21 May 2021	Condition assessment of aquatic habitats and named waterways in accordance with Policy and Guidelines for fish habitat conservation and management (DPI, 2013)
27 to 28 May 2021	<p>Fauna surveys including habitat assessment, diurnal bird surveys, targeted Koala scat searches using the Rapid Spot Assessment Technique (SAT) (Phillips & Wallis, 2016; based off Phillips & Callaghan, 2011) (SAT) and collection of detection devices.</p> <p>Flora surveys including eight vegetation plots sampling PCTs: 731, 1103 and 1155.</p>
11 to 13 August 2021	Stag watch for suitable breeding hollows of threatened large forest owl species including Sooty Owl, Powerful Owl, Barking Owl and Masked Owl. Diurnal searches for breeding individuals and breeding habitat of threatened raptor species (Little Eagle and White-bellied Sea-Eagle). Additional Koala scat searches using Rapid SAT. Confirmation of PCTs and vegetation condition classes. Confirmation of the extent of present Threatened Ecological Communities (TECs).
5 to 6 October 2021	Targeted surveys in locations where Purple Copper Butterfly presence was considered most likely
Survey to be conducted	<p>Spring 2021: Targeted surveys for non-seasonal threatened flora species and spring flowering species including <i>Acacia flocktoniae</i>, <i>Asterolasia buxifolia</i>, <i>Baloskion longipes</i>, <i>Boronia deanei</i>, <i>Eucalyptus pulverulenta</i>, <i>Kunzea cambagei</i>, <i>Swainsona sericea</i> and <i>Thesium australe</i>.</p> <p>Diurnal searches for breeding individuals and breeding habitat of threatened Gang-gang Cockatoo.</p> <p>Targeted spotlighting searches for the Booroolong frog (<i>Litoria booroolongensis</i>)</p> <p>Summer 2021/2022: Targeted surveys for summer flowering threatened flora species <i>Veronica blakelyi</i>.</p>

Impact assessment

Potential impacts to biodiversity as a result of the proposal were identified and assessed. This included an assessment of direct and indirect construction and operational impacts. Mitigation measures for avoiding, managing or reducing impacts on biodiversity values during detailed design, construction and operation were identified. Offsetting requirements for any residual impacts that cannot be avoided, minimised or mitigated were outlined and discussed.

6.1.2 Existing environment

Landscape features

The biodiversity landscape features of the construction footprint are summarised in Table 6-2 and shown in Figure 6-1.

Table 6-2 Biodiversity landscape features

Landscape feature	Subject land
IBRA bioregions and subregions	<p>The subject land lies within two IBRA Bioregions: the Sydney Basin bioregion and the South Eastern Highlands Bioregion shown in Figure 6-1. The north-western and south-eastern 208.45 hectares of the subject land are located within the Sydney Basin bioregion and the central 58.69 hectares, plus 1.44 hectares at the north-western extent of the subject land, are located within the South Eastern Highlands bioregion.</p> <p>All areas of the subject land within the Sydney Basin bioregion are in the Burratorang IBRA subregion, and all areas within the South Eastern Highlands bioregion are in the Bathurst IBRA subregion.</p> <p>In accordance with Section 5.2.1 of the BAM, separate habitat suitability assessments have been undertaken for threatened species in each IBRA subregion. Consequently, two BAM calculator files have been established and species and PCTs have been split and assessed according to PCT/IBRA subregion association of Burratorang and Bathurst.</p>
NSW landscape regions (Mitchell landscapes)	<p>The subject land lies within two Mitchell Landscapes as mapped by Eco Logical Australia (2008), the boundaries of which roughly follow the IBRA bioregion boundary. The north western and south eastern areas are mapped within the Sydney Basin Western Escarpment Mitchell Landscape, while the central area is mapped within the Bathurst Granites Mitchell Landscape.</p> <p>The Sydney Basin Western Escarpment has a landscape of steep dissected slopes on the western margin of Triassic rocks, descending into Permian conglomerate, shale and sandstone (Eco Logical Australia, 2008). The Bathurst Granites landscape consists of undulating to steep hills on Carboniferous granites and granodiorite, with tors and rock outcrops around the margins (Eco Logical Australia, 2008).</p>
Areas of geologic significance and soil hazard features	<p>The construction footprint does not contain any karst, caves, crevices, cliffs or other areas of geological significance. It is located to the west of the Blue Mountains and south of the Newnes Plateau, both of which contain substantial geological formations of exposed sandstone cliffs sitting above deep incised valleys.</p> <p>Soils within the construction footprint are comprised of Lithgow, Hassans Walls, Cullen Bullen, Marrangaroo and Round Mount soil landscape types, with some minor areas of Disturbed Terrain (DPIE, 2021a). Exposed granite rocks and boulders are present throughout many portions of the construction footprint, particularly associated with the Bathurst Granites Mitchell Landscape in the centre of the proposal.</p> <p>High risk areas for erosion include a large portion of both the River Lett Hill to Forty Bends and Forty Bends to Lithgow sections as well as the far eastern and western section of the Little Hartley to River Lett Hill Section and far eastern section of the Cocks River Road Section.</p>

Landscape feature	Subject land
Native vegetation extent surrounding the proposal	Native vegetation covers about 40 per cent of land within 500 metres of the proposal, as mapped in the Central Tablelands Biometric Vegetation Mapping (DPIE, 2017a), as shown in Figure 4-2 of the BDAR (Appendix D).
Cleared areas	Of the 319 hectares of land within the construction footprint, about 215 hectares is cleared. Cleared land comprises mostly of cleared grassland on rural and rural-residential land.
Rivers and streams	The proposal transects several named and unnamed waterways, including River Lett (a sixth order stream), Boxes Creek (a fourth order stream) and its associated unnamed tributaries, tributaries of Butlers Creek and Whites Creek and several other first and second order streams.
Wetlands	The construction footprint does not contain any wetlands. The closest wetland to the subject land is the Macquarie Marshes, over 300 kilometres from the proposal.
Connectivity features	There are no mapped wildlife corridors within the construction footprint, however the Blue Mountains Western Escarpment wildlife corridor occurs between Mount Victoria and Little Hartley to the east of the proposal. More broadly, the proposal is located to the south and west of expansive vegetation of the Greater Blue Mountains area. The Blue Mountains National Park lies to the east and Newnes Plateau to the north. Narrow remnants of native vegetation pass through the construction footprint in a north-south orientation linking vegetation in these expanses to more fragmented vegetation on rural land and riparian corridors. These corridors are important for habitat connectivity to native vegetation remnants to the immediate south and conservation areas further on such as Kanangra-Boyd National Park.
Areas of geological significance and soil hazard features	<p>The subject land does not contain any karst, caves, crevices, cliffs or other areas of geological significance. It is located to the west of the Blue Mountains and south of the Newnes Plateau, both of which contain substantial geological formations of exposed sandstone cliffs sitting above deep incised valleys.</p> <p>Soils within the subject land are comprised of Lithgow, Hassans Walls, Cullen Bullen, Marrangaroo and Round Mount soil landscape types, with some minor areas of Disturbed Terrain (DPIE, 2021b). Exposed granite rocks and boulders are present throughout many portions of the subject land, particularly associated with the Bathurst Granites Mitchell Landscape in the centre of the subject land.</p> <p>High risk areas for erosion include a large portion of both the River Lett Hill to Forty Bends and Forty Bends to Lithgow sections as well as the far eastern and western section of the Little Hartley to River Lett Hill section and far eastern section of the Coxs River Road section.</p>
Areas of outstanding biodiversity value	No Areas of Outstanding Biodiversity Value (AOBVs) occur within or surrounding the construction footprint.

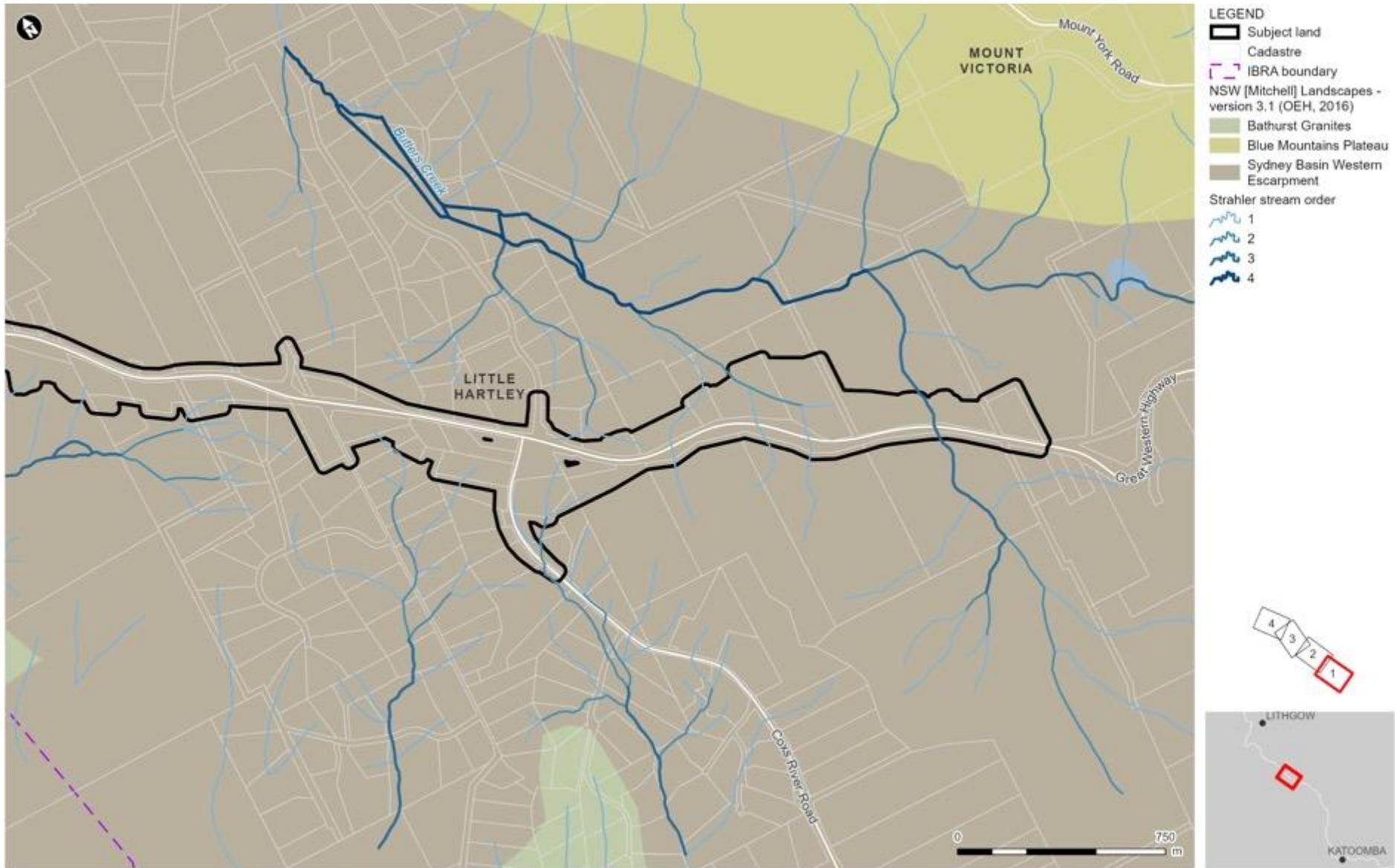


Figure 6-1 a Biodiversity landscape features

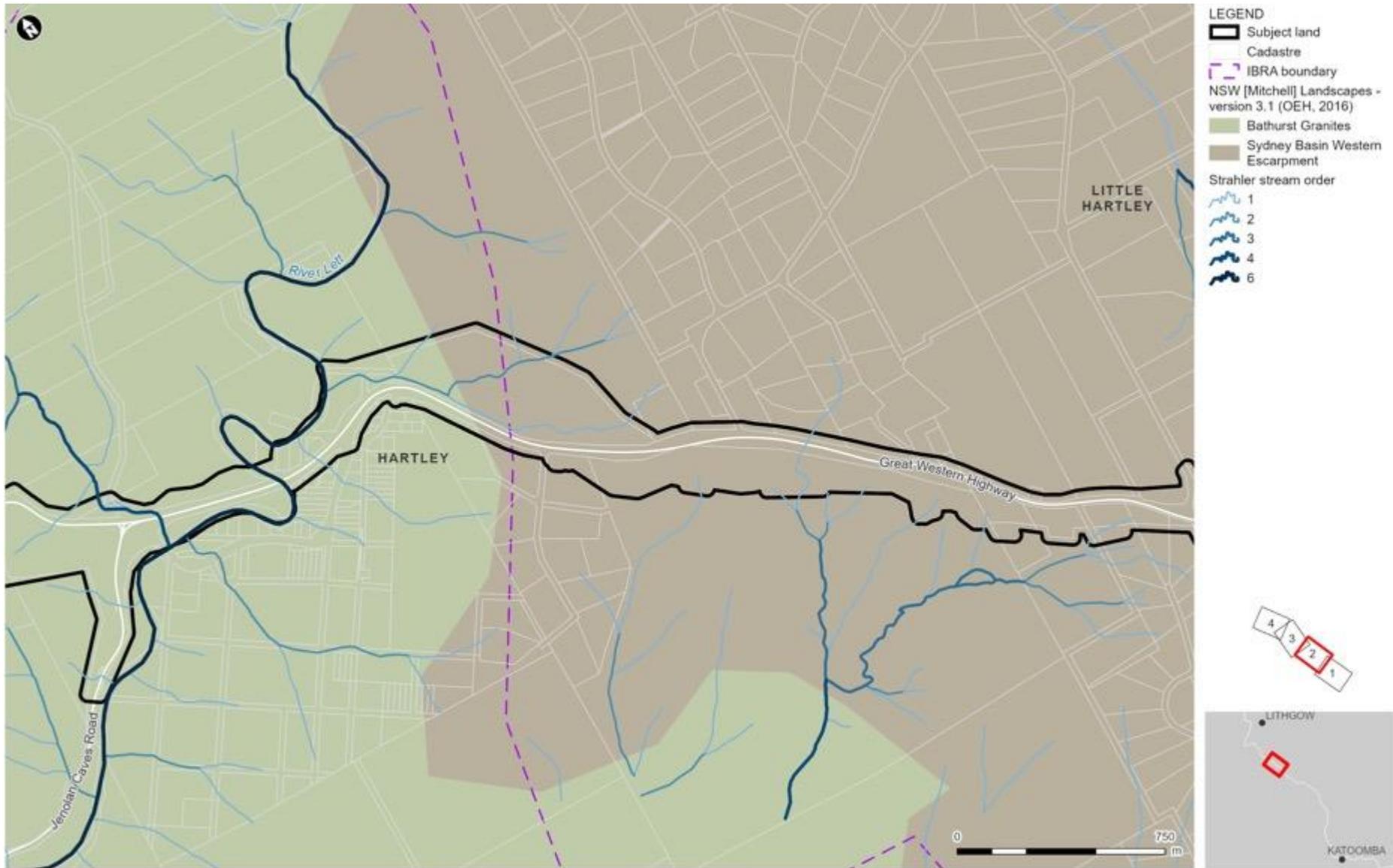


Figure 6-1 b Biodiversity landscape features

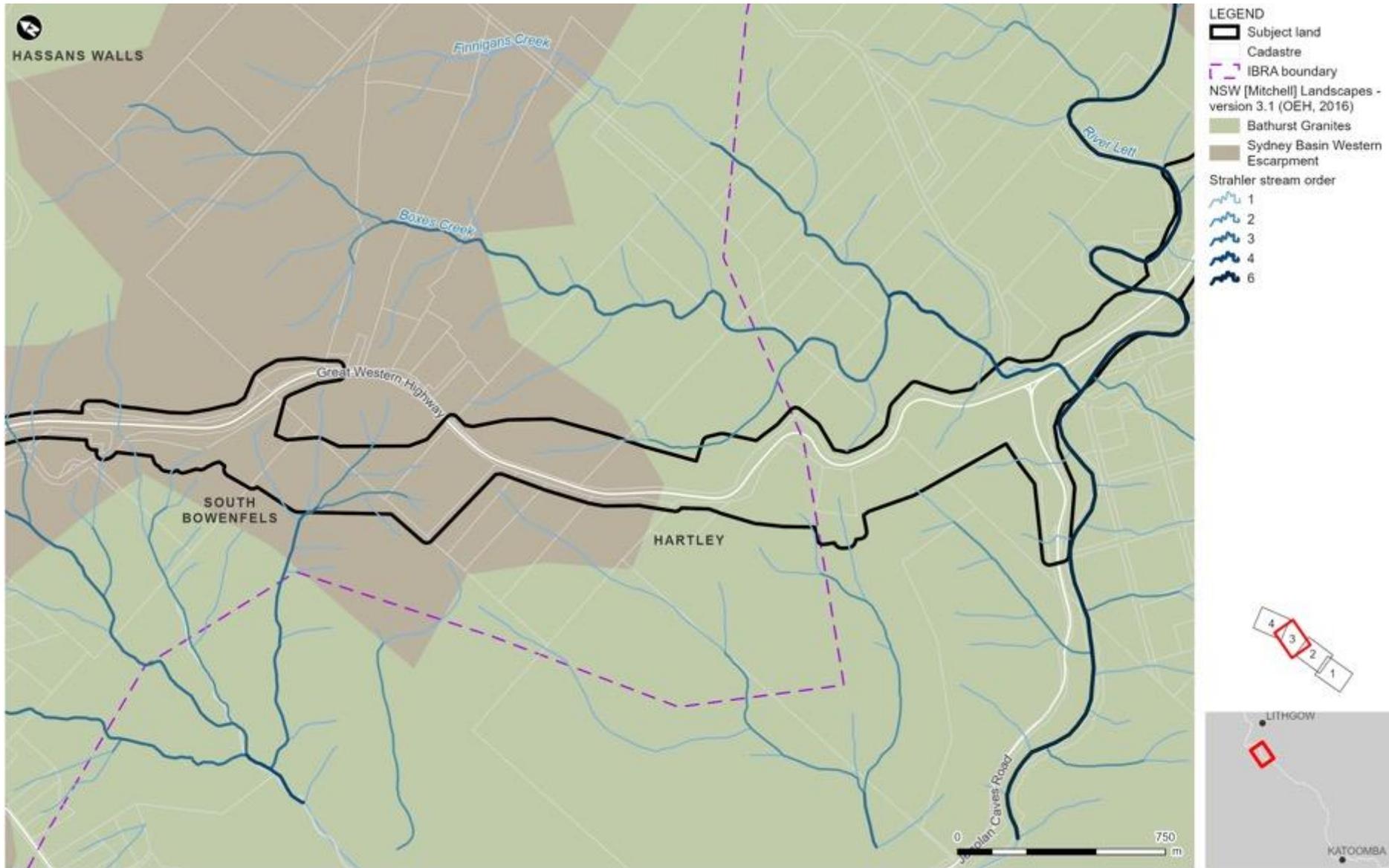


Figure 6-1 c Biodiversity landscape features

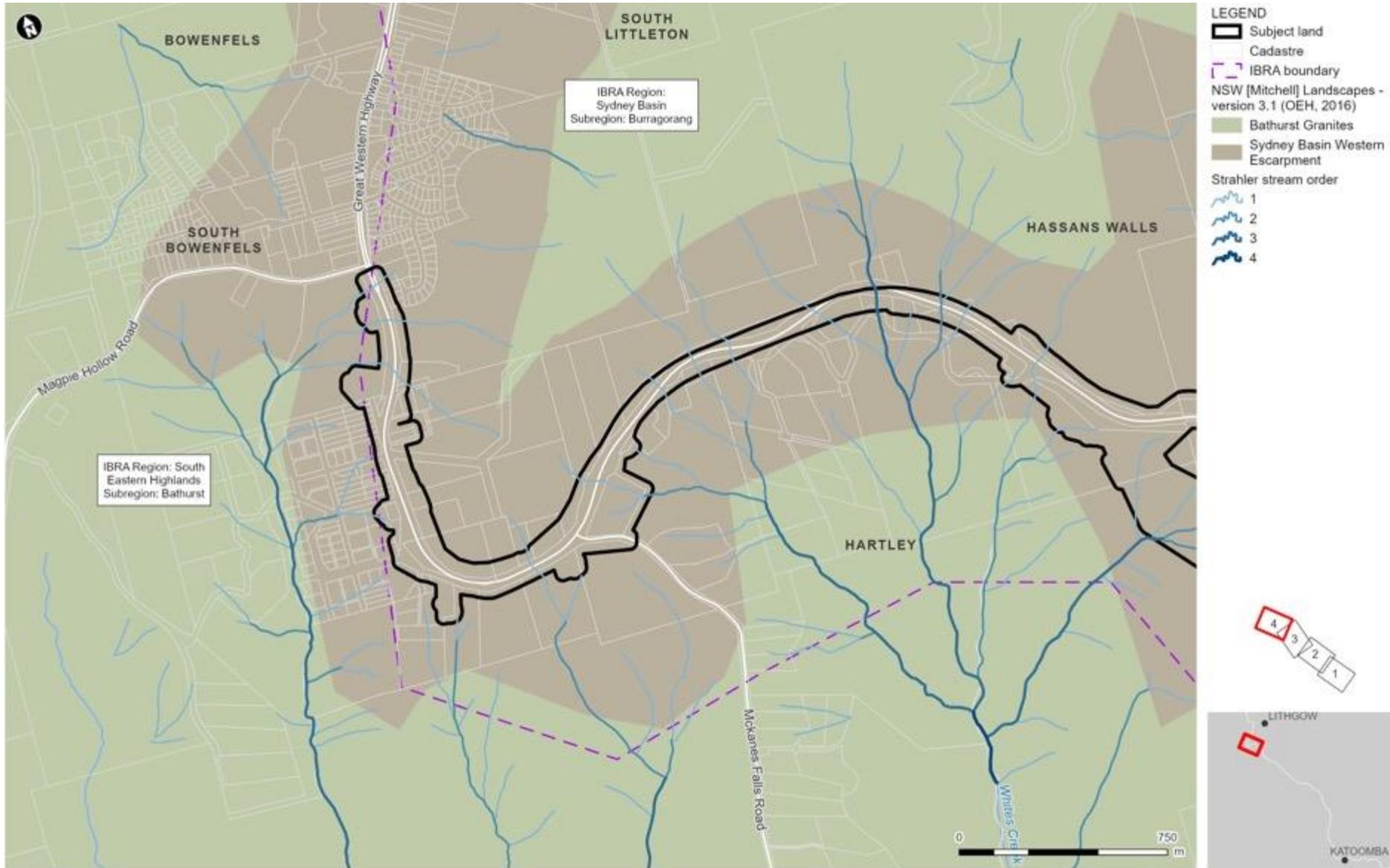


Figure 6-1 d Biodiversity landscape features

Flora

Vegetation types

The native vegetation within the construction footprint is consistent with six plant community types (PCT):

- River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (PCT 85)
- Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (PCT 732)
- Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (PCT 963)
- Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (PCT 1103)
- Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (PCT 731)
- Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (PCT 1155)

Native vegetation covers about 27 per cent of the construction footprint. The remaining 73 per cent is cleared, comprising mostly of cleared grassland on rural and rural-residential land.

The area of coverage of the vegetation types is provided in Table 6-3 and their location is shown in Figure 6-2.

Threatened ecological communities

There are 17.59 hectares of PCT 1103 within the construction footprint that meets the description of the threatened ecological community (TEC) Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion, listed as endangered under the *Biodiversity Conservation Act 2016*.

There are 7.60 hectares of PCT 1103 within the construction footprint that meets the description of the TEC White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions, listed as critically endangered under the *Biodiversity Conservation Act 2016*. Of this area, there are 4.64 hectares that also meet the size and condition threshold criteria for the TEC listed as critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999*.

The location of TECs is shown in Figure 6-3.

Table 6-3 Vegetation types

Vegetation type	PCT number	Structure/ condition class	Status		Extent within construction footprint (hectares)	Hollow bearing trees present
			BC Act	EPBC Act		
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion	85	Moderate	-	-	3.95	2
		Disturbed	-	-	0.35	2
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion	731	Good	-	-	12.44	4
		Variant - good	-	-	3.08	4
		Moderate	-	-	14.61	5
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion	732	Moderate	-	-	6.42	11
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion	963	Good	-	-	2.34	10
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the	1103	Good	Endangered ¹²	Critically Endangered ³	11.62	41

¹ Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion

² White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions

Vegetation type	PCT number	Structure/ condition class	Status		Extent within construction footprint (hectares)	Hollow bearing trees present
			BC Act	EPBC Act		
eastern tablelands; South Eastern Highlands Bioregion		Moderate	Endangered ¹²	Critically Endangered ³	6.94	27
		Low-Moderate	Endangered ¹		4.79	10
		Disturbed	Endangered ¹		1.85	0
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion	1155	Moderate	-	-	10.24	13
Total area native vegetation					78.63	129

³ Patches meet the criteria for Critically Endangered listed under the EPBC Act

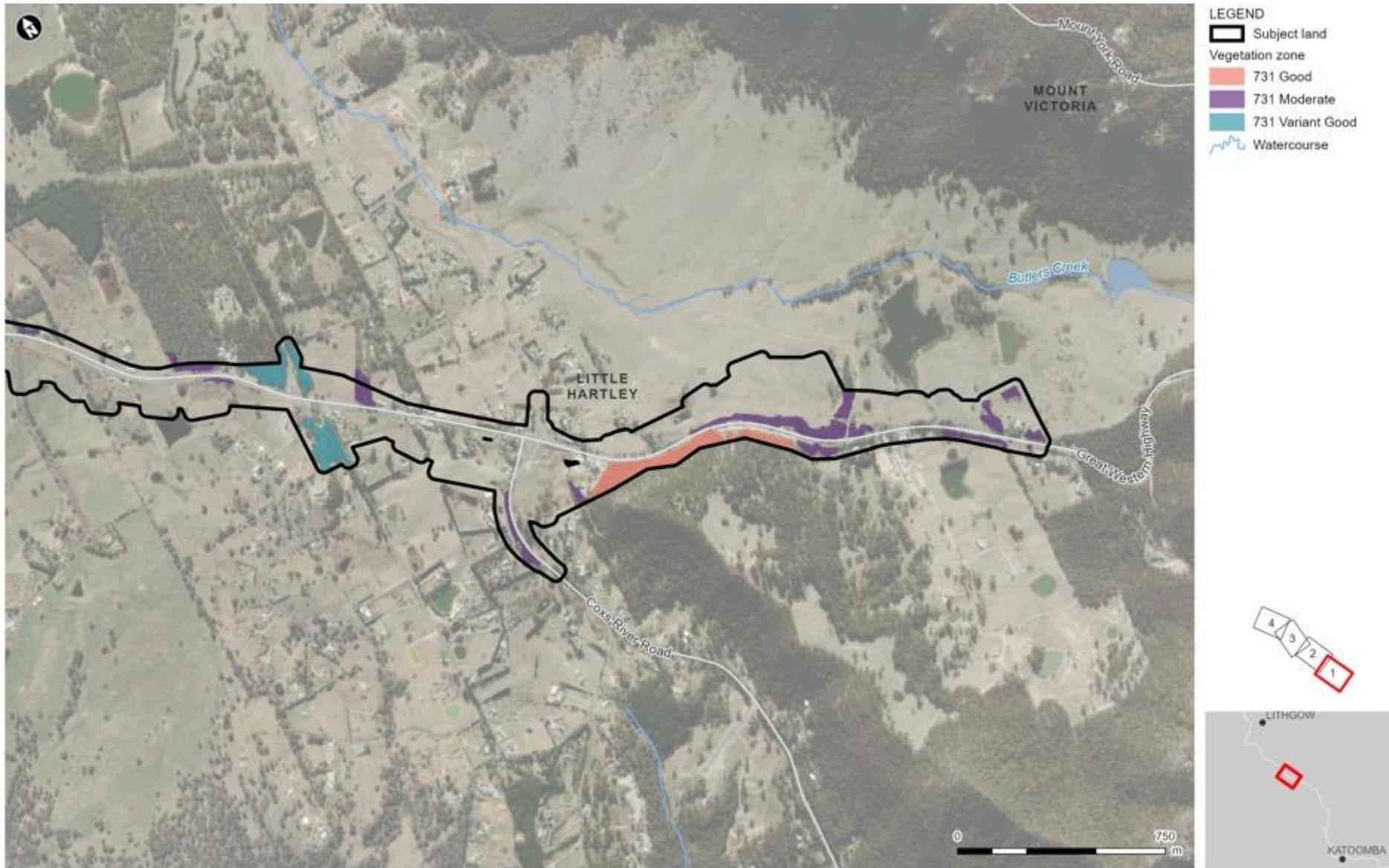


Figure 6-2 a Vegetation types

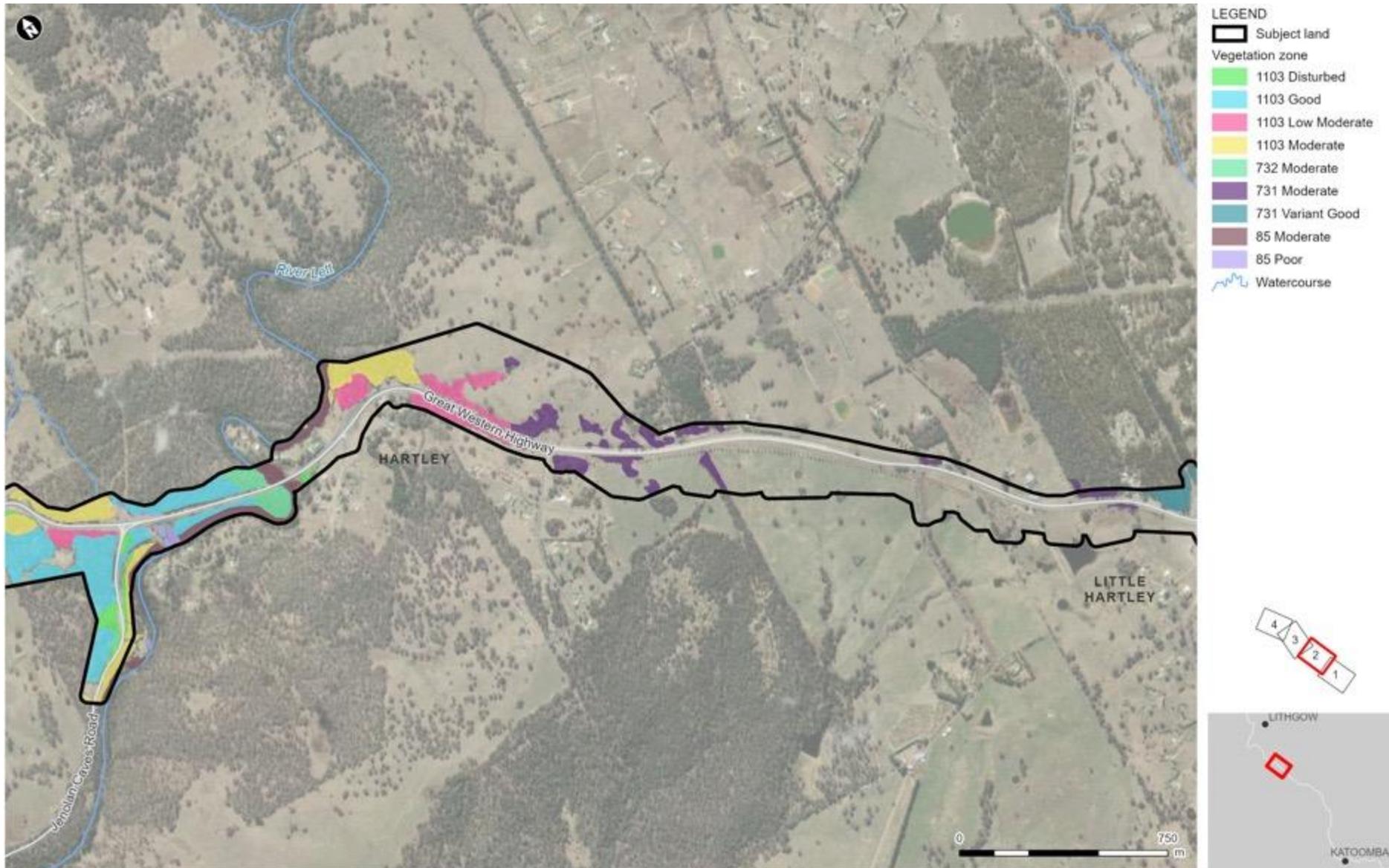


Figure 6-2 b Vegetation types

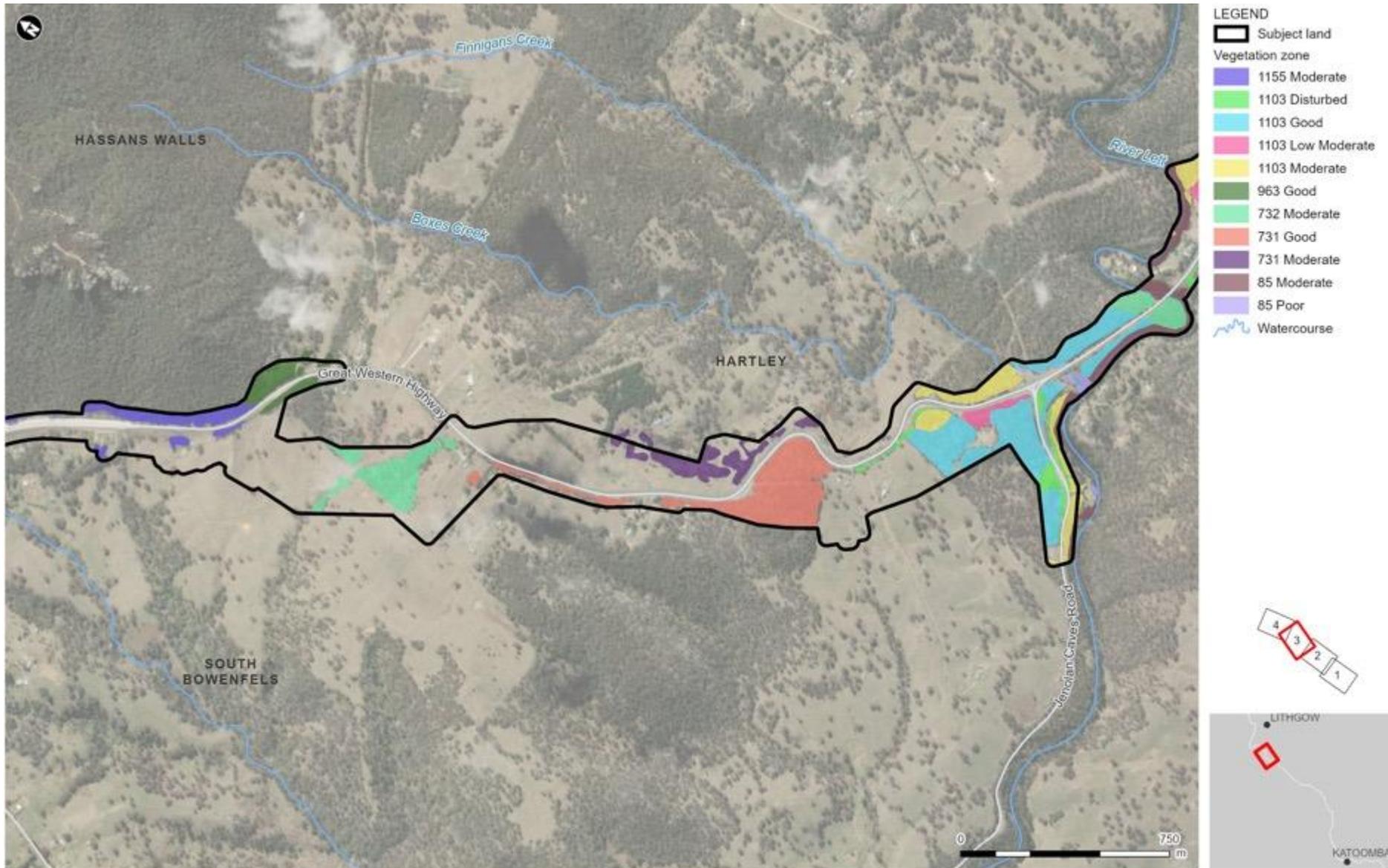


Figure 6-2 c Vegetation types

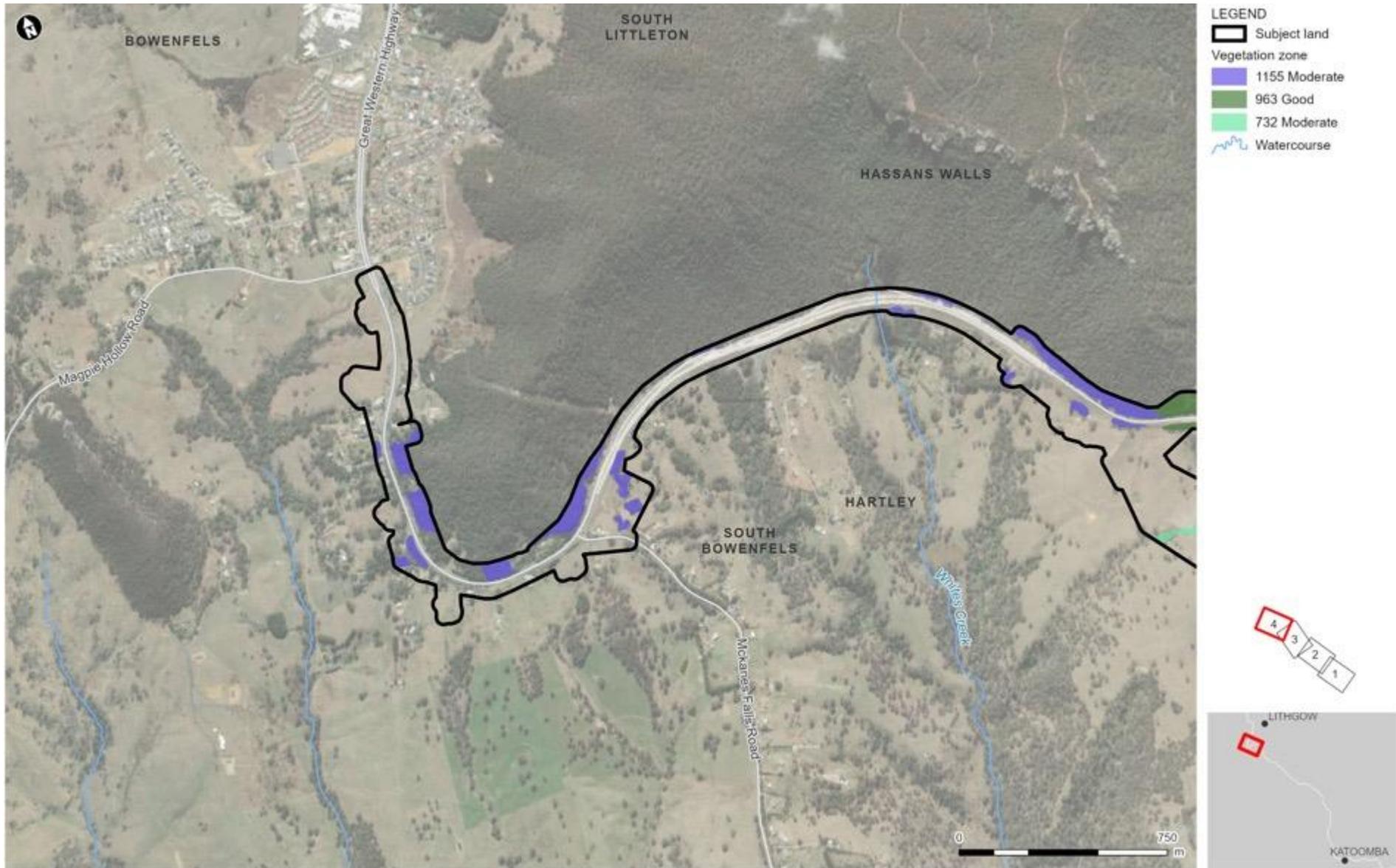


Figure 6-2 d Vegetation types

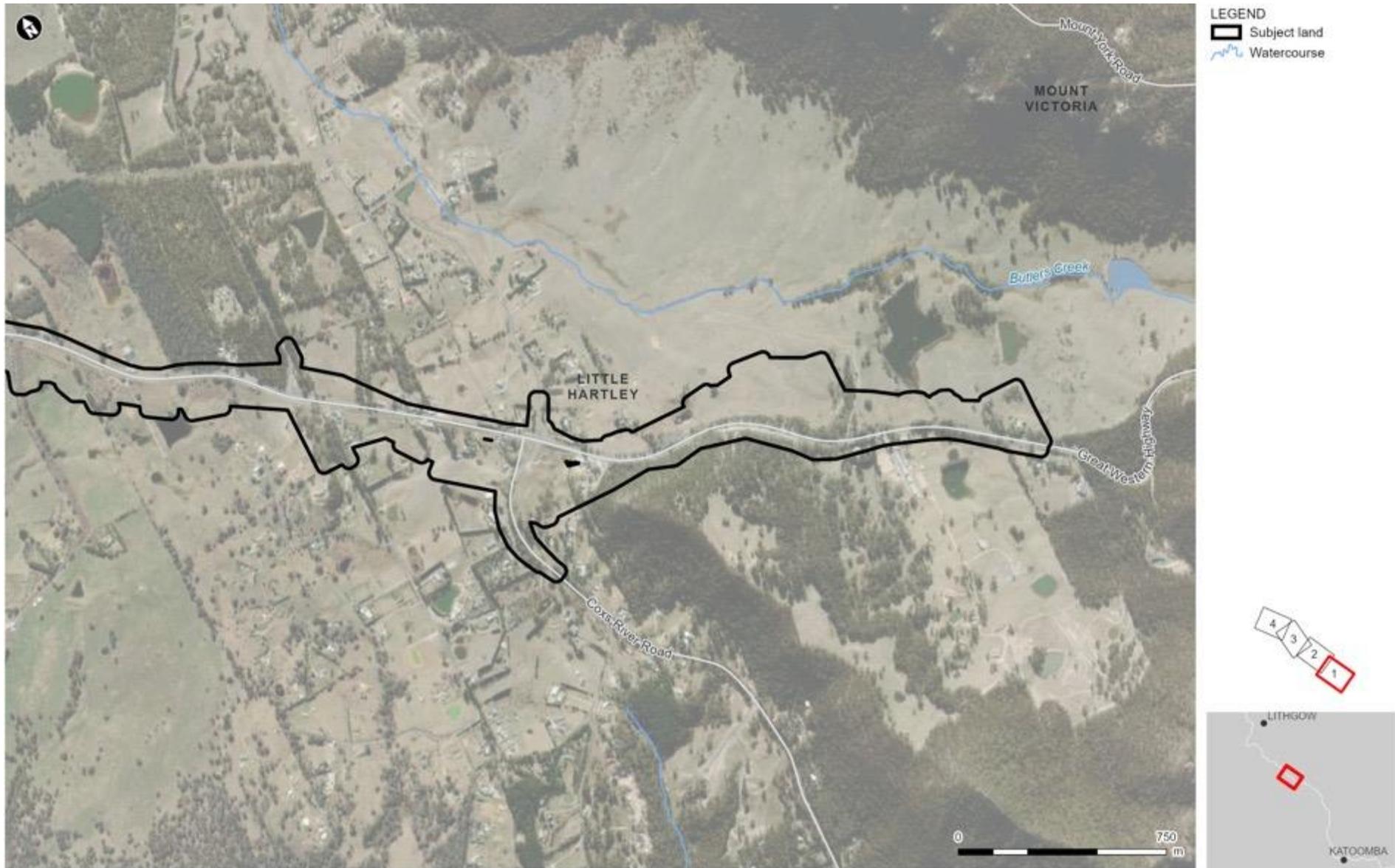


Figure 6-3 a TECs

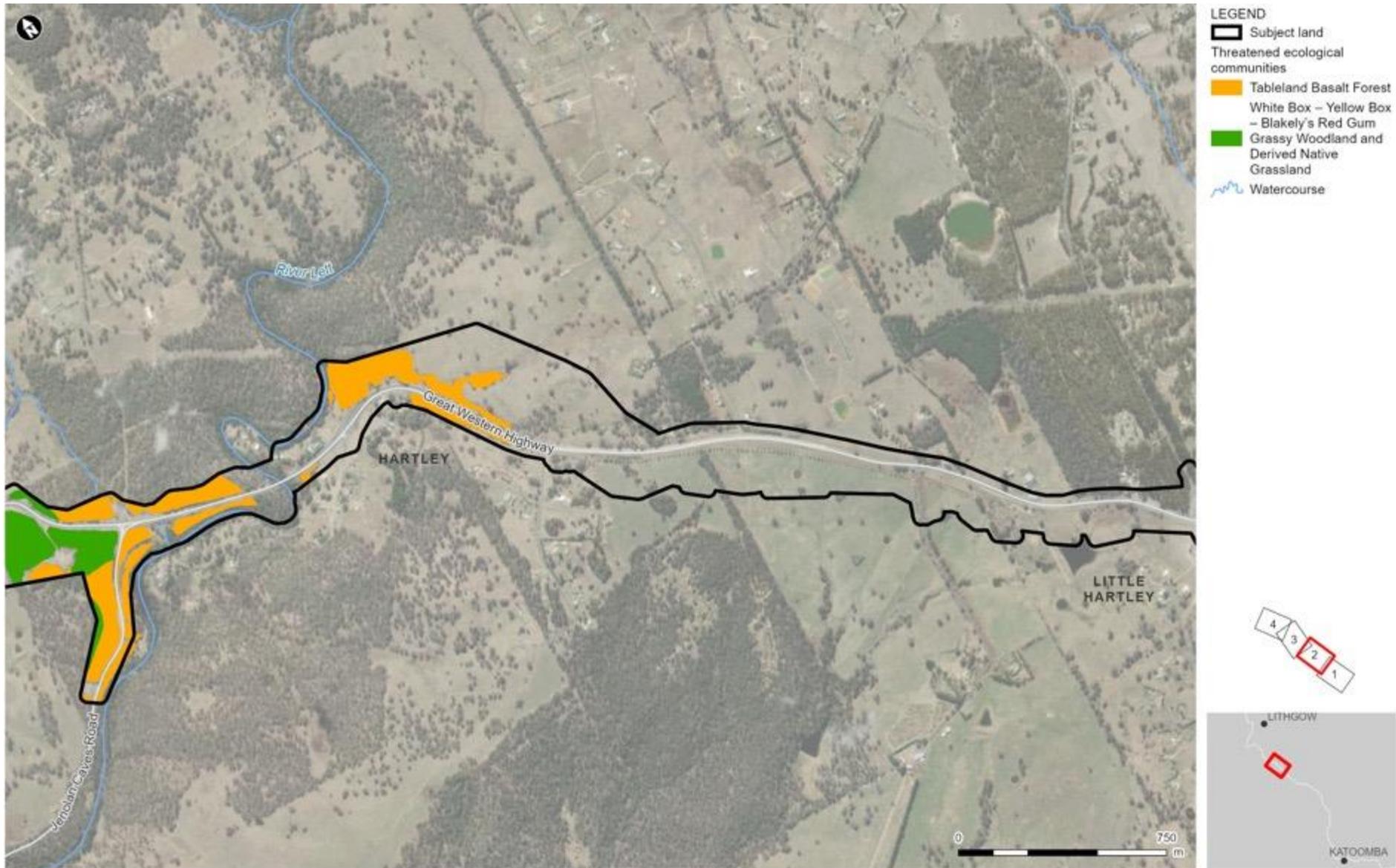


Figure 6-3 b TECs

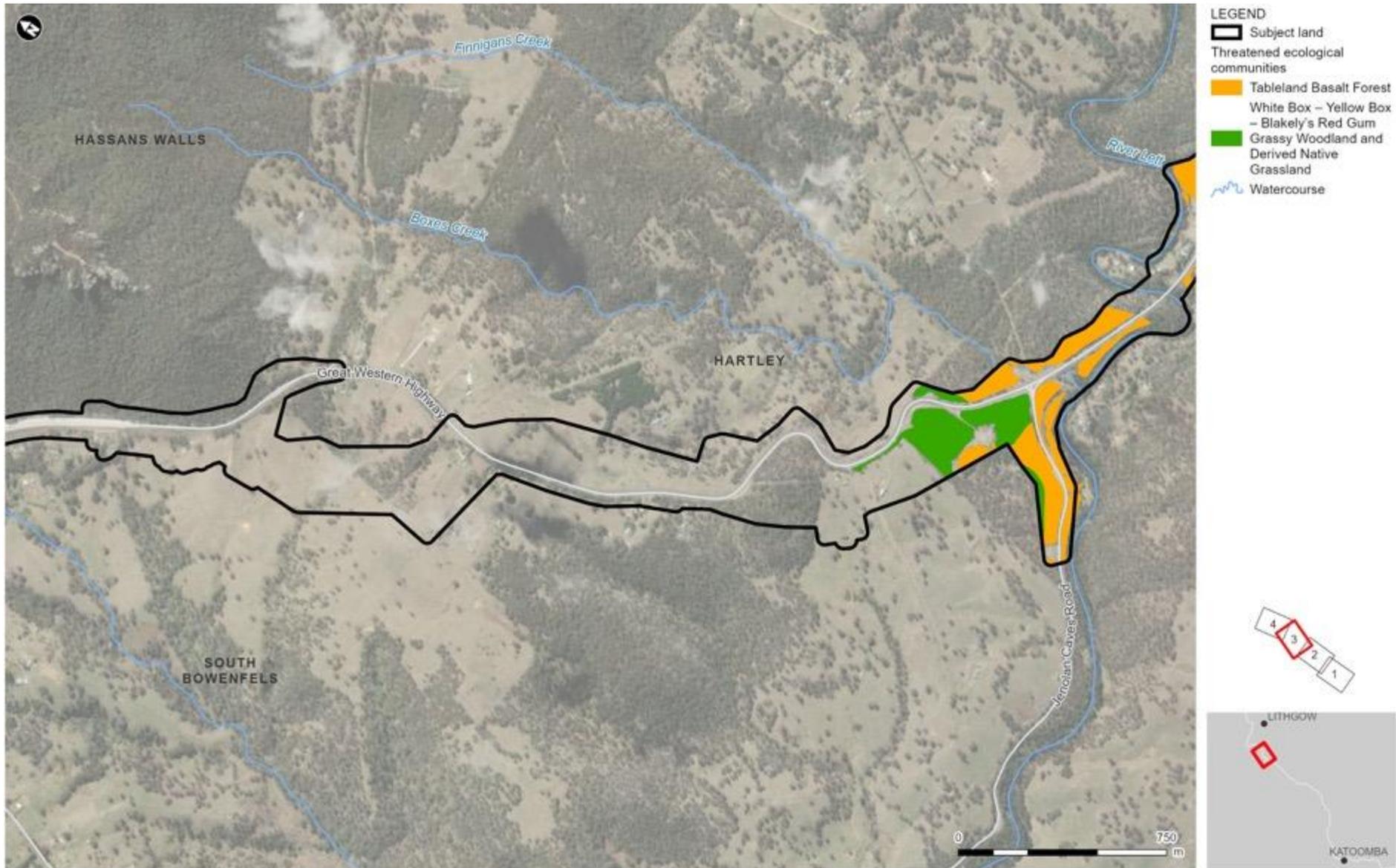


Figure 6-3 c TECs

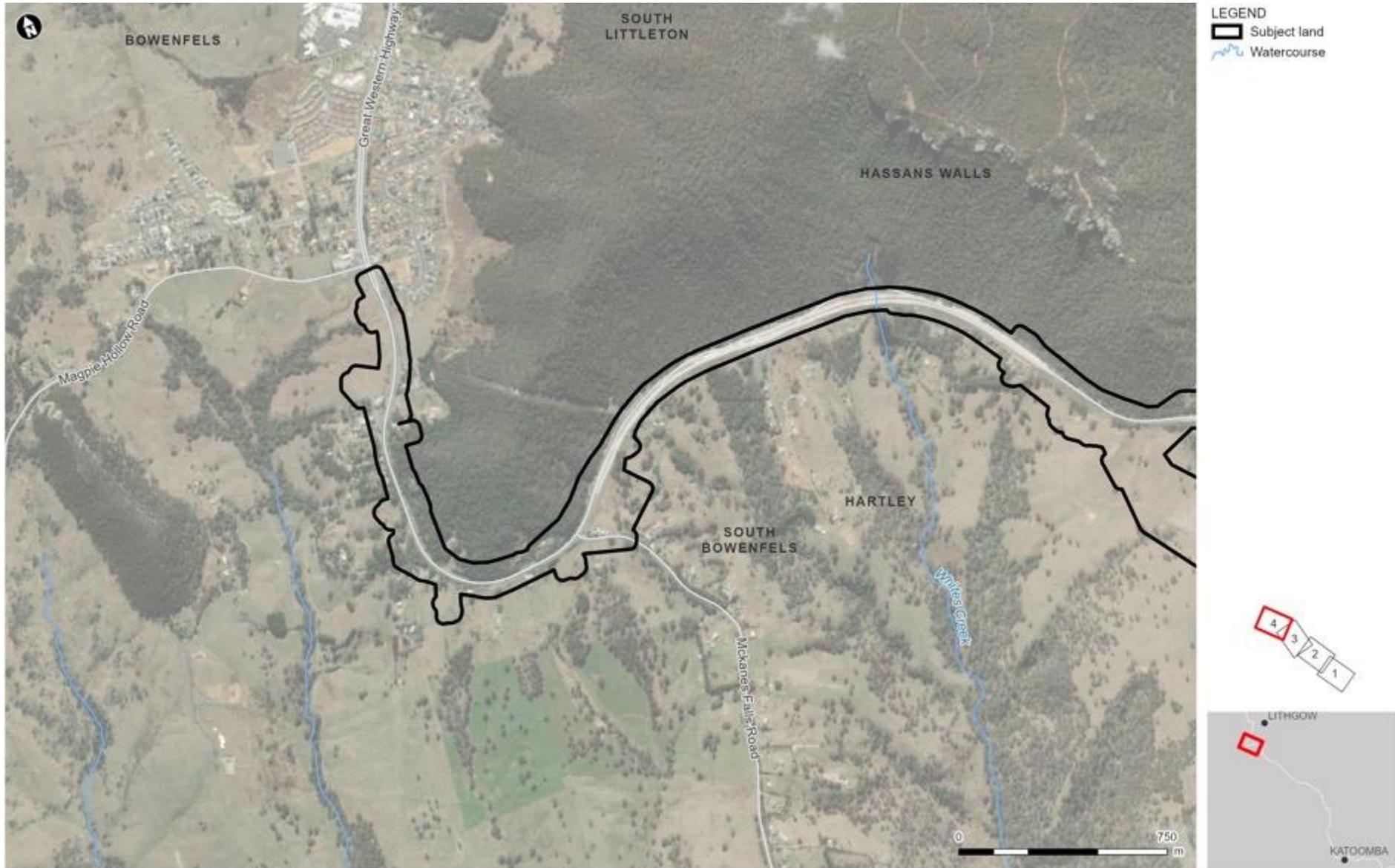


Figure 6-3 d TECs

Threatened flora species

No threatened flora species have been identified within the construction footprint during general flora surveys. Targeted threatened flora surveys would be carried out in spring 2021 to meet the recommended survey periods as listed in the TBDC (DPIE (EES), 2021a) for the target flora species to maximise the chance of detection. The findings from these targeted surveys will be included in the Response to Submissions report prepared for the proposal.

Groundwater dependent ecosystems

About 42.85 hectares of ecosystems with low, moderate and high potential to be interactive with groundwater have been recorded within the construction footprint. Figure 6-4 identifies potential groundwater dependent ecosystems within the construction footprint.

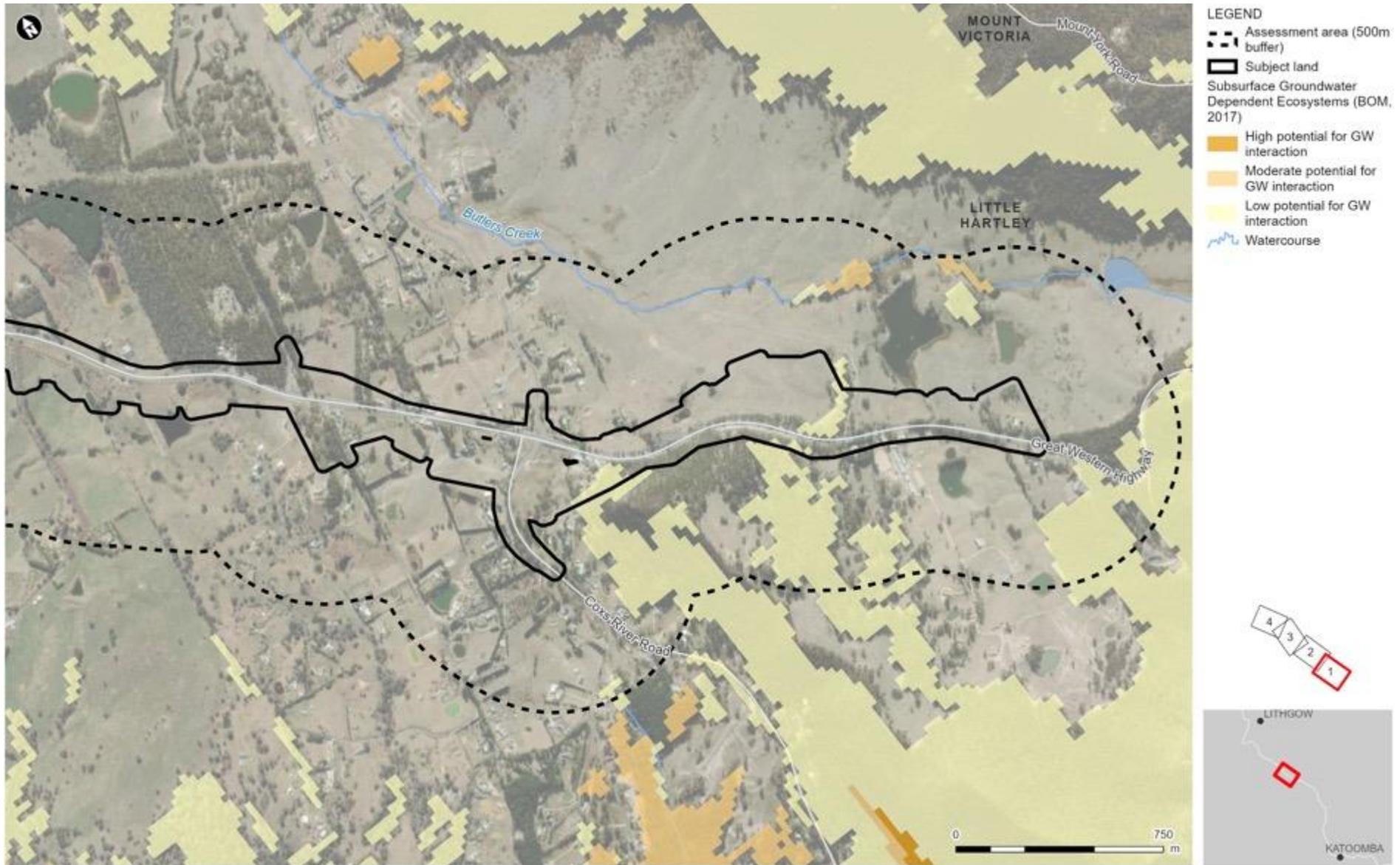


Figure 6-4 a Potential groundwater dependent ecosystems

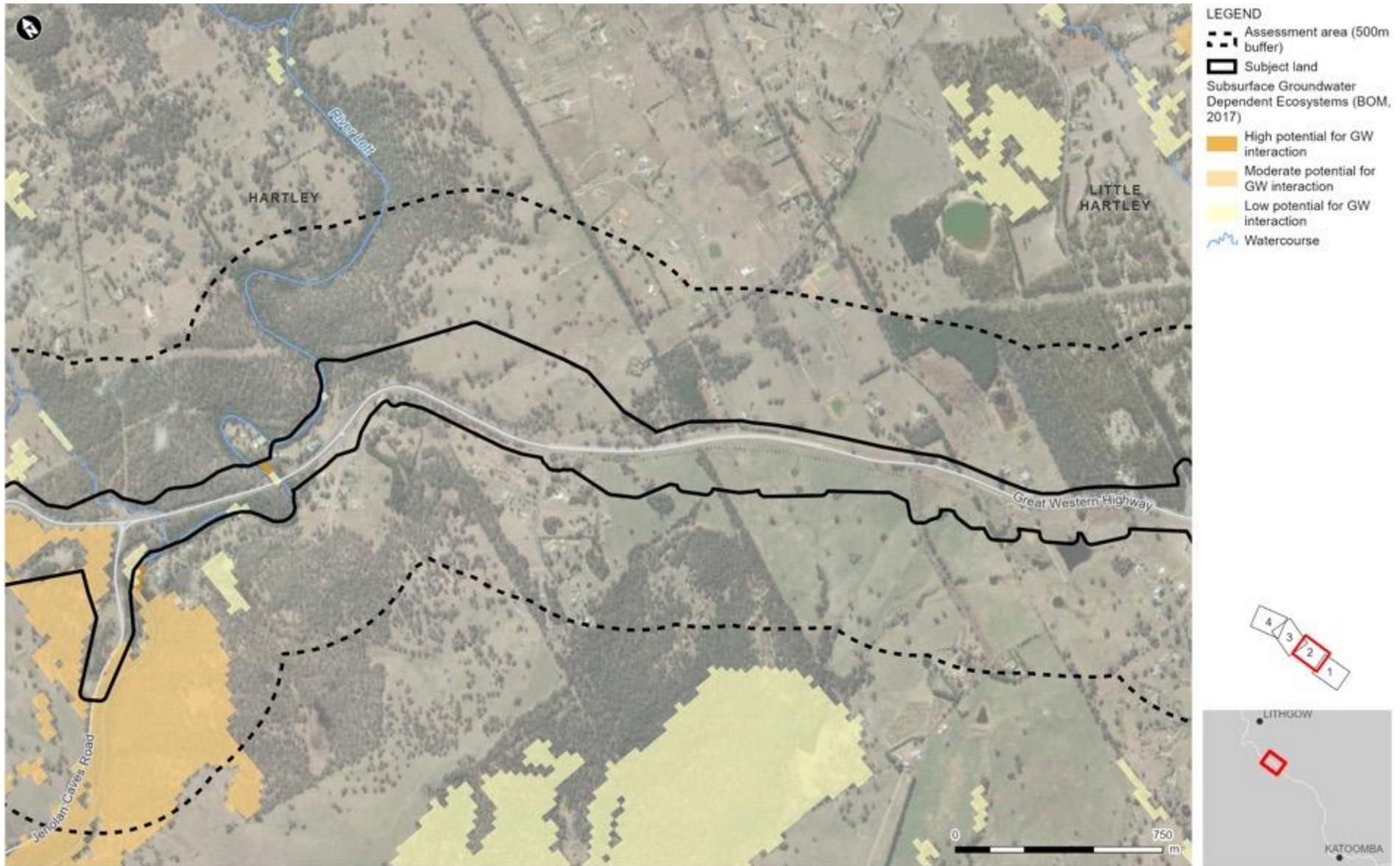


Figure 6-4 b Potential groundwater dependent ecosystems

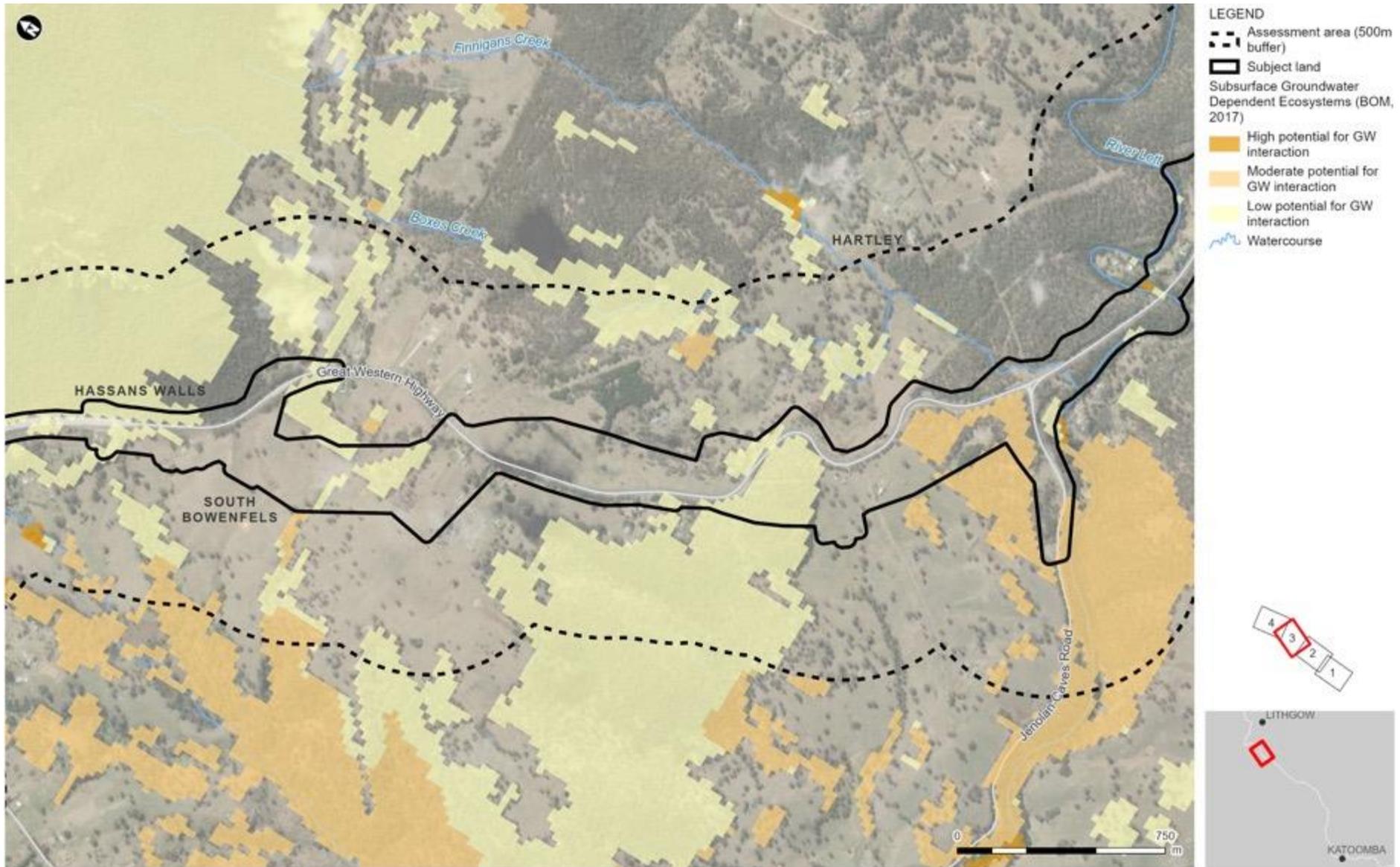


Figure 6-4 c Potential groundwater dependent ecosystems

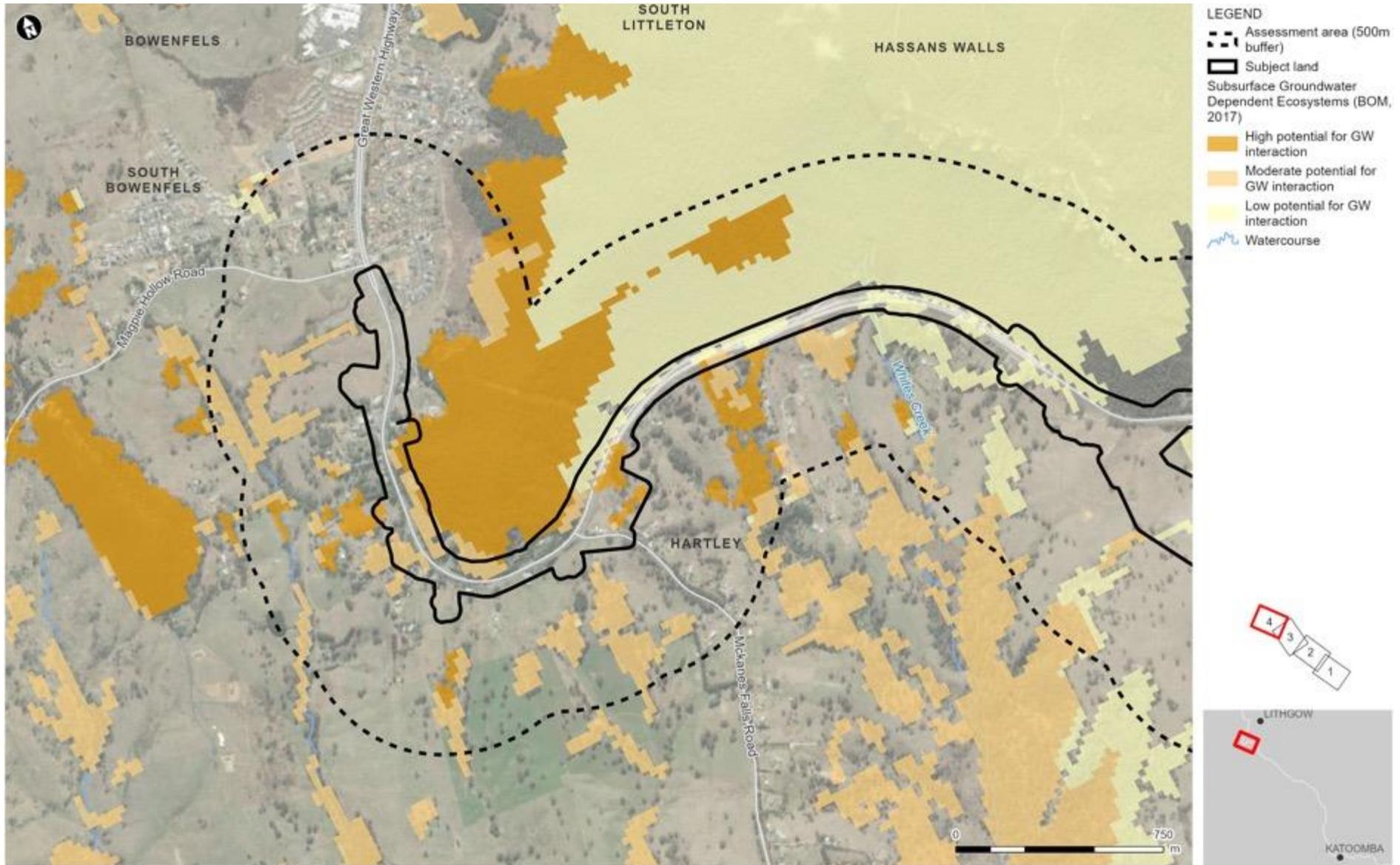


Figure 6-4 d Potential groundwater dependent ecosystems

Weeds

Surveys identified 49 exotic species within the construction footprint, of which six are listed as Priority Weeds for the Central Tablelands region under the *Biosecurity Act 2015*. Four of these six species are also included on the Commonwealth list of Weeds of National Significance. (WoNS).

Nineteen exotic species recorded within the construction footprint are considered to be high threat weeds (DPIE, 2020c). The names, classification and legal requirements for high threat weed species identified in the site investigation area are listed in Table 6-4.

Table 6-4 High threat weeds recorded in the construction footprint

Species	WoNS	Priority Weed	<i>Biosecurity Act 2015</i> status
<i>Bidens pilosa</i> Cobblers' Pegs	No	No	N/A
<i>Cotoneaster sp.</i>	No	No	N/A
<i>Cyperus eragrostis</i> Umbrella Sedge	No	No	N/A
<i>Cytisus scoparius</i> Scotch Broom	Yes	Yes	Prohibition on certain dealings: Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Protect conservation and natural environments that are free of Scotch broom
<i>Ehrharta erecta</i> Panic Veldtgrass	No	No	N/A
<i>Eragrostis curvula</i> African Lovegrass	No	No	N/A
<i>Hedera helix</i> English Ivy	No	No	N/A
<i>Hypericum perforatum</i> St Johns Wort	No	Yes	Regional Recommended Measure: Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be

Species	WoNS	Priority Weed	Biosecurity Act 2015 status
			bought, sold, grown, carried or released into the environment. Protect grazing land that is free of St. John's wort
<i>Ligustrum sinense</i> Small-leaved Privet	No	Yes	Regional Recommended Measure Exclusion zone: urban areas of Bathurst Council, Blayney Council, Lithgow Council, Oberon Council, and Orange City Council Whole region: The plant should not be bought, sold, grown, carried or released into the environment. Exclusion zone: The plant is prevented from flowering and fruiting. Land managers should mitigate spread from their land. Land managers should mitigate the risk of the plant being introduced to their land. Outside exclusion zone: Land managers reduce impacts from the plant on priority assets.
<i>Lonicera japonica</i> Japanese Honeysuckle	No	No	N/A
<i>Nassella trichotoma</i> Serrated Tussock	Yes	Yes	Prohibition on certain dealings Must not be imported into the state, sold, bartered, exchanged or offered for sale. Regional Recommended Measure Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment. Protect conservation areas, natural environments and primary production lands that are free of serrated tussock
<i>Paspalum dilatatum</i> Paspalum	No	No	N/A
<i>Pinus radiata</i> Radiata Pine	No	No	N/A
<i>Pyracantha angustifolia</i> Orange Firethorn	No	No	N/A
<i>Rosa rubiginosa</i> Sweet Briar	No	No	N/A
<i>Rubus anglocandicans</i>	Yes	Yes	Prohibition on certain dealings

Species	WoNS	Priority Weed	Biosecurity Act 2015 status
Blackberry			<p>Must not be imported into the state, sold, bartered, exchanged or offered for sale.</p> <p>Regional Recommended Measure</p> <p>Land managers should mitigate the risk of new weeds being introduced to their land. Land managers should mitigate spread from their land. The plant should not be bought, sold, grown, carried or released into the environment.</p> <p>Protect conservation areas, natural environments and primary production lands that are free of blackberry</p>
<i>Rumex acetosella</i> Sheep Sorrel	No	No	N/A
<i>Rumex sagittatus</i> Turkey Rhubarb	No	No	N/A
<i>Senecio madagascariensis</i> Fireweed	Yes	Yes	<p>Prohibition on certain dealings</p> <p>Must not be imported into the state, sold, bartered, exchanged or offered for sale.</p> <p>Regional Recommended Measure</p> <p>Exclusion zone: Whole region except for the core infestation area of Bylong Valley and Kanimbla Valley (lower Cox River Catchment)</p> <p>Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant. Land managers should mitigate the risk of the plant being introduced to their land. Core infestation area: Land managers should mitigate spread from their land. Land managers reduce impacts from the plant on priority assets.</p>

Fauna

Threatened fauna species

Thirty-eight threatened fauna species were identified as having potential to occur within the construction footprint and were targeted during field surveys. Eleven threatened fauna species listed under the EPBC Act and/or BC Act were recorded during surveys carried out for the proposal. These include:

- Squirrel Glider (*Petaurus norfolcensis*) (Vulnerable – BC Act)
- Greater Glider (*Petauroides volans*) (Vulnerable – EPBC Act)
- Gang-gang Cockatoo (*Callocephalon fimbriatum*) (Vulnerable – BC Act)
- Little Bent-winged Bat (*Miniopterus australis*) (Vulnerable – BC Act)
- Large Bent-winged Bat (*Miniopterus orianae oceanensis*) (Vulnerable – BC Act)
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (Vulnerable – BC Act, Vulnerable – EPBC Act)
- Brown Treecreeper (*Climacteris picumnus victoriae*) (Vulnerable – BC Act)

- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*) (Vulnerable – BC Act)
- Greater Broad-nosed Bat (*Scoteanax rueppellii*) (Vulnerable – BC Act)
- Scarlet Robin (*Petroica boodang*) (Vulnerable – BC Act)
- Purple Copper Butterfly (*Paralucia spinifera*) (Endangered – BC Act, Vulnerable – EPBC Act).

The location of threatened fauna species is shown in Figure 6-5. Potential impacts to threatened fauna species are detailed in Section 6.1.3.

Additional targeted surveys for Purple Copper Butterfly and Booroolong Frog, and surveys to detect breeding of Gang-gang Cockatoo, will be carried out while the REF is on public display, with findings being included in the Response to Submissions stage of the proposal.

Squirrel Glider

Squirrel Glider was recorded on remote camera at five locations within the construction footprint. All individuals were recorded on the northern side of the Great Western Highway. Individuals were recorded within larger patches (more than five hectares) of native vegetation opposite Jenolan Caves Road and at Forty Bends, inhabiting PCTs 1155, 1103 and 963.

Squirrel Glider is a species credit species known to inhabit mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest west of the Great Dividing Range. This species forages on invertebrates, pollen, Acacia gum, eucalypt sap, nectar, honeydew and manna, and requires abundant tree hollows for refuge and nest sites (DPIE, 2017b).

Suitable foraging, sheltering and breeding habitat is present for Squirrel Glider throughout the construction footprint, particularly in patches of vegetation where it has been recorded. Eucalypts trees including *Eucalyptus viminalis* are abundant and occasional stands of Acacias (*Acacia falciformis*, *Acacia melanoxylon*) in the midstorey constitutes preferred foraging habitat. Hollow-bearing trees are common within larger patches of vegetation across the construction footprint which this species would utilise for breeding and nesting.

A species polygon has been prepared to include all PCTs associated with Squirrel Glider and the additional PCT where this species was recorded during surveys: PCT 85, 731, 963, 1103 and 1155. Patch size was not considered when reviewing suitability of habitat however patches were only included in the species polygon if hollow-bearing trees or nest boxes were present. Potential habitat (associated PCTs) unable to be investigated due to property access arrangements was conservatively included in the species polygon despite the presence of tree hollows not being verified.

Greater Glider

Two individuals of Greater Glider were recorded within the construction footprint near Forty Bends in PCT 1155 during spotlighting surveys. There are an additional 24 records for this species within 10 kilometres of the subject land, the most recent from 2019.

Greater Glider is a species credit species because it occurs across a broad range of vegetation types and can be reliably detected from survey (DPIE, 2020c). Suitable habitat for this species includes all associated PCTs which contain hollow-bearing trees. Hollow-bearing trees provided sheltering and nesting habitat and are essential for breeding.

The construction footprint provides foraging and breeding habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of Greater Glider as they are listed as associated vegetation communities and contain hollow-bearing trees.

A species polygon has been prepared for potential habitat of Greater Glider. Potential habitat for this species is considered present in patches of native vegetation with a total patch size greater than five hectares that have a Vegetation Integrity Score (DPIE EES 2020) of 17 or higher and are listed as

associated PCTs of the species (DPIE EES 2021). Further, these patches of native vegetation must contain hollow-bearing trees or nest boxes. Potential habitat (associated PCTs) unable to be investigated due to property access arrangements was conservatively included in the species polygon despite the presence of tree hollows not being verified.

Gang-gang Cockatoo

Three flocks of Gang-gang Cockatoo were observed within the construction footprint. Two flocks of between six and 10 individuals were observed on two separate occasions at the eastern extent of the subject land in private property near The Lolly Bug. A small flock of two birds was observed flying over the site in private property nearest Carroll Drive, and the species has been observed in the area surrounding the subject land. Individuals were heard calling at each observation.

Gang-gang Cockatoo is a dual credit species. The species credit component is based on the presence of suitable breeding habitat (eg tree hollows with a diameter of 10 centimetres or larger which are at least nine metres above the ground). Gang-gang Cockatoo utilise a variety of habitats including tall mountain forests, open eucalypt forests, sub-alpine woodlands and temperate rainforests. This species favours old growth forest and woodlands for nesting and roosting, and forages on a range of eucalypt seed capsules and fruiting shrubs (i.e *Personia* sp.) (Recher, 2016; DPIE, 2017c).

The construction footprint contains vegetation that constitutes suitable foraging and breeding habitat for this species. A suite of eucalypts species including *Eucalyptus macrorhyncha* (Red Stringybark), *Eucalyptus sparsifolia* (Narrow-leaved Stringybark) and *Eucalyptus cypellocarpa* (Monkey Gum) are present which offer foraging habitat as well as fruit bearing shrubs like *Personia linearis* (Narrow-leaved Personia). Hollows suitable for Gang-gang breeding are relatively abundant, particularly in larger patches of native vegetation around Jenolan Caves Road and Forty Bends.

No species polygon has been prepared for Gang-gang Cockatoo as the species credit component (breeding) is yet to be identified within the construction footprint and the potential for breeding is considered to be low. Surveys are scheduled for October 2021 to determine whether the construction footprint is being used by this species for breeding. The findings from surveys will be included in the Response to Submissions report prepared for the proposal.

Little Bent-winged Bat and Large Bent-winged Bat

Little Bent-winged Bat was recorded at one location and Large Bent-winged Bat was recorded at four locations within the construction footprint during targeted Anabat surveys. There are 25 separate records for both species within a 10 kilometre radius of the construction footprint. None of the records included microhabitat code 'IC – in cave' or observation type code 'E nest-roost', indicating potential breeding habitat within the construction footprint or nearby.

Little Bent-winged Bat and Large Bent-winged Bat are dual credit species with the species credit component relating to specific breeding habitat. Potential breeding habitat includes caves, tunnels, mines or other structures known or suspected to be used by these threatened microbat species (DPIE, 2019). Little Bent-winged Bat and Large Bent-winged Bat are listed as Serious and Irreversible Impact (SAIL) species. A SAIL for these two species is any impact to breeding habitat as defined above.

The construction footprint contains culverts and bridge structures that could be inhabited by these species over-wintering periods and in the breeding season. Targeted searches were conducted within culverts and for bridge structures to detect the presence of either species and to make an assessment of the habitat suitability. These species share similar roosting and breeding habitat requirements and are known to share sites during breeding to provide the high temperatures needed to rear young (DPIE, 2021b). These species are known to breed in maternity caves for which they show high fidelity.

Microbats and signs of microbat presence (guano etc.) were identified at two culverts beneath the upgraded section of Great Western Highway between Forty Bends and Lithgow. Microbats observed within

culverts were unable to be positively identified during inspections, however there is potential for individuals to be Little Bent-winged Bat and/or Large bent-winged Bat. An additional four structures were considered to provide suitable habitat to these bat species and Southern Myotis however no signs of inhabitation were observed.

No caves have been identified in the construction footprint. Based on habitat within structures and the number of microbats observed during inspections, Little Bent-winged Bat and/or Large Bent-winged Bat are considered to use the construction footprint for temporary roosting and over wintering.

A species polygon has not been prepared for these species as the construction footprint does not contain breeding habitat of these species.

The ecosystem credit component applies to all PCTs associated with this species within the construction footprint which may be used for foraging and dispersal (DPIE, 2021b).

Large-eared Pied Bat

Large-eared Pied Bat was recorded at one location within the construction footprint during targeted Anabat surveys. There are nine records of the species within a 10 kilometre radius of the construction footprint, the most recent from 2019.

Large-eared Pied Bat is a species credit species because it cannot be reliably predicted to occur on a site based on vegetation and other landscape features. Potential breeding habitat includes PCTs associated with the species within 100 metres of rocky areas containing caves, overhangs or crevices, cliffs or escarpments, old mines, tunnels, or culverts and/or derelict concrete buildings. Potential foraging and dispersal habitat includes PCTs listed within the Threatened Biodiversity Data Collection (TBDC) that are within two kilometres of caves, scarps, cliffs, rock overhangs and disused mines (DPIE, 2021b). The Large-eared Pied Bat is listed as a SAI species. A SAI for the species is any impact to breeding habitat as defined above.

A species polygon has been established to include all habitat on the subject land (aligned with PCTs listed within the TBDC) that is within two kilometres of caves, scarps, cliffs, rock overhangs and disused mines (DPIE (EES), 2021a)

Purple Copper Butterfly

Purple Copper Butterfly is a species credit species. This species has niche habitat requirements relying exclusively on *Bursaria spinosa* subsp. *lasiophylla* and the attendant ant species *Anonychomyrma itinerans* to complete its lifecycle. Purple Copper Butterfly is restricted geographically, only occurring at elevations above 850 metres above mean sea level. (DPIE, 2021b).

Habitat assessment identified *Bursaria spinosa* species at multiple locations on the subject land. *Bursaria spinosa* species in the eastern half of the subject land is not considered habitat of Purple Copper Butterfly due to being located below the geographic elevation constraint of 850 metres amsl (DPIE (EES), 2021a). In the northern half of the subject land, around Forty Bends, intact bushland contains regular occurrence of *Bursaria spinosa* species, and scattered occurrences of *Bursaria spinosa* species also exist within private agricultural land holdings at Forty Bends. Only areas with a low canopy cover and *Bursaria spinosa* species above an elevation of 850 metres is considered high quality potential habitat of Purple Copper Butterfly.

A total of eight individuals of Purple Copper Butterfly were found in one patch of *Bursaria spinosa* subsp. *lasiophylla* at the eastern extent of Forty Bends within the subject land during targeted surveys conducted in October 2021. Previous surveys conducted by Niche (2020) during options assessment stage for the proposal identified this species at the western extent of Forty Bends within the subject land and in adjoining areas of bushland below Hassans Walls. A total of 14 individuals of Purple Copper Butterfly were identified during the survey, one of these was in the subject land (Niche, 2021d).

A species polygon has been established to include all areas of occupied habitat and high quality habitat of Purple Copper Butterfly on the subject land.

Brown Treecreeper

The Brown Treecreeper was heard calling on two occasions within the construction footprint. There is one additional record of the species within 10 kilometres of the construction footprint from 2006.

The species is an ecosystem credit species. Brown Treecreeper inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species. They can also be found in mallee and River Red Gum (*Eucalyptus camaldulensis*) forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses. Fallen timber is an important habitat component for foraging. The species nests in hollows of dead or live trees or tree stumps.

The construction footprint provides habitat for this species. PCTs 731 and 1103 are considered habitat of Brown Treecreeper as they are listed as associated vegetation communities. Hollow bearing trees are found within the construction footprint and provide potential breeding habitat within these vegetation communities. Fallen timber is found throughout the construction footprint varying in abundance providing potential foraging habitat within associated PCTs.

Eastern False Pipistrelle

Eastern False Pipistrelle were captured in targeted Anabat surveys within the construction footprint, near Jenolan Caves Road and on properties to the west. The observation is recorded as possible indicating uncertainty of identification from Anabat analysis. For the purpose of this assessment the species has been assumed present due to this record, and availability of suitable habitat within the construction footprint. There are nine additional records of the species within 10 kilometres of the construction footprint, the most recent from 2019.

Eastern False Pipistrelle are an ecosystem credit species. The species prefers moist habitats, with trees over 20 metres tall. The Eastern False Pipistrelle generally roosts in eucalypt hollows but has also been found under loose bark on trees, or in buildings.

The construction footprint provides habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of Eastern False Pipistrelle as they are listed as associated vegetation communities. Hollow bearing trees present which provides potential roosting habitat.

Greater Broad-nosed Bat

The Greater Broad-nosed Bat was recorded in the construction footprint during targeted Anabat surveys near Jenolan Caves Road. The observation is listed as possible indicating a lower level of confidence due to quality of recording. For the purpose of this assessment the species has been assumed present due to this record and availability suitable habitat within the construction footprint. There are a further four records of the species within 10 kilometres of the construction footprint with the most recent record from 2014.

The Greater Broad-nosed Bat is an ecosystem credit species. The species utilises a variety of habitats from woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest. Although the species predominantly roosts in tree hollows, it has also been recorded roosting in buildings.

The construction footprint provides habitat for this species. PCTs 731, 732, 963, 1103 and 1155 are considered habitat of the Greater Broad-nosed Bat as they are listed as associated vegetation communities. Hollow bearing trees present which provides potential roosting habitat.

Scarlet Robin

Scarlet Robin was recorded at one location within the construction footprint during remote camera surveys on a property west of Jenolan Caves Road. There are 16 records of the species within 10 kilometres of the construction footprint, with the most recent from 2020.

The Scarlet Robin is an ecosystem credit species. The species inhabits dry eucalypt forests and woodlands usually with an open and grassy understory with few scattered. The species lives in both mature and regrowth vegetation, occasionally occurring in mallee or wet forest communities, or in wetlands and tea-tree swamps. Abundant logs and fallen timber are key components of the species habitat. In autumn and winter, the Scarlet Robin may occupy open grassy woodlands and grasslands or grazed paddocks with scattered trees.

The construction footprint provides habitat for this species. PCTs 85, 731, 732, 963, 1103 and 1155 are considered habitat of the Scarlet Robin as they are listed as associated vegetation communities. Fallen timber and logs are found throughout the construction footprint varying in abundance.

Non-native fauna species

Four non-native fauna species were recorded within the construction footprint:

- European Fox (*Vulpes vulpes*)
- European Rabbit (*Oryctolagus cuniculus*)
- Feral Cat (*Felis catus*)
- Common Myna (*Acridotheres tristis*).

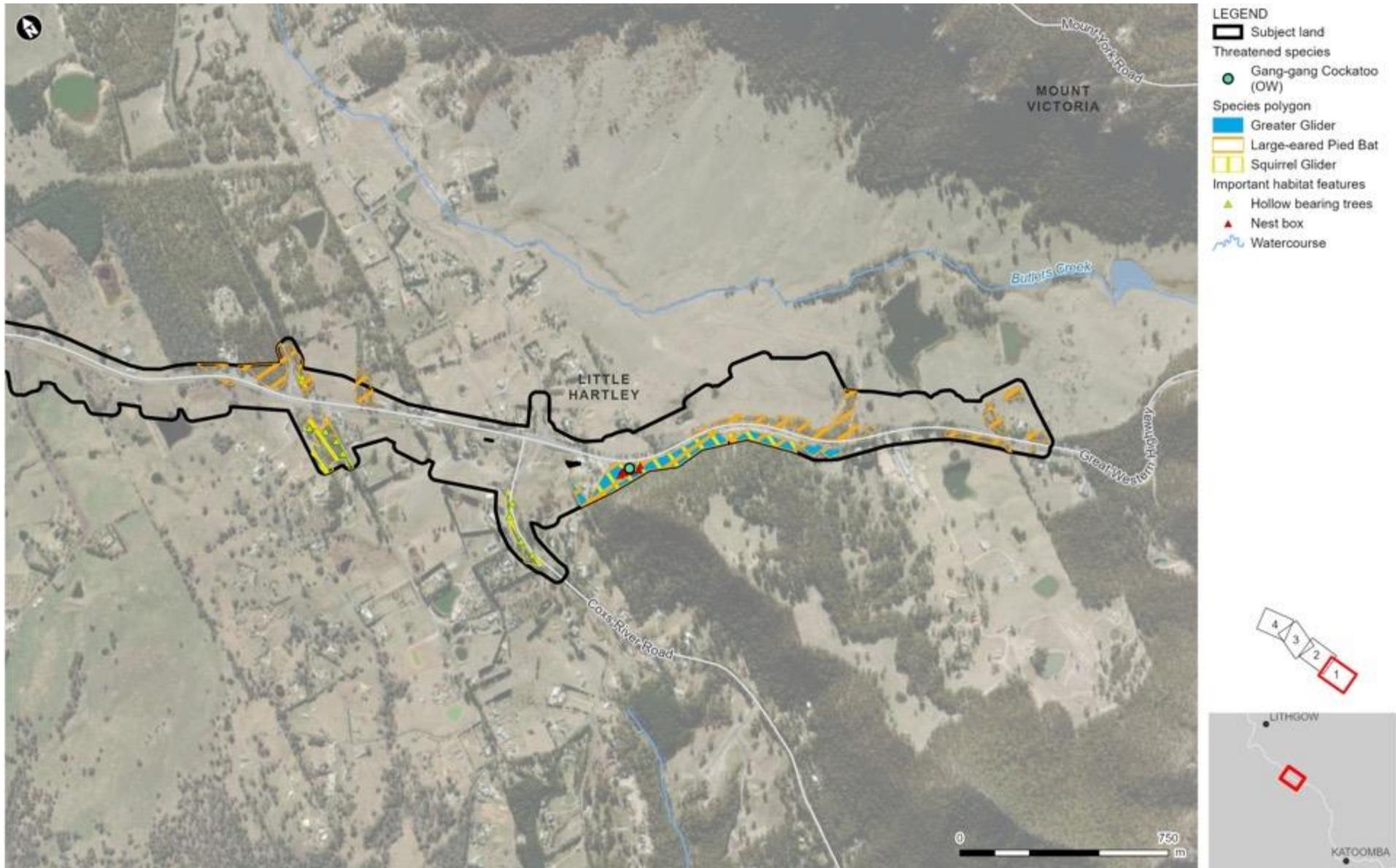


Figure 6-5 a Recorded threatened fauna species

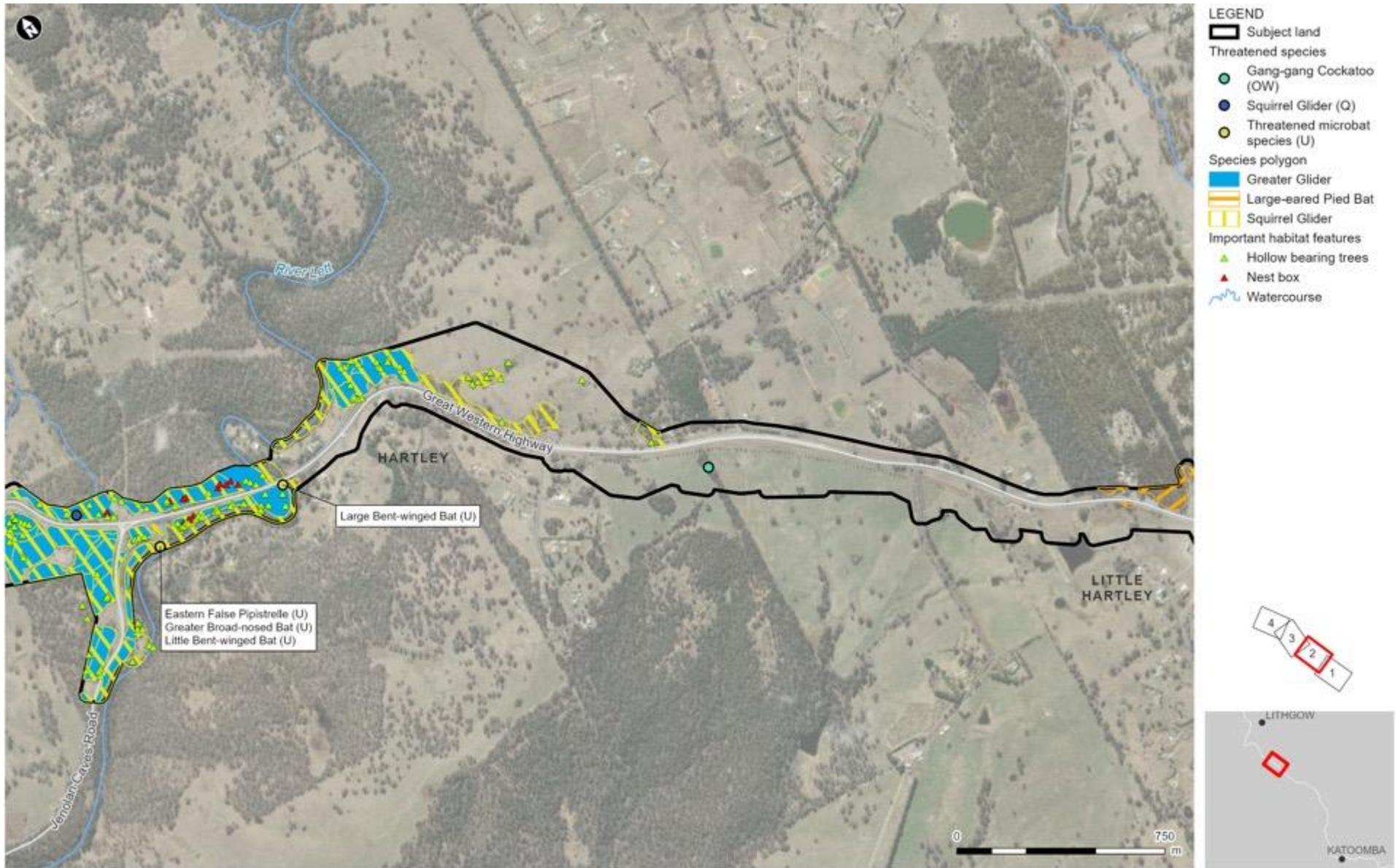


Figure 6-5 b Recorded threatened fauna species

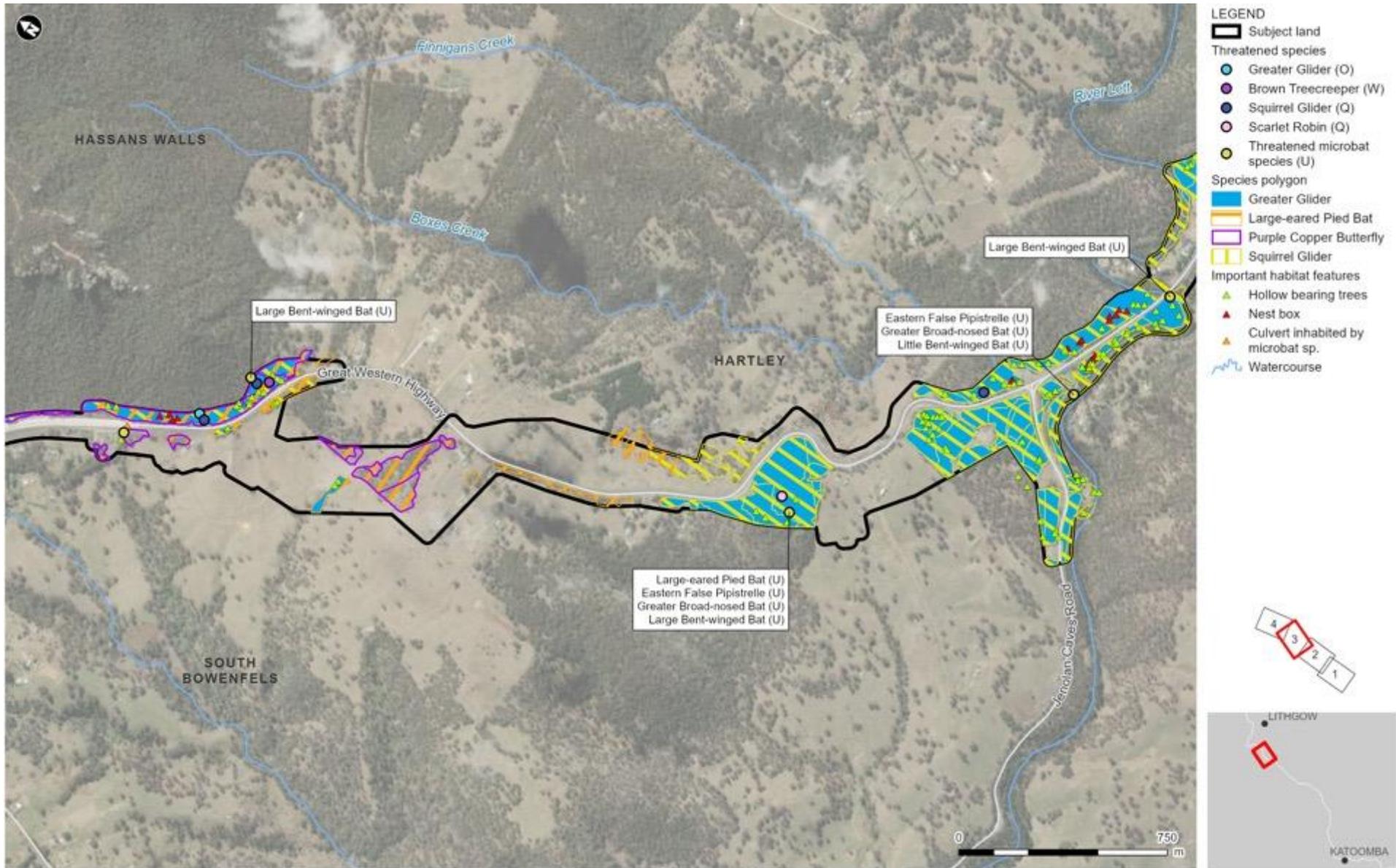


Figure 6-5 c Recorded threatened fauna species

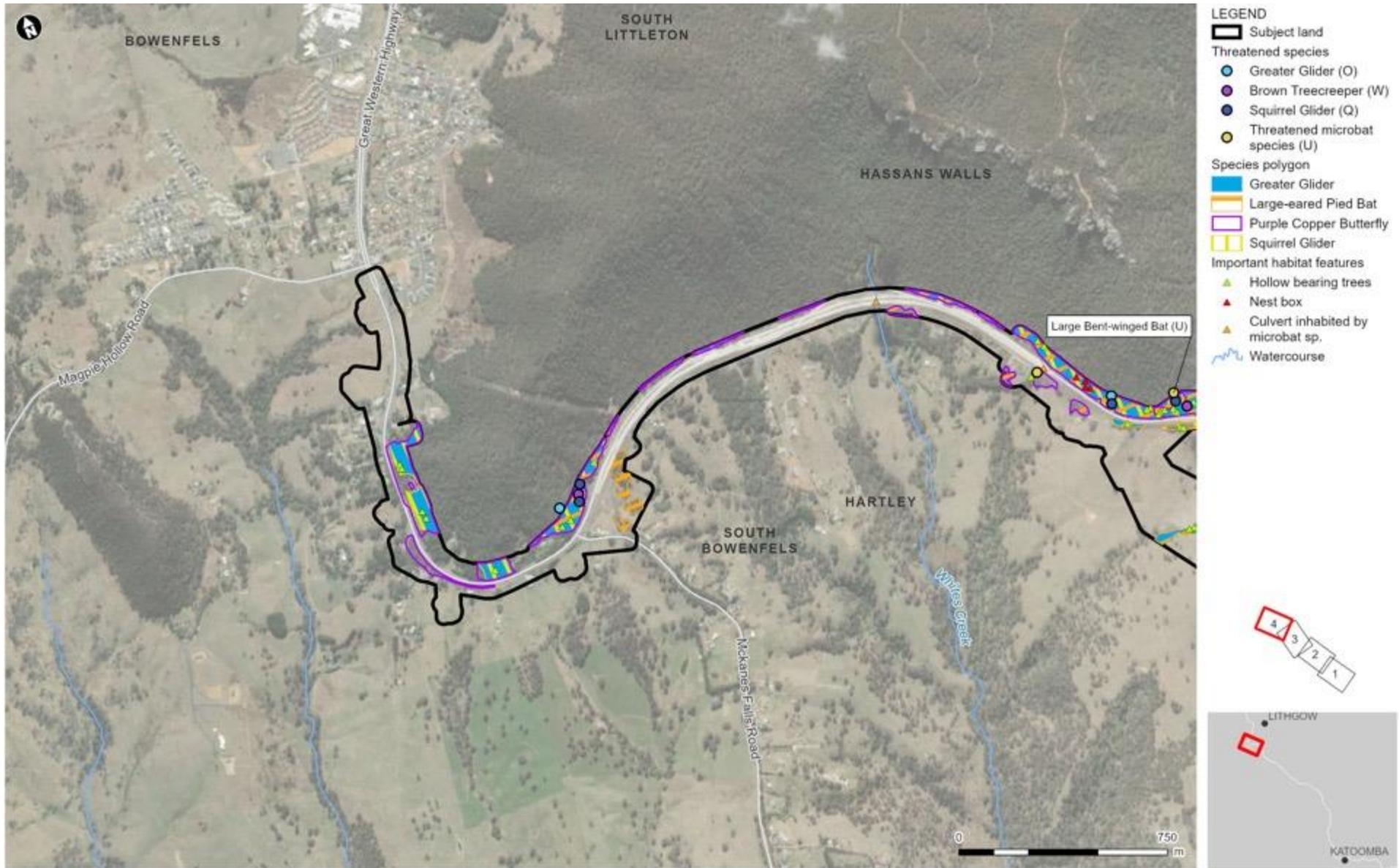


Figure 6-5 d Recorded threatened fauna species

Aquatic habitat and species

The proposal transects several named and unnamed waterways, including River Lett, Boxes Creek and associated unnamed tributaries, tributaries of Butlers Creek (Rosedale Creek) and Whites Creek and several other first and second order streams.

No mapped habitat for any threatened fish species listed under the *Fisheries Management Act 1994* (FM Act) is identified within the construction footprint. The closest mapped habitat is for the Purple Spotted Gudgeon eight kilometres west and Macquarie Perch nine kilometre east. Mapped habitat for both species are not connected to waterways that intersect the proposal. No threatened species listed under the FM Act are likely to occur in any waterways that intersect or occur directly downstream of the proposal.

Key Fish Habitat is mapped where the subject land crosses the intersection of Jenolan Caves Road along Boxes Creek and the River Lett and tributaries of Butlers Creek (Rosedale Creek) and Whites Creek (Figure 6-6). A summary of the aquatic habitat values identified during surveys at key waterways are in Table 6-5

Table 6-5 Aquatic habitat assessment

Feature	Description
River Lett	
Description	Major river flowing west/southwest, a tributary of the Coxs River. Crossing the proposal east of the Jenolan Caves Road intersection through a large concrete bridge under the Great Western Highway. Flows parallel to the Great Western Highway then heads southwest following Jenolan Caves Road beyond the subject land for about 1.5 kilometres to the headwaters of the Coxs River.
Stream order	Sixth order
Ecosystem type	Freshwater river
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI 2021) Type 1 – highly sensitive key fish habitat (DPI 2013) Class 1 – major key fish habitat (DPI 2013)
Dimensions of waterway and depth of water	Five to eight metres wide 1.5 to two metres deep
Flow characteristics and hydrological features	Fast flowing river with deep channel and large boulders and sandbanks creating riffles and pools.
Bed substrate	Sandy bed with gravel and large boulders
Habitat features	Pools and riffles, undercut grassy banks, large woody debris (snags). Channel largely free of aquatic vegetation with sedges and grasses on the creek banks.
Existing infrastructure and barriers to fish movement	A disused bridge of the Old Great Western Highway contains piles that have led to the formation of sandbanks such that several channels and pools are located off the main channel around this location. The channels reform downstream of the bridge into a single channel. Fish movement would be affected by the bridge in the smaller channels in periods of low flow.

Feature	Description
	The main bridge over the Great Western Highway crossing maintains fish passage with some minor impacts on flow characteristics from the pile on the right bank.
Riparian vegetation	15 metre wide riparian zone with open grassy woodland dominated by <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> (River Oak). Minimal shrubs are present and the groundlayer contains sedges and grasses such as <i>Lomandra longifolia</i> , <i>Microlaena stipoides</i> and large matted areas of <i>Lonicera japonica</i> (Japanese Honeysuckle).
Water quality	Water quality impacted by local agriculture and highway run off. High turbidity in shallows and side pools and streams adjacent to the main channel. Algae present.
Boxes Creek	
Description	Creek at bottom of descending valley north of the highway at the intersection of Jenolan Caves Road. Flowing southwest, crosses Blackmans Creek Road then under the highway through a four cell concrete box culvert to meet River Lett southeast of the Jenolan Caves Road intersection.
Stream order	Fourth order
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI 2021) Type 1 – highly sensitive key fish habitat (DPI 2013) Class 2 – moderate key fish habitat (DPI 2013)
Dimensions of waterway and depth of water	One to two metres wide 0.5 metres deep
Flow characteristics and hydrological features of aquatic habitat	Meandering ephemeral creek at with well-defined channel that opens to pooled water.
Bed substrate	Sandy substrate with fine gravel on creek bed.
Habitat features (eg pools, riffles, billabongs, reefs)	Pools, overhanging vegetation on undercut banks, large woody debris (snags). Occasional patches of emergent aquatic vegetation instream including <i>Persicaria</i> sp, <i>Phragmites australis</i> , <i>Juncus</i> sp..
Existing infrastructure and barriers to fish movement (natural or artificial)	Culverts under Blackmans Creek Road and Great Western Highway have modified flow but maintain fish passage.
Riparian vegetation	Narrow riparian zone with open grassy eucalypt woodland dominated by <i>Eucalyptus viminalis</i> . Grassy groundlayer with <i>Rubus fruticosus</i> sp. aggregate (Blackberry) infestation on banks shading sections of the creek.

Feature	Description
Water quality	Water quality impacted by local agriculture and highway run off. Water clear at survey location.
Rosedale Creek	
Description	Creek passing through cleared paddocks with intermittent pools. Flowing north under the highway through a two cell concrete box culvert. The waterway channel is not well defined, particularly upstream of the highway
Stream order	3
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 1 – highly sensitive key fish habitat (DPI, 2013) Class 3 – minimal key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	Six metres wide downstream of culvert 30 centimetres deep at time of survey
Flow characteristics and hydrological features of aquatic habitat	Flowing ephemeral creek with an undefined channel and intermittent pools.
Bed substrate	Silty substrate with evidence of cattle trampling.
Habitat features (eg pools, riffles, billabongs, reefs)	Juncus sp. in stream and Rubus fruticosus sp. Aggregate (Blackberry) infestation. Some intermittent pools. Snags present
Existing infrastructure and barriers to fish movement (natural or artificial)	A two cell box culvert (2.4 metre by three metres) has modified flow, altering fish passage though not blocking it.
Riparian vegetation	Grassy banks and a cleared riparian zone (pasture)
Water quality	Water quality appears poor. High turbidity and some bubbles on surface
Tributary to Whites Creek 1	
Description	Narrow creek through grassy paddock that has cattle grazing. Sits in a large valley, below the Great Western Highway. Runoff from road, surrounding agricultural land and bushland in adjacent private property.
Stream order	1
Ecosystem type	Freshwater creek

Feature	Description
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 3 – minimally sensitive key fish habitat (DPI, 2013) Class 4 – unlikely key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	Three to four metres wide 0.5 metres deep
Flow characteristics and hydrological features of aquatic habitat	Ephemeral creek at with well-defined channel that features pools and riffles.
Bed substrate	Silty substrate and granite rock bed, brown/orange clay, silt-like soils, and algae.
Habitat features (eg pools, riffles, billabongs, reefs)	Large pools, riffles, floating aquatic weeds. Undercut banks with grass growing over. Erosion on sides deep and severe in places and large snags present.
Existing infrastructure and barriers to fish movement (natural or artificial)	Nil.
Riparian vegetation	Riparian vegetation narrow, approximately 3.5 metres and large remnant Eucalyptus sp. present on the banks with grassy understorey.
Water quality	Water quality impacted by local agriculture and highway run off. Water appears poor quality, is clear but with oil slicks and brown algae
Whites Creek	
Description	Creek line passing through a large constructed culvert under the highway lined with rock then forming narrow channel in grassy paddock grazed by sheep.
Stream order	3
Ecosystem type	Freshwater creek
Key Fish Habitat Type and Class	Mapped as Key Fish Habitat (DPI, 2021b) Type 1 – highly sensitive key fish habitat (DPI, 2013) Class 2 – moderate key fish habitat (DPI, 2013)
Dimensions of waterway and depth of water	0.6 to 1 metre metres wide 0.2 metres deep
Flow characteristics and hydrological	Ephemeral creek, fast flowing at time of survey.

Feature	Description
features of aquatic habitat	
Bed substrate	Silty substrate with rocks and pebbles on bed.
Habitat features (eg pools, riffles, billabongs, reefs)	No visible aquatic vegetation, undercut banks.
Existing infrastructure and barriers to fish movement (natural or artificial)	Some fallen timber, large culvert with rock at northern entrance flowing into small sandstone pipe culvert underneath service road.
Riparian vegetation	<i>Eucalyptus viminalis</i> and exotic shrubs present on eastern side of the creek only.
Water quality	Water quality affected by road runoff. Algae visible.

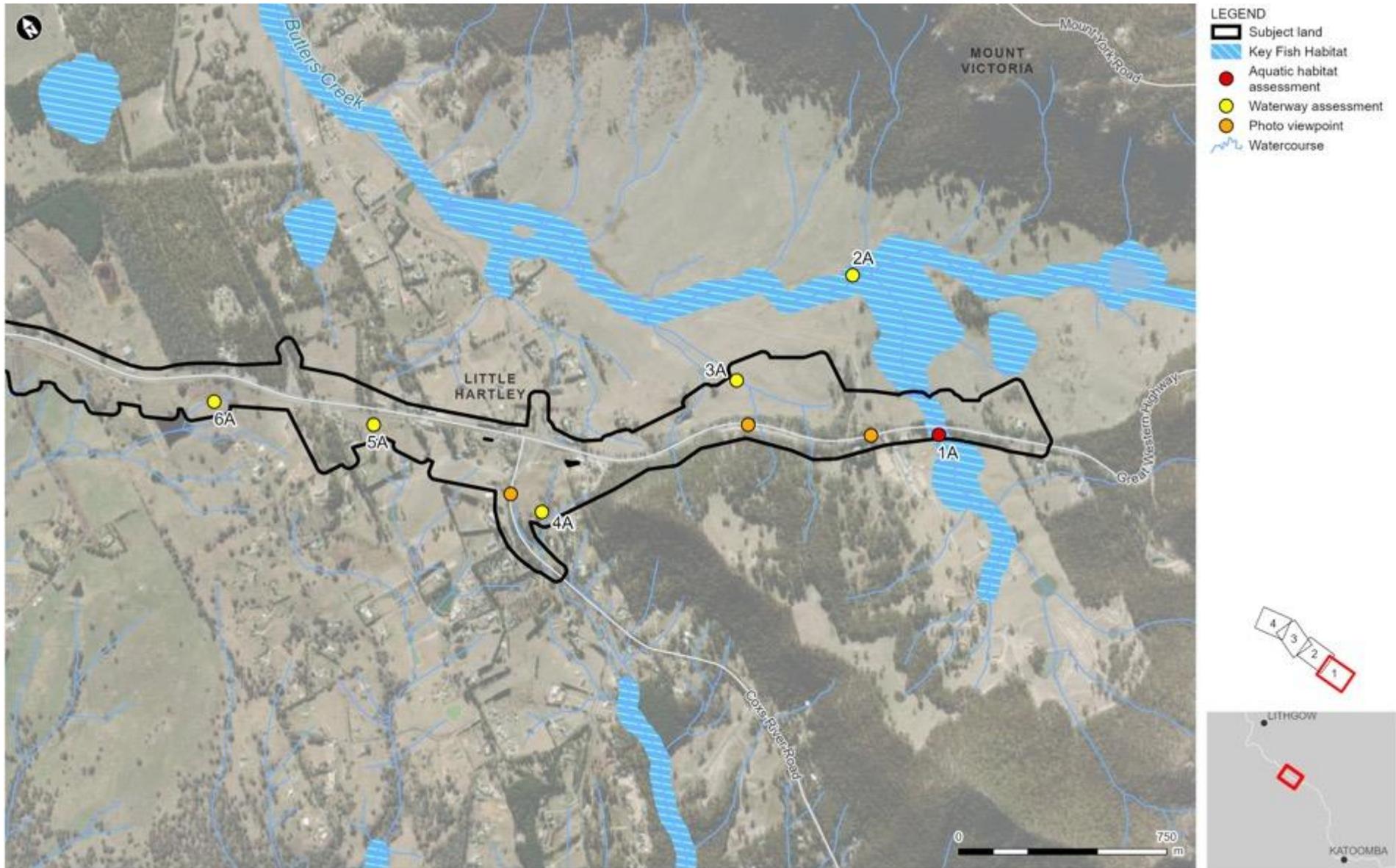


Figure 6-6 a Aquatic habitat

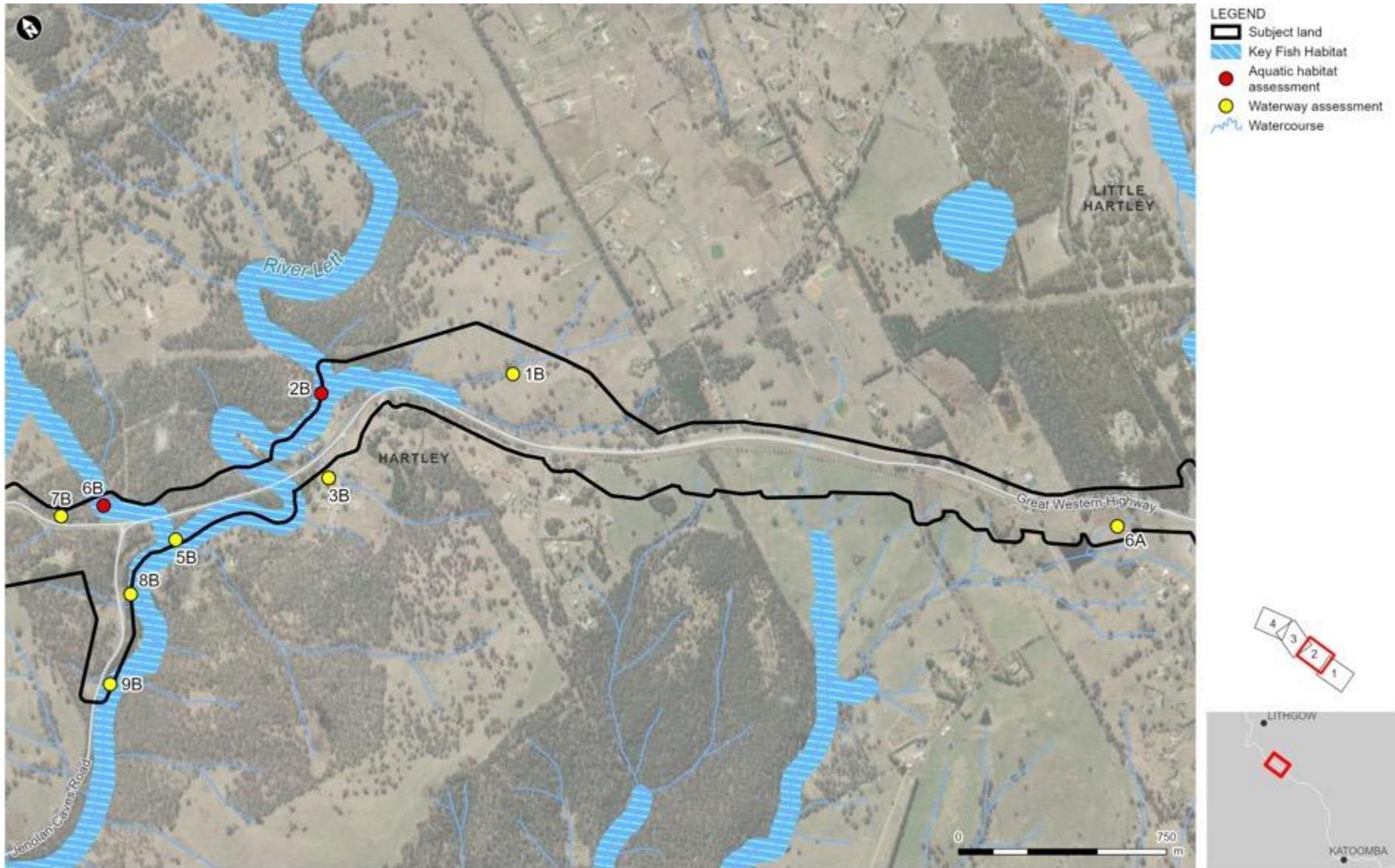


Figure 6-6 b Aquatic habitat

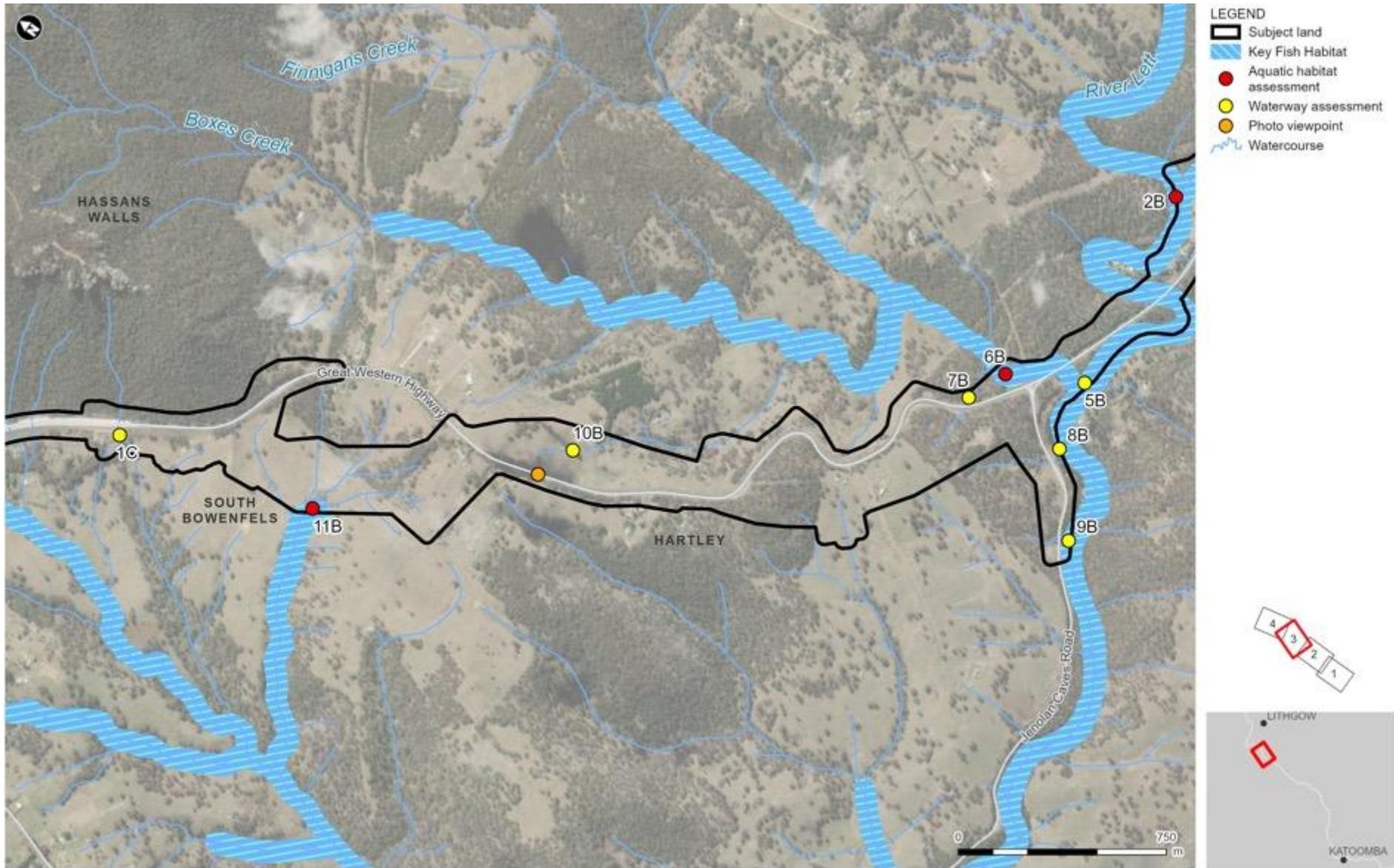


Figure 6-6 c Aquatic habitat

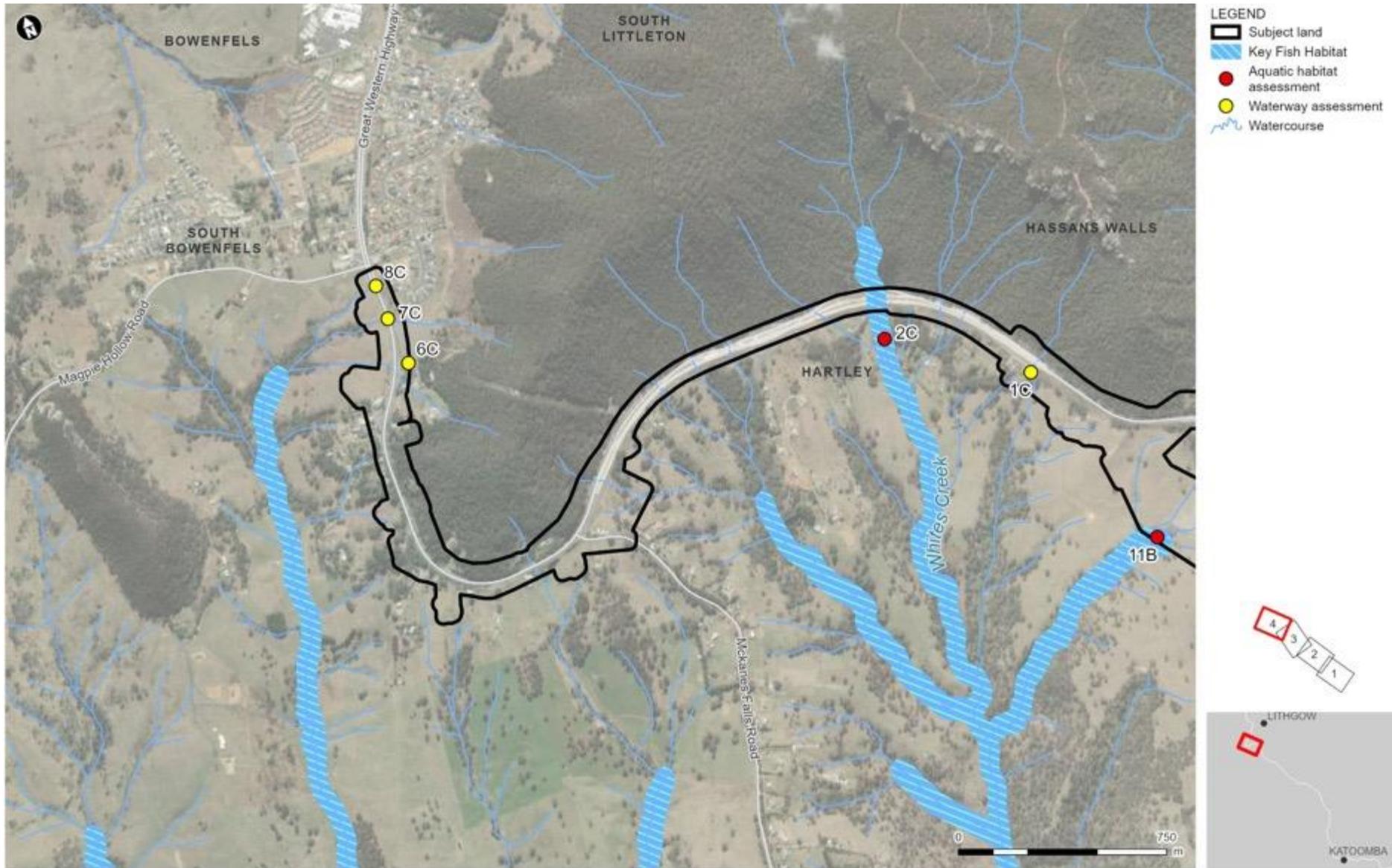


Figure 6-6 d Aquatic habitat

6.1.3 Potential impacts

Avoidance and minimisation of impacts

Section 2 considered describes the corridor options in detail that were considered and explains how and why the proposal was selected as the preferred option. Biodiversity considerations were considered through the corridor and route options assessment and the design refinement process. Direct and indirect biodiversity impacts were avoided or minimised through:

- Selection of a route option with lower native vegetation clearing required
- Selection of a route option that largely follows the existing highway alignment and therefore has the least impact to habitat connectivity
- Siting of ancillary facilities in areas of cleared land where feasible
- Provision of a number of fauna crossings to provide fauna connectivity across the highway
- Provision of fauna fencing in selected areas of wildlife connectivity to reduce the risk of vehicle strike and fauna mortality as well as guide fauna towards fauna crossing structures
- Making provision for the demarcation, ecological restoration, rehabilitation and/or ongoing maintenance of retained native vegetation habitat within the construction footprint.

Construction

Removal of native vegetation

Construction of the proposal would require the removal of 75.19 hectares of native vegetation that occurs in the construction footprint. Vegetation from eight PCTs would be removed, one of which (PCT 1103) falls within the definition of two TECs listed under the BC Act and one TEC listed under the EPBC Act.

A total of 142 hollow-bearing trees were identified on the subject land and will be removed by the Proposal, 129 of which are located within patches of native vegetation. The remaining 13 hollow-bearing trees are non-native trees which have not been mapped as native vegetation.

The area of vegetation zones to be cleared are listed in Table 6-6.

Table 6-6 Direct impacts to native vegetation

Plant community type (PCT)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)	Number of hollow bearing trees impacted
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85 (moderate)	3.95	3.95	2
	85 (disturbed)	0.35	0.35	2
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (732)	732 (moderate)	6.42	6.42	11
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the	963 (good)	2.34	1.2	10

Plant community type (PCT)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)	Number of hollow bearing trees impacted
upper Blue Mountains; Sydney Basin Bioregion (963)*				
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103 (disturbed)	1.85	1.71	0
	1103 (good)	11.62	10.72	41
	1103 (low – moderate)	4.79	4.79	10
	1103 (moderate)	6.94	6.20	27
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731 (good)	12.44	12.44	4
	731 (moderate)	14.61	14.61	4
	731 (variant – good)	3.08	3.08	5
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (1155)	1155 (moderate)	10.52	9.72	13
Total		78.91	75.19	129

Removal of threatened ecological communities

The 75.19 hectares of native vegetation to be cleared for the proposal includes 23.41 hectares of vegetation that meets the criteria for a threatened ecological community under the BC Act. These areas are listed in Table 8 2.

Table 6-7 Direct impacts to threatened ecological communities

Threatened ecological community (TEC)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)
Tableland Basalt Forest in the Sydney Basin and South Eastern Highlands Bioregion (Endangered)	1103 (good)	6.62	6.62
	1103 (moderate)	5.68	5.68
	1103 (low – moderate)	3.97	3.97
	1103 (disturbed)	1.32	1.32
	Total	17.59	17.59

Threatened ecological community (TEC)	Vegetation zone	Area within subject land (ha)	Area to be impacted (ha)
White Box – Yellow Box – Blakely’s Red Gum Grassy Woodland and Derived Native Grassland in the NSW North Coast, New England Tableland, Nandewar, Brigalow Belt South, Sydney Basin, South Eastern Highlands, NSW South Western Slopes, South East Corner and Riverina Bioregions (Critically Endangered)	1103 (good)	5.00	4.10
	1103 (moderate)	1.26	0.52
	1103 (low – moderate)	0.82	0.82
	1103 (disturbed)	0.52	0.38
	Total	7.60	5.82

Removal of threatened flora

As discussed in Section 6.1.2, threatened flora surveys would be carried out in Spring 2021 to meet the recommended survey periods for the targeted flora species. The findings from these targeted surveys, including any required removal, will be included in the Response to Submissions report prepared for the proposal.

Removal of threatened fauna habitat

A total of 290.51 hectares of vegetation would be removed for the proposal of which 75.19 hectares is native.

A total of 142 hollow-bearing trees were identified on the subject land and will be removed by the Proposal, 129 of which are located within patches of native vegetation. The remaining 13 hollow-bearing trees are non-native trees which have not been mapped as native vegetation.

The proposal has will impact 4.3 hectares of specialist habitat (*Bursaria spinosa* subsp. *lasiophylla*) of the Purple Copper Butterfly. Of this, 0.33 hectares is known breeding and foraging habitat of this species. The quality and occupancy of the remaining 3.97 hectares of habitat is unknown due to the area not being surveyed. Following removal of habitat within the subject land it is considered unlikely that the proposal will have indirect impacts on retained habitat adjacent to Great Western Highway. Retained habitat will remain upslope of road and is unlikely to be significantly impacted by edge effects.

Species credit species

Of the 11 threatened fauna species recorded during surveys, four are identified as species credit species. Potential impacts on species credit species are summarised in Table 6-8. Additional targeted surveys are required for Booroolong Frog, and to detect breeding of Gang-gang Cockatoo, which if identified would require additional offsetting as a species credit. The findings from these targeted surveys will be included in the Response to Submissions report prepared for the proposal.

Table 6-8 Impacts on species credit threatened fauna

Threatened fauna species	Status		Associated PCT	Area within subject land (ha)	Potential area of habitat to be impacted (ha)	Likely significant impact?
	BC Act	EPBC Act				
Squirrel Glider	Vulnerable	-	731, 963, 1155	54.14	50.87	No
Greater Glider	-	Vulnerable	731, 732, 963, 1103, 1155	43.52	40.24	No
Large-eared Pied Bat	Vulnerable	-	731, 732, 963, 1155	25.86	24.22	No
Purple Copper Butterfly	Endangered	Vulnerable	732, 963, 1155	5.94	4.3	No

Ecosystem credit species

The removal of native vegetation and anticipated removal of 142 hollow bearing trees would also remove potential foraging and/or roosting habitat for multiple ecosystem credit species, including:

- Gang-gang Cockatoo
- Glossy Black-Cockatoo
- Large-eared Pied Bat
- Little Bent-winged Bat
- Large Bent-winged Bat
- Koala
- Grey-headed Flying-fox
- Diurnal Raptors (Square-tailed Kite, White-bellied Sea-Eagle, Little Eagle)
- Large forest owls (Masked Owl, Powerful Owl, Barking Owl, Sooty Owl)
- Brown Treecreeper
- Scarlet Robin
- Eastern False Pipistrelle
- Greater Broad-nosed Bat.

Aquatic habitat impacts

The proposal would not result in any impacts to threatened species or communities listed under the FM Act. However, the proposal would impact waterways with fish habitat, including mapped Key Fish Habitat at several locations including River Lett, Boxes Creek and associated unnamed tributaries, Rosedale Creek and Whites Creek. A total of 16.26 hectares of mapped Key Fish Habitat lies within the subject land. Key Fish habitat mapping is conservative and estimates a considerably wider area of waterway than actual. As such, impacts to actual habitat would be considerably less.

During construction there is a potential for waterways to be temporarily blocked or diverted. Blocking or diversion of drainage lines will block fish passage, though is unlikely to affect any threatened species and would be temporary in nature.

Water quality impacts associated with the construction phase include increased turbidity from sedimentation which can reduce visual amenity and increased nutrients which can lead to algal blooms and affect the quality of fish habitat. Water quality impacts would be managed through an erosion and sediment control strategy.

Fauna injury and mortality

The primary cause of increased fauna injury and mortality during the construction stage of the proposal would be as a result of vegetation clearing activities (particularly during the felling of hollow-bearing trees or trees containing undetected arboreal mammals (eg gliders, reptiles or active nests) or may result from collisions with work vehicles or plant, or accidental entrapment in plant, trenches or other works.

The removal of fauna habitat has inherent risks that can, in part, be mitigated through implementing appropriate clearing procedures. The majority of native and threatened fauna species that have habitat within the site investigation area are highly mobile and typically vacate the vegetation in which they reside at the commencement of vegetation clearing. Other, typically ground dwelling, species are less mobile and at higher risk of construction phase mortality. Measures to reduce accidental injury or mortality to fauna are proposed in Section 6.1.4.

Invasion and spread of weeds

Six exotic species recorded within the construction footprint are listed as Priority Weeds in the Central Tablelands region, which includes the Lithgow City LGA:

- Scotch Broom (*Cytisus scoparius*)
- St Johns Wort (*Hypericum perforatum*)
- Small-leaved Privet (*Ligustrum sinense*)
- Serrated Tussock (*Nassella trichotoma*)
- Blackberry (*Rubus anglocandicans*)
- Fireweed (*Senecio madagascariensis*).

Invasive exotic grasses such as *Eragrostis curvula*, also represent a threat to native vegetation.

An increase in the movement of people, vehicles, machinery, vegetation waste and soil during and following construction of the proposal may facilitate the introduction or spread of exotic weeds that currently occur within the construction footprint.

Disturbed areas, such as those in which earthworks are to be carried out, would be particularly susceptible to weed establishment. Management measures would be required to minimise the risk of introduction and spread of weeds.

Invasion and spread of pests

Activities such as vegetation clearing, habitat removal, increased noise and human presence as a result of the proposal have the potential to disperse pest species across the surrounding landscape and increase the ability of such species to utilise habitats during construction and operational phases. Vegetation clearing, and consequent fragmentation can result in the establishment of predator pest species such as the European Red Fox, which pose a high risk to birds and small terrestrial fauna. The proposal is not considered to increase pest animal populations more than what already exists.

Invasion and spread of pathogens

The proposal has the potential to increase the spread of pathogens that threaten native biodiversity values, such as the soil-borne pathogen *Phytophthora* (*Phytophthora cinnamomi*). *Phytophthora* infects roots and is associated with damage and death to native plants. It may be dispersed over large distances in flowing water, such as storm runoff, or may be spread within a site via mycelial growth from infected roots to roots of healthy plants. Propagules of *Phytophthora* may also be dispersed by vehicles (eg cars and earth moving equipment), animals, walkers and movement of soil. It is listed as a Key Threatening Process (defined as a process which threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community) under BC Act. There may be an increased risk of dispersal of *Phytophthora* as a result of the construction activities that involve soil disturbance.

Noise, light, and vibration

While the construction phase of the proposal may cause temporary disturbance, the impact of noise and vibration on fauna would likely be localised to the construction footprint and would be unlikely to have a significant, long-term impact on fauna.

Additionally, while the proposal is likely to increase the amount of artificial lighting within the site investigation area and surrounds during the construction, roads within the locality already currently experience light exposure. These impacts are not considered to have a significant, long-term impact on fauna, including threatened fauna, as fauna within construction footprint would already be adapted to light pollution, and the increased artificial lighting associated with the proposal is unlikely to have a substantial effect.

Most locally occurring fauna would likely relocate from areas adjacent to the highway which are indirectly impacted by noise and light spill to more suitable areas of habitat further afield for the duration of construction.

Unidentified species of microbats and signs of microbat presence (guano etc.) were identified at two culverts beneath the upgraded section of Great Western Highway between Forty Bends and Lithgow. Indirect impacts to microbats inhabiting the culverts could occur during construction from noise and vibration and increased disturbance from human activity.

Assuming microbats are roosting at the time of the works, microbats would either seek alternative roosting habitat or tolerate the noise and continue to roost. Given the short duration of works, and small numbers of microbats observed roosting in the culvert (three individuals) it is unlikely that the disturbance would impact the local and bioregional persistence of the species present. Given the uncertainty around the response of microbats to the works, culvert 3 would be monitored and environmental management measures to minimise impacts on the species would be developed in response to any observable impacts using an adaptive management strategy.

Groundwater dependent ecosystems

A total of 42.85 hectares mapped by the Bureau of Meteorology (2020) as potential GDEs would be removed for the proposal.

The groundwater assessment technical working paper (JAJV, 2021) concluded that predicted changes to groundwater levels are small and localised to the vicinity of the proposal. As such, no impacts to GDEs as a result of predicted groundwater drawdown are anticipated. Furthermore, the assessment found that in most areas, the existing water table is likely within rock and at a sufficient depth such that it is not significantly used by the potential GDEs in the vicinity of the proposal.

Potential groundwater contamination is considered to be unlikely to occur as a result of the proposal, as the proposal is not likely to intersect the water table.

Operation

Wildlife connectivity and habitat fragmentation

There are no mapped wildlife corridors in the subject land, however the Blue Mountains Western Escarpment wildlife corridor between Mount Victoria and Little Hartley is located east of the proposal. More broadly, the proposal is located to the south and west of expansive vegetation of the Greater Blue Mountains area. The Blue Mountains National Park lies to the east and Newnes Plateau to the north. Narrow remnants of native vegetation cross the proposal in a north-south orientation linking vegetation in these expanses to more fragmented vegetation on rural land and riparian corridors. These corridors are important for habitat connectivity to native vegetation remnants to the immediate south and conservation areas further on such as Kanangra-Boyd National Park, particularly around the Jenolan Caves Road intersection which also connects to riparian vegetation of the Coxs River.

The proposal includes the provision of a fauna exclusion fence on both sides of the highway. This fauna exclusion fence would prevent fauna from accessing the road and being subjected to vehicle strike (discussed further below).

The fauna exclusion fence would also guide animals to move along the fence toward a number of fauna underpasses that would be provided beneath the highway. These underpasses (ie concrete box culverts) would facilitate the safe crossing of fauna beneath the road. Underpasses would be designed to convey surface water flows as well as facilitate fauna crossings. These would include a raised bench on one side of the base of the culvert, to allow for the dry passage of animals during periods of high flow. All are single cell concrete box culverts 3.3 metres by 3.3 metres to allow for crossing of large mammals such as Common Wallaroos (*Osphranter robustus*) and Eastern Grey Kangaroos (*Macropus giganteus*). Additionally, two existing large box culverts would be maintained and extended at Boxes Creek and Rosedale Creek, which would include fauna friendly design elements to encourage fauna crossing.

Design of underpasses would be in accordance with *Wildlife Connectivity Guidelines: Managing wildlife connectivity of road projects (draft)* (Roads and Maritime, 2011) and best available knowledge from other Transport projects.

Maintenance of any fencing and underpasses is critical to the efficacy of these measures and would be detailed in an Operational Environmental Management Plan or existing Environmental Management System that incorporates the proposal.

Edge effects on adjacent native vegetation and habitat

The proposal would result in indirect impacts on some areas of native vegetation adjoining the construction footprint, mainly due to the creation of new edges in native vegetation adjacent to the widened and/or realigned Great Western Highway, which may result in edge effects.

Edge effects occur when environmental conditions are altered (ie light levels, wind speed and temperature) and consequently can promote the growth of different vegetation types (including weeds), invasion by feral fauna, or change the behaviour of resident fauna. Most of the subject land adjoins cleared land or small, fragmented patches of vegetation within cleared pasture. This vegetation is often already situated adjacent to an existing cleared edge, such as a road, and is subject to ongoing disturbance and edge effects.

Larger areas of native vegetation which occur along the margins of the Great Western Highway are currently subject to edge effects, including weed incursion at the road margin. The realignment and upgrade of Great Western Highway would result in additional edge effects in some areas through the creation of new edges in previously undisturbed vegetation. Indirect impacts to this vegetation could include the introduction and spread of weeds, soil disturbance and trampling, though impacts are likely to be minor and contained to the edge of subject land.

The analysis of potential for edge effects found a total of 8.5 hectares of native vegetation would be subject to increased edge effects as a result of the proposal due to the creation of one or more new edges within previously unfragmented vegetation. These new edges could be subject to degradation by the establishment and spread of weeds, enriched runoff from road pavement and dumping of rubbish. However, the proposal would include the provision of drainage infrastructure that would appropriately manage surface water flows.

Aquatic impacts

Instream impacts would occur at culvert extensions at Boxes Creek and Rosedale Creek about 55 metres and 51 metres, respectively. Culvert extensions would result in the permanent removal of aquatic vegetation, rock and snags over a small area. Culvert extensions would result in alterations to the flows of these two creeks. They are both highly modified from the existing highway and surrounding roads/land use practices and flow alteration impacts are expected to be minor.

Additionally, twin bridges over the River Lett would be installed which would change hydrology of the river and increase shading. Shading impacts would be over a relatively small area and hydrological changes are expected to be minor. There would be no permanent structures instream (under normal flow conditions).

Riparian vegetation would be permanently removed at each waterway. Impacts would be limited to small areas around each crossing structure and disturbed areas would be revegetated upon completion of construction.

Fauna injury and mortality

The primary cause of increased fauna injury and mortality during the operational stage of the proposal is anticipated to be vehicle collisions. Existing cases of fauna injury and mortality are dispersed across the proposal alignment and not concentrated in any particular area.

Fauna connectivity measures, including combined fauna culverts and fauna fencing would be constructed across the proposal alignment which would direct species across the road corridor and prevent vehicle strike to susceptible fauna species. The main vehicle strike risk area at Jenolan Caves Road comprises a bridge that would allow for safe crossing. As such, it is considered unlikely that any species would be impacted by vehicle strike such that the persistence of the species is impacted at a local or bioregional scale.

The design specifications of the culverts and fauna exclusion fencing would be developed during further design development.

Conclusion on significance of impacts

The proposal is likely to have a significant impact on the critically endangered ecological community White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland, listed as critically endangered under the BC Act, therefore a BDAR has been prepared (Appendix D).

The proposal is not likely to significantly impact threatened species or ecological communities or their habitats, within the meaning of the FM Act.

The proposal is not likely to significantly impact threatened species, ecological communities or migratory species, within the meaning of the EPBC Act.

6.1.4 Safeguards and management measures

Table 6-9 Safeguards and management measures – biodiversity

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
BI01	Biodiversity	<p>A Flora and Fauna Management Plan will be prepared in accordance with Transport’s <i>Biodiversity Guidelines: Protecting and Managing Biodiversity on Projects</i> (RMS, 2011) and implemented as part of the CEMP. It will include, but not be limited to:</p> <ul style="list-style-type: none"> plans showing areas to be cleared and areas to be protected, including exclusion zones, protected habitat features and revegetation areas requirements set out in the <i>Landscape Guideline</i> (RMS, 2008) pre-clearing survey requirements procedures for unexpected threatened species finds and fauna handling procedures addressing relevant matters specified in the <i>Policy and guidelines for fish habitat conservation and management</i> (DPI Fisheries, 2013) Protocols to manage weeds and pathogens. 	Transport/ Contractor	Detailed design Prior to construction	Section 4.8 of QA G36 Environment Protection
BI02	Removal of native	Native vegetation and habitat removal will be	Contractor	Detailed design	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
BI03	vegetation, threatened species habitat, habitat features and threatened plants	minimised through detailed design. Further consideration for the placement of ancillary facilities (including drainage and sediment basins) currently positioned in native vegetation and high value areas will be considered during the detailed design stage.	Transport/ Contractor	Detailed design	Appendix D
BI04		Pre-clearing surveys will be undertaken in accordance with Guide 1: Pre-clearing process of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI05		Vegetation and habitat removal will be undertaken in accordance with Guide 4: Clearing of vegetation and removal of bushrock of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI06		Native vegetation will be re-established in accordance with Guide 3: Re-establishment of native vegetation of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI07		The unexpected species find procedure is to be followed under Biodiversity Guidelines: Protecting and managing	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		biodiversity on RTA projects (RTA, 2011) if threatened ecological communities, not assessed in the biodiversity assessment, are identified in the proposal site.			
BI08		Habitat removal will be minimised through detailed design.	Contractor	Construction	Appendix D
BI09		Fauna will be managed in accordance with Guide 9: Fauna handling of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI10		Habitat will be replaced or re-instated in accordance with Guide 5: Re-use of woody debris and bushrock and Guide 8: Nest boxes of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011). Modified limbs salvaged from removed vegetation in the subject land would be preferenced over nest boxes for artificial hollow construction.	Contractor	Construction	Appendix D
BI11		Vegetation removal will be minimised around mapped Purple Copper Butterfly habitat.	Contractor	Construction	Appendix D
BI12		A Purple Copper Butterfly management plan will be developed within the Flora and Fauna Management Sub-plan which will include measures to minimise	Transport/ Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		impacts to the species including consideration of construction activity timing/scheduling to minimise mortality in areas of mapped habitat and a monitoring strategy to detect efficacy of management measures.			
BI13	Aquatic impacts	Aquatic habitat will be protected in accordance with Guide 10: Aquatic habitats and riparian zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011) and 3.3.2 Standard precautions and mitigation measures of the Policy and guidelines for fish habitat conservation and management Update 2013 (DPI, 2013).	Contractor	Construction	Appendix D
BI14		Creek works and bridges would be designed in accordance with the Policy and Guidelines for Fish Friendly Waterway Crossings (DPI, 2003)	Contractor	Detailed design	Appendix D
BI15		Instream works would be undertaken during periods of low flow where possible. Where not possible, any creek diversions would require a permit from DPI (Fisheries).	Contractor	Construction	Appendix D
BI16		A Construction Soil and Water Management Plan (CSWMP) would be developed as a subplan to the CEMP and will outline measures to	Transport/ Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		manage water quality impacts associated with construction work.			
BI17		A surface water quality monitoring program will be developed in accordance with the <i>Guidelines for Construction Water Quality Monitoring</i> (RTA, 2003) as part of the Soil and Water management Sub-plan of the CEMP. The program will monitor surface water prior to construction, during construction and during operation.	Transport/ Contractor	Construction Operation	Appendix D
BI18	Groundwater dependent ecosystems	Interruptions to water flows associated with groundwater dependent ecosystems will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI19	Changes to hydrology	Changes to existing surface water flows will be minimised through detailed design.	Contractor	Detailed design	Appendix D
BI20	Fragmentation of identified habitat corridors	Connectivity measures will be implemented in accordance with the <i>Wildlife Connectivity Guidelines for Road Projects</i> (RTA, 2011). This will include retrofitting culverts with fauna friendly design features suitable for target species.	Contractor	Construction	Appendix D
BI21		Any connectivity measures implemented will be installed under the supervision of an experienced ecologist	Transport	Operation	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		and maintained during proposal operation.			
BI22		Revegetation of unused pavement beneath the bridge at Jenolan Caves Road would be investigated as a potential option to increase fauna connectivity in this area. This would need to consider risk of road strike and feasibility of fauna fencing at this intersection.	Contractor	Detailed design	Appendix D
BI23		Riparian zone under the twin bridges at River Lett would be revegetated, where feasible, to ensure habitat connectivity is retained.	Contractor	Detailed design	Appendix D
BI24	Indirect impacts on native vegetation and habitat	Exclusion zones will be set up at the limit of clearing in accordance with Guide 2: Exclusion zones of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI25	Invasion and spread of weeds	Weed species will be managed in accordance with Guide 6: Weed management of the Biodiversity Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).	Contractor	Construction	Appendix D
BI26	Invasion and spread of pests	Pest species will be managed within the construction footprint.	Contractor	Construction	Appendix D
BI27	Invasion and spread of	Pathogens will be managed in accordance with Guide 2: Exclusion zones of the Biodiversity	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
	pathogens and disease	Guidelines: Protecting and managing biodiversity on RTA projects (RTA, 2011).			
BI28	Noise, light and vibration	Works in proximity to cuvert 2 and 3 would be undertaken at night to minimise impacts to roosting microbats	Contractor	Construction	Appendix D
BI29		Permanent shading and artificial light impacts will be minimised through detailed design.	Contractor	Detailed design Construction	Appendix D
BI30		<p>Construction lighting impacts would be minimised as follows:</p> <ul style="list-style-type: none"> • Lighting would only be used as necessary to conduct construction activities at night. Lights would be turned off when not needed • Adaptive light controls to manage light timing, intensity and colour would be installed • Only the object or area intended would be lit where feasible • Lights would be kept close to the ground, directed and shielded to avoid light spill • The lowest intensity lighting appropriate for the task would be used • Use non-reflective, dark-coloured surfaces where possible 	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		<ul style="list-style-type: none"> Use lights with reduced or filtered blue, violet and ultra-violet wavelengths where possible. 			
BI31	Impacts to habitat in human made structures	<p>A Microbat Management Plan would be prepared as a part of the Fauna and Flora Management Sub-Plan to manage impacts to microbats.</p> <p>It would include pre-clearance checks of culverts, monitoring of microbats during noisy works and stop works procedures.</p>	Contractor	Construction	Appendix D
BI32		<p>Permanent roost habitat for cave-dwelling microbats should be considered for inclusion in the design of new bridges and culvert structures. This may include pre-casting roosting chambers on the underside of bridges or in the roof of culverts, and/or retrofitting/modifying standard structures to make them more suitable for microbats ie leaving grab holes and section joins unsealed, scabbling of concrete surfaces to make structures more suitable, particularly in recesses and potential roosting sites.</p>	Transport/ Contractor	Detailed design Construction	Appendix D
BI33		<p>Access to Culvert 2 and 3 would be restricted during construction to minimise impacts to roosting microbats. If access to either culvert is required, consultation with an</p>	Contractor	Construction	Appendix D

No	Impact	Environmental safeguards	Responsibility	Timing	Reference
		ecologist would be undertaken and/or an ecologist would supervise activities/access.			
BI34	Vehicle strike	<p>Fauna fencing would be installed at targeted locations along the highway to minimise vehicle strike where reasonable and feasible. Fauna fencing would be designed to minimise impacts to threatened fauna species and species subject to vehicle strike. Locations selected would consider connectivity requirements of fauna and proposed structures.</p> <p>A monitoring strategy would be developed to detect efficacy of fauna fencing and maintenance requirements would be detailed as part of the Flora and Fauna Management Sub-plan of the CEMP.</p>	Transport/ Contractor	Detailed design Construction Operation	Appendix D

6.1.5 Biodiversity offsets

Ecosystem and species credits

Subject to vegetation clearing minimisation efforts, preparation of a biodiversity offset strategy (BOS) would be required in accordance with the *Guideline for Biodiversity Offsets* (Roads and Maritime Services, 2016) for potential impacts to the BC Act and EPBC Act listed TEC and threatened species habitat. Offsets may be delivered through a range of mechanisms, including securing offset properties under an appropriate legal instrument, purchasing and retiring biodiversity credits, paying into the Biodiversity Conservation Fund or progressing stewardship Site Agreements on suitable properties in accordance with the *Guideline for Biodiversity Offsets* (Roads and Maritime, 2016).

To determine the likely biodiversity credit requirements for the impacts of the proposal, the data collected in the proposal construction footprint was entered into the BAM Calculator. The biodiversity credit values of the native vegetation and threatened species habitat within the proposal construction footprint are presented in **Error! Reference source not found.** and **Error! Reference source not found.**

For indirect impacts resulting in new edges, offsets were calculated outside the BAM calculator based on a percentage of the biodiversity credit value of the affected patches, and assuming the vegetation integrity values present in the same zones within the construction footprint. Ecosystem credits for potential indirect impacts of the proposal are presented in **Error! Reference source not found.**

Table 6-10 Ecosystem credit values for impacts in vegetation zones identified within the construction footprint

Plant community type (PCT)	Vegetation zone code	Area to be impacted (hectares)	Ecosystem credits required
Bathurst Subregion / South Eastern Highlands Bioregion			
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85_Moderate	3.95	112
	85_Disturbed	0.35	6
Broad-leaved Peppermint - Ribbon Gum grassy open forest in the north east of the South Eastern Highlands Bioregion (732)	732_Moderate*	6.42	180
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (963)	963_Good*	1.20	37
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103_Disturbed	1.71	0
	1103_Good	10.72	543
	1103_Low-Moderate	4.79	128
	1103_Moderate	6.20	259
Burratorang subregion / Sydney Basin Bioregion			
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731_Good	12.44	516
	731_variant_Good	3.08	129
	731_Moderate	14.61	388
Silvertop Ash - Narrow-leaved Peppermint open forest on ridges of the eastern tableland, South Eastern Highlands Bioregion and South East Corner Bioregion (1155)	1155_Moderate	9.72	230
Total (Bathurst Subregion / South Eastern Highlands Bioregion)		35.34	1,265
Total (Burratorang subregion / Sydney Basin Bioregion)		39.85	1,263
Total (all bioregions)		75.19	2,528

*Although all areas of this PCT in the subject land are within the Sydney Basin Bioregion, the BAM calculator does not allow selection of this PCT within the bioregion; therefore the PCT has been included in the calculator for the South East Highlands bioregion.

Table 6-11 Species credit values for the species identified in the construction footprint

Species	Loss of habitat (ha)		Total loss of habitat (hectares)	Total species credits required
	Bathurst Subregion / South Eastern Highlands Bioregion	Burraborang subregion / Sydney Basin Bioregion		
Chalinolobus dwyeri Large-eared Pied Bat	5.60	18.62	24.22	1,215
Paralucia spinifera Purple Copper Butterfly	3.97	0.33	4.30	137
Petauroides volans Greater Glider	20.81	19.44	40.25	1,484
Petaurus norfolcensis Squirrel Glider	25.16	25.72	50.88	1,787

*Some areas of habitat in the subject land located within the Sydney Basin Bioregion have been included in the BAM calculator for the South Eastern Highlands, due to associated PCTs.

Table 6-12 Ecosystem credits required for indirect impacts of the proposal

Plant community type (PCT)	Vegetation zone code	Area to be impacted (hectares)	Ecosystem credits required
Bathurst Subregion / South Eastern Highlands Bioregion			
River Oak forest and woodland wetland of the NSW South Western Slopes and South Eastern Highlands Bioregion (85)	85 (moderate)	2.67	15
Sydney Peppermint - Silvertop Ash heathy open forest on sandstone ridges of the upper Blue Mountains; Sydney Basin Bioregion (963)	963 (good)*	0.14	1
Ribbon Gum - Yellow Box grassy woodland on undulating terrain of the eastern tablelands; South Eastern Highlands Bioregion (1103)	1103 (disturbed)	0.11	0
	1103 (good)	0.74	8
	1103 (moderate)	1.31	11
Burraborang subregion / Sydney Basin Bioregion			
Broad-leaved Peppermint - Red Stringybark grassy open forest on undulating hills, South Eastern Highlands Bioregion (731)	731 (good)	1.20	10
	731 (variant – good)	1.12	10
	731 (moderate)	1.30	7

Total (Bathurst Subregion / South Eastern Highlands Bioregion)	4.97	35
Total (Burraborang subregion / Sydney Basin Bioregion)	3.62	27
Total (all bioregions)	8.59	62

*Although some or all areas of this PCT in the subject land are within the Sydney Basin Bioregion, the BAM calculator does not allow selection of this PCT within the bioregion; therefore the PCT has been included in the calculator for the South East Highlands bioregion

Aquatic offsets

The offsets for aquatic habitat are limited to the area of Key Fish Habitat impacted and are considered separately from impacts offset under the BAM. Aquatic offsets would be provided for in accordance with Section 3.3.3 Rehabilitation and compensation measures of the *Policy and guidelines for fish habitat conservation and management Update 2013* (DPI (Fisheries NSW) 2013. DPI (2013) calculates habitat compensation on a minimum 2:1 basis for all Key Fish Habitat lost; a greater compensation ratio may be considered if offsets cannot be sourced near the impact, or are not of the same habitat type as that impacted.

The proposal intersects four mapped areas of Key Fish Habitat: Boxes Creek, River Lett and tributaries of Butlers Creek and Whites Creek. About 228,000 square metres of mapped Key Fish Habitat at these creeks falls within the construction footprint. However, this is considerably overestimated due to width of Key Fish Habitat being well beyond the actual instream habitat. The impacts would be accurately calculated during detailed design to reflect instream habitat impacts only. Final offset calculations will be carried out following detailed design and avoidance of Key Fish Habitat impacts would be undertaken.