5 The existing environment

An understanding of the characteristics of the existing natural and social-economic environment is essential to provide base information for assessment of route options and aid selection of a preferred route option. This chapter describes the existing biophysical, social and cultural environment of the study area.

The description of the biophysical environment includes topography, geology and soils, water resources, terrestrial and aquatic ecology, climate and air quality, bushfire, infrastructure and utilities, and the social and cultural environment that includes cultural heritage, demographics and social-economic profiles and visual amenity.

5.1 Assessment Methodology

5.1.1 Initial Desktop Investigations

Initial desktop investigations comprising a review of available information were conducted to provide basic information on the environmental constraints and opportunities associated with the study area, and to assess the relative potential impacts of Options 1-10 in Phase 1 of the route options assessment (see **Section 7.2**). The outcomes of the desktop investigations were also used to develop an initial shortlist of four options for further investigation (see **Sections 8.2 - 8.5**).

5.1.2 Additional Detailed Investigations

Based on the findings of the initial desktop investigations and taking into account the alignment of the four shortlisted options, Cardno developed survey methodologies for more detailed field investigations in consultation with the RMS. Field surveys were conducted to characterise:

- Terrestrial biodiversity
- Aquatic biodiversity
- Aboriginal cultural heritage
- Non-Aboriginal heritage.

These field surveys provided additional information used to compare the shortlisted options, and identify the preferred route option (**Chapter 10**). It is intended that the detailed field investigations may also be used to inform any subsequent environmental impact assessment of the preferred option.

5.2 Biophysical environment

5.2.1 Topography, geology and soils

A desktop study of topography, geology and soils was conducted, comprising a review of:

- Geological maps
- Topographical maps
- Acid sulfate soil maps
- Review of the information compiled in a preliminary geotechnical assessment for the project (RMS, 2012).

Further detailed site investigations of geological or soil characteristics were not conducted at this stage.

5.2.1.1 Topography

The study area consists of two topographically distinct portions – a southern portion and a northern portion (see **Figure 5-1**).

The southern portion comprises two prominent ridgelines with steep side slopes, containing areas of sub-vertical to 60˚ granite outcrops and soil covered slopes of up to about 20˚ to 25˚, containing scattered granite boulders. The ridgelines are located east and west of the current New England Highway alignment.

The ridgeline west of the current highway alignment strikes north-east to south-west and has a maximum elevation within the study area of around RL1040 metres. The ridgeline east of the current highway alignment strikes north-north-east to south-south-west and has a maximum elevation within the study area of around RL1000 metres.

The northern portion of the study area has reasonably flat topography and is grass covered with no rock outcrops (**Figure 5-1**).

5.2.1.2 Geology

Bolivia Hill is located within the New England Fold belt. Bolivia Hill is formed from an early Triassic granitoid, the 'Bolivia Range Leucomonzogranite'. Reference to aerial photographs of the study area shows major structural lineaments running in a north-north-east direction through the range.

Geology maps show granite covering the southern, hilly part of the New England Highway with the Dundee Rhyodacite over the northern end of the study area (1:100000 Geological Sheet 9239) (**Figure 5-2**). Fresh, slightly weathered granite outcrops are observed along ridgelines and in some areas on the sides of hills in the study area. Rail cuttings predominantly expose slightly weathered to fresh granite as the cuttings occur towards the top of the hill. The existing New England Highway cuttings are on the side of the hill and expose both distinctly weathered granite and slightly weathered to fresh granite.

The rock weathering and strength variations within the study area, particularly abrupt changes in weathering, may have implications for any options that involve tunnelling. This is discussed in further detail in **Section 6.4**.

Granite may also weather to form rounded fresh corestones within a more weathered matrix. The corestones can be of a size ranging from about 0.5 metre diameter to many metres in diameter. These conditions can cause difficulty with excavation and final trimming of cut slopes, where high strength corestones project above the final cut profiles. Some corestone development in a weathered matrix can be observed in the railway cuttings, though depth of weathering is minimal (generally around one to three metres only). No corestones have been observed in the existing road cuttings.

5.2.1.3 Acid sulfate soils

Acid sulfate soils (ASS) are soils that contain iron sulfides and when exposed to air after being disturbed produce sulfuric acid caused by oxidation of the sulfides. ASS are typically found in mangroves, saltmarshes, floodplains, swamps, wetlands, estuaries, and brackish or tidal lakes, particularly in low-lying coastal areas.

The Australian Soil Resource Information System website shows the study area to be located within an area defined as C4 Extremely Low Probability/Very Low Confidence of ASS. Less than one kilometre north of Brickyard Creek, the map shows B4 Low Probability/Very Low Confidence of ASS. Based on this information, it is considered that there is a generally low probability of ASS occurrence in the study area.

5.2.1.4 Acid rock drainage

Acid rock drainage requires the presence of sulfide minerals (sulfidic ores) in rock, particularly iron sulfide or pyrite. These can form within veins (eg quartz) within the granite rock. Acid rock drainage is primarily associated with coal mining, however it can be associated with any metaliferous mine.

Although no obvious veining was observed within outcrops in the study area, RMS (2012) indicated past mining activities accessing quartz veins and, therefore, any excavations associated with the proposal may encounter some acid producing rock. Sampling and laboratory testing will be required to determine the acid producing potential of the rock material.

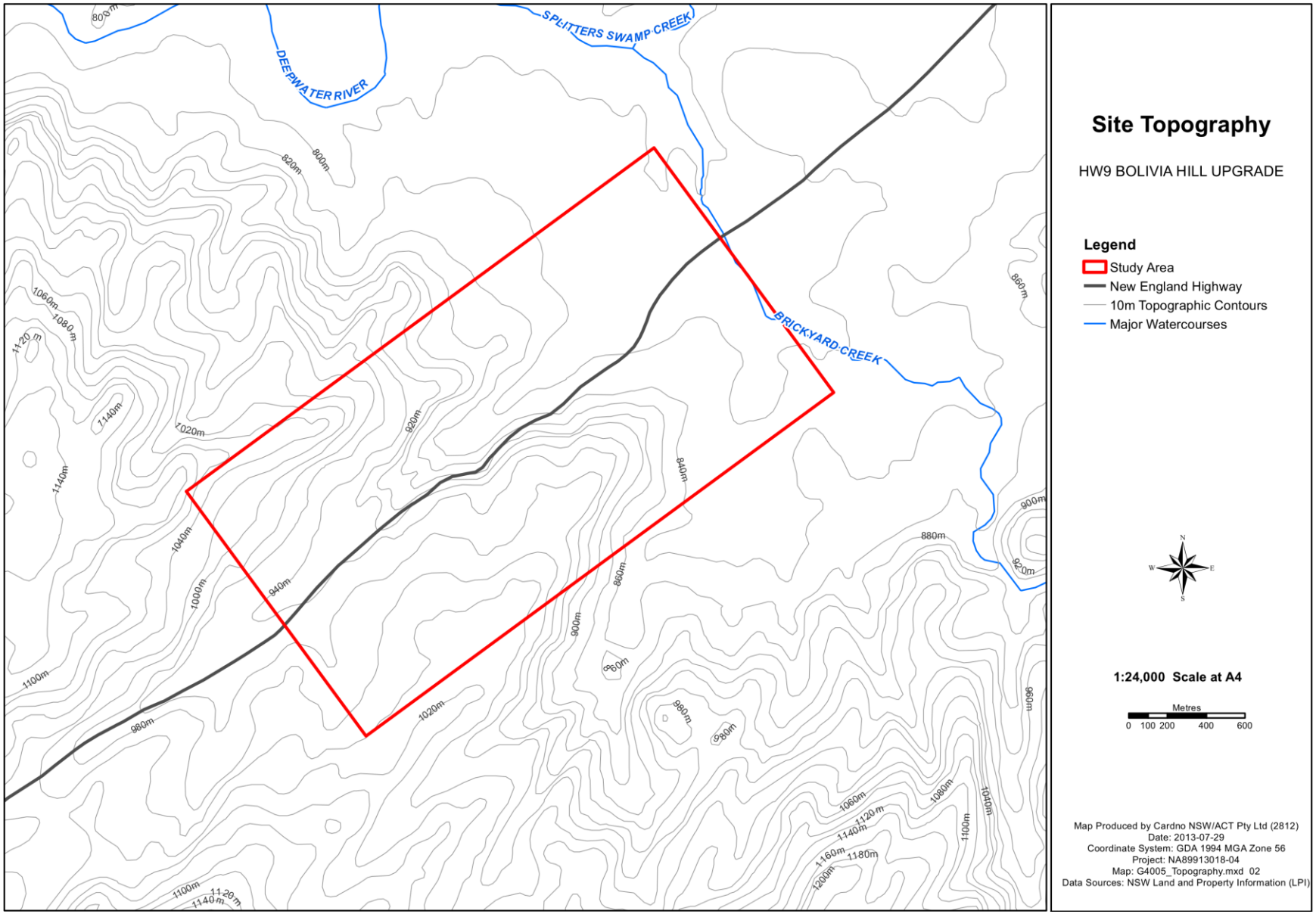


Figure 5-1 **Study area topography**

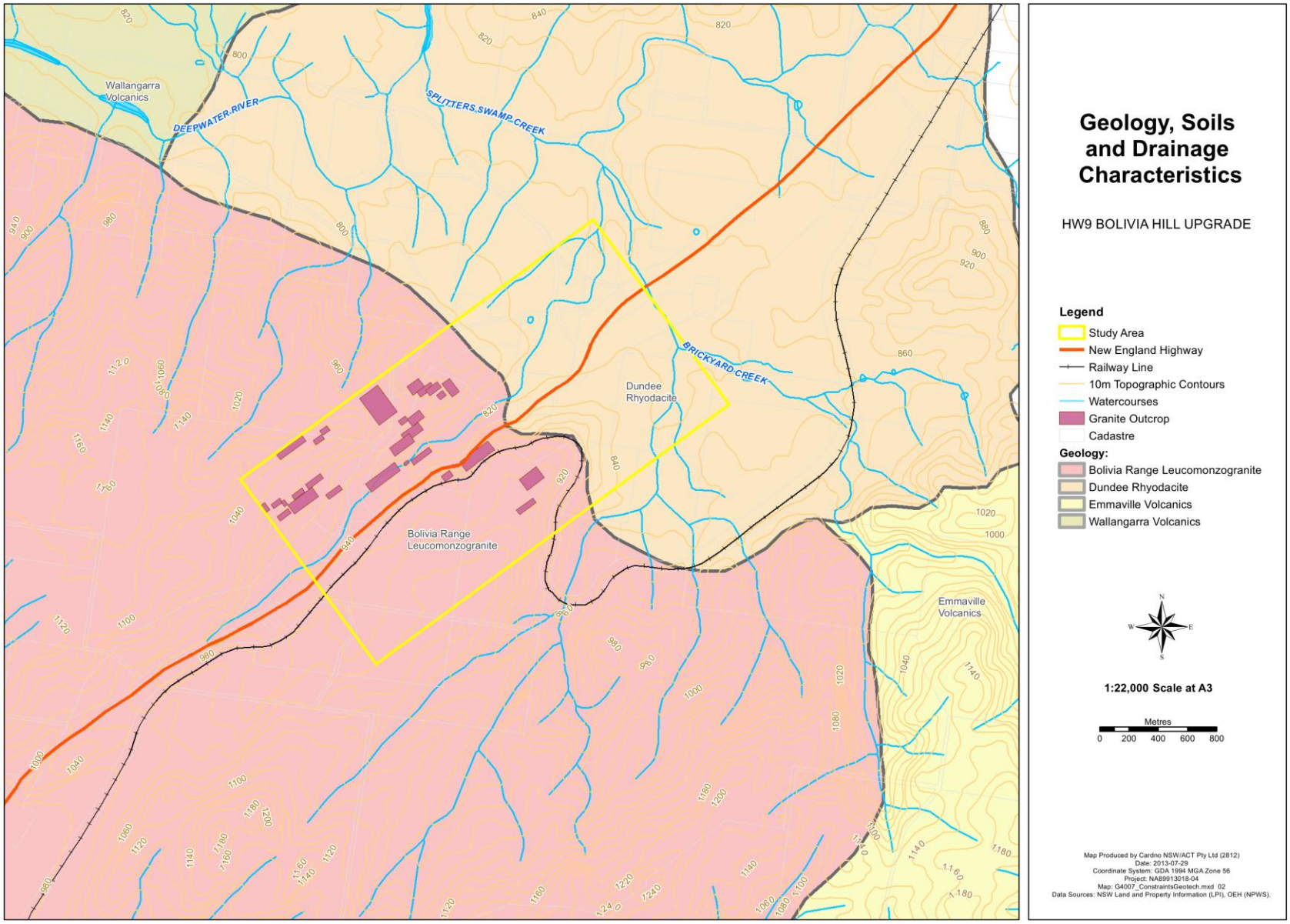


Figure 5-2 **Geology, soils and drainage constraints of the study area**

5.2.2 Water resources

5.2.2.1 Surface water hydrology

Figure 5-1 shows surface drainage lines in the study area. The study area lies at the headwaters of the Deepwater River, a tributary of the MacIntyre River.

The main watercourse in the study area is a first order stream that is unnamed and flows in a north-easterly direction roughly parallel to the New England Highway on the western side. The headwaters of this watercourse lie at an elevation of approximately RL940 metres at the south-eastern end of the study area, and falls to about RL820 metres towards the base of Bolivia Hill (**Figure 5-2**). It then meanders across flat terrain forming a local floodplain and crosses Pyes Creek Road about 400 metres west of the highway. The unnamed watercourse has a catchment area of approximately 530 hectares comprised of forested and rural land. The watercourse has gouged a deep (approximately 20 metres) steep sided gorge exposing fresh granite outcrop, approximately 200 metres west of the current road alignment.

The main unnamed watercourse has a minor tributary in the upper part of its catchment that runs parallel to the main gully and close to the western side of the New England Highway, and is separated from the main gully by a small ridgeline. This tributary joins the main gully about 150 metres west of the highway and is indicated on the hydrology constraints map in **Figure 6-1**.

At the northern end of the study area is Brickyard Creek, which is a fourth order stream that intersects the study area. Brickyard Creek has a catchment area of approximately 1,700 hectares, with the majority of the catchment lying south-east of the New England Highway.

No river flow gauges are located within the main unnamed watercourse or on Brickyard Creek. The nearest river flow gauging station is located on Deepwater River, approximately five kilometres downstream of the study area.

Several minor overland flow paths convey runoff from the two main ridgelines within the study area and thereafter into the main unnamed watercourse. Site inspections in September 2012 indicated that all overland flow paths running off the ridgelines were dry at the time, with only minor ponded water observed in some areas.

Given the distance of the existing road from the main unnamed watercourse and its floodplain, there are no instances of flooding of the existing road that have been identified and no local flooding issues were identified during the consultation period.

Further information is available in **Section 6.3**, which details the outcomes of hydrological and hydraulic modelling of the catchment that has been undertaken.

5.2.2.2 Groundwater hydrology

Groundwater resources are defined and recognised by State and Territory agencies as Groundwater Management Units (GMUs) or Unincorporated Areas.

A GMU is a hydraulically connected groundwater system that is recognised as a major aquifer with high production and high usage. The Australian Natural Resources Data Library states that "*this definition allows for management of the groundwater resource at an appropriate scale at which resources issues and intensity of use can be incorporated into groundwater management practices*". GMUs may be grouped into provinces with respect to state or geological boundaries.

Unincorporated Areas are defined as those areas not included as a GMU.

The study area is located within an Unincorporated Area indicating limited groundwater resources.

The locations of existing groundwater bores are shown in **Figure 5-3**, as sourced from the NSW Groundwater Database.

Figure 5-3 indicates that there are no registered groundwater bores within the study area. A review of three boreholes northeast of the study area indicates only one recording a very low yield of 0.37 L/s. This suggests very limited groundwater resources in the region.

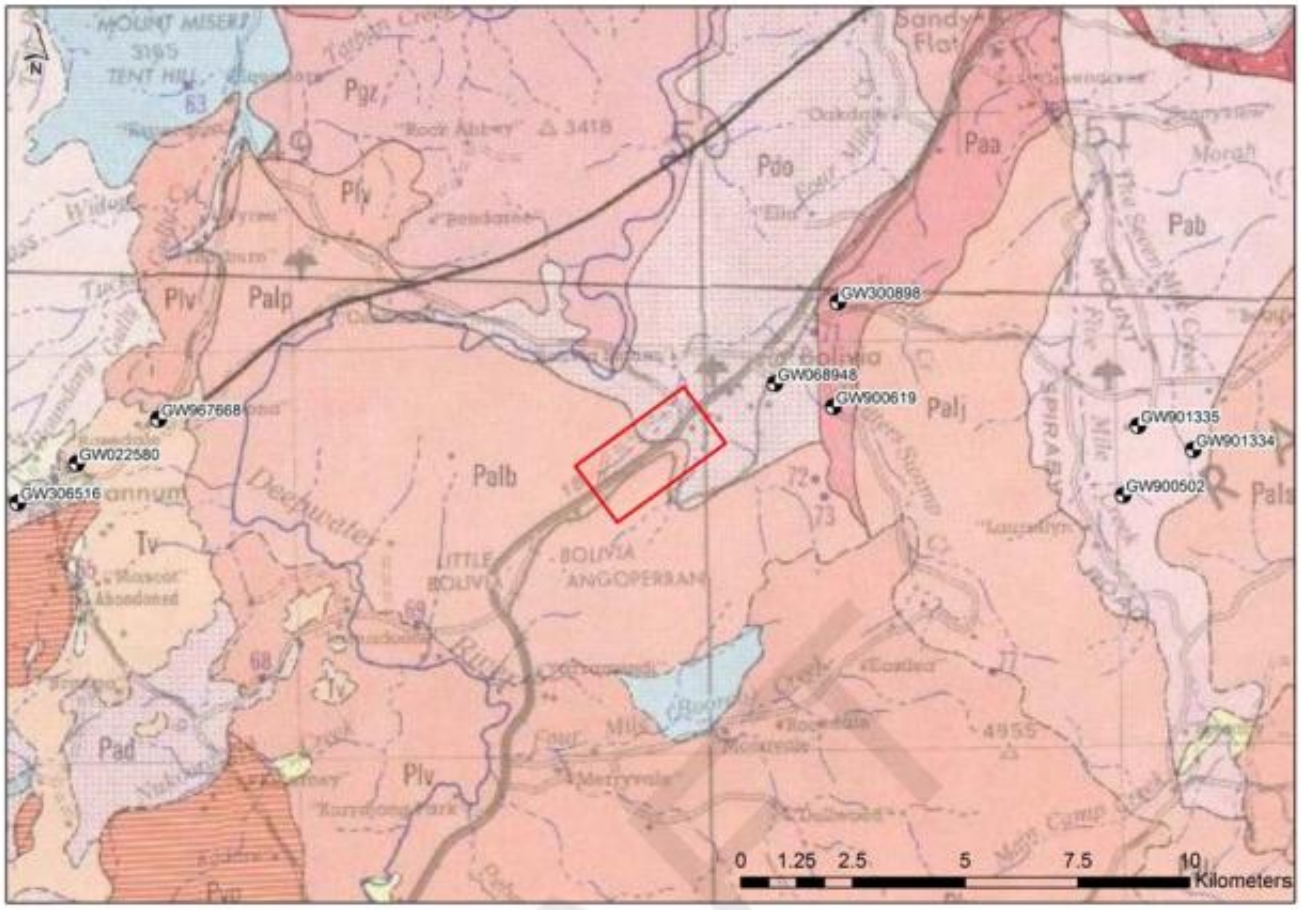


Figure 5-3 Location of registered boreholes

Source: http://waterinfo.nsw.gov.au/gw/

5.2.3 Terrestrial biodiversity

An assessment of potential constraints associated with terrestrial biodiversity on the route selection and design process was conducted based on a combination of desktop and field investigations of the flora, fauna and ecosystems of the study area.

The initial desktop assessment involved a review of the relevant Commonwealth, state and local government databases containing information concerning flora, fauna, vegetation communities and other environmentally relevant features. There are also several scientific reports and management plans of relevance to the study area and the surrounding landscape that were reviewed and considered as part of the assessment.

Specifically, the following resources are relevant to the study area:

- Aerial images of the study area (GoogleEarth)
- NSW Bionet Wildlife Atlas (using a 10x10 kilometre polygon around the study area)
- PlantNET
- EPBC Act Protected Matters Search Tool (using a 10x10 kilometre polygon around the study area)
- *Vegetation and Floristics of the Tenterfield Nature Reserves* (Hunter, 2002)
- *Plan of Management: Bluff River Nature Reserve and Bolivia Hill Nature Reserve* (NPWS, 2011).

Based on the findings of the desktop review a field survey was conducted between October and December 2012 and involved:

- Flora surveys to develop vegetation maps and identify conservation significant vegetation
- Trapping of arboreal and ground-dwelling fauna

- Motion trigger infrared camera traps
- Aural detection, including passive digital audio/ultrasonic recordings
- Diurnal and nocturnal spotlight transect surveys
- Searches for scats, tracks, scratches and other signs
- Habitat assessments.

The detailed methodology for the terrestrial biodiversity impact assessment is provided in Cardno (2013a; **Appendix D**).

5.2.3.1 Bolivia Hill Nature Reserve

The Bolivia Hill Nature Reserve (NR) forms the eastern boundary of the existing alignment of the New England Highway in the study area (**Figure 5-4**). The reserve encompasses an area of 1,782 hectares and is considered to be of high floral diversity, supporting a number of threatened ecological communities and threatened flora and fauna species (NPWS, 2011).

NPWS (2011) identified the following key threatening processes (KTPs) for the Bolivia Hill NR:

- Weeds and pest animals
- Non-prescribed/ uncontrolled fire
- Isolation and fragmentation of vegetation and fauna through clearing and development
- Climate change.

While many of these processes relate to competition for resources and degradation of habitat by feral fauna species, some could be exacerbated by the project including:

- Invasion by exotic grass species
- Fire frequency increases
- Loss of hollow-bearing trees
- Micro habitat (ie rock, fallen timber and trees) removal
- Isolation and fragmentation via vegetation clearing.

Based on the likely requirements of the project, including vegetation clearance for the road corridor and preparation of laydowns and site offices for construction, it is considered that the project is likely to increase the probability of KTPs occurring if mitigation measures are not employed. Due to the high ecological value of the Bolivia Hill NR, any shortlisted route options should avoid this area in so far as is reasonable and feasible.

5.2.3.2 Vegetation communities and flora species

The desktop review of available database resources suggested that there was potential for up to 12 different vegetation communities, and 18 flora species listed as Vulnerable or Endangered under the TSC Act or EPBC Act, within a 10x10 kilometre search area surrounding the study area.

These results were ground-truthed during the flora and vegetation surveys undertaken by Dr John Hunter between October and November 2012. The field surveys recorded a total of 374 vascular plant taxa, from 87 families and 239 genera with the proportion of exotic species being 17 percent (Hunter, 2012).

A total of 10 vegetation communities were recorded by Hunter (2012), as mapped in **Figure 5-4**. Details concerning the name, extent, condition and conservation status of each community are provided in **Table 5-1**, along with some general comments regarding each community. Four of these communities are considered to support the requisite species, and be of a suitable quality and structure, to be classified threatened ecological communities (TECs) under the TSC Act and/or the EPBC Act. These communities are mapped in **Figure 5-5**.

A total of 20 threatened flora species were identified via the desktop review, primarily within the Bolivia Hill NR by Dr Hunter and others. Four species were confirmed from the study area via the field surveys (Hunter, 2012):

- Black Cypress Pine (*Callitris endlicheri*)
- Bolivia Wattle (Acacia pycnostachya)
- Bolivia Hill Pimelea (*Pimelea venosa*)
- Pungent Bottlebrush (*Callistemon pungens*).

The recorded locations of these species are shown in **Figure 5-4**. For all 20 threatened flora species, their critical habitat requirements and likelihood of occurrence ratings for the study area are discussed in **Table 5-2**. The likelihood of occurrence ratings for both flora and fauna are based on the following criteria:

- **Confirmed** – Species recorded during current surveys of the study area
- **Likely** – Study area supports known critical habitat resources for the species and a NSW Atlas record exists for the species within 10 kilometres of the study area
- **Possible** – Study area supports known critical habitat resources for the species, the EPBC Protected Matters Search Tool indicates the species is likely to occur within 10 kilometres of the study area, but there is no NSW Atlas record of the species within 10 kilometres of the study area
- **Unlikely** – Study area contains very limited, degraded or no known habitat for the species.

The field survey results also noted impacts associated with weed abundance were noted as a KTP, with the most prolific weed species being African Lovegrass (*Eragrostis curvula*), Whiskey Grass (*Andropogon virginicus*) and Coolatai Grass (*Hyparrhenia hirta*).

Table 5-1 Vegetation communities within the study area

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C1. Fuzzy Box – Yellow Box – Blakely's Red Gum Grassy Woodland	2.6	0.0 (-)	-	-	Though areas dominated by *Eucalyptus conica* (Fuzzy Box) are not listed as a TEC within the New England Tablelands Bioregion, such areas should be considered at least as near threatened. This is because areas dominated by Yellow Box and Blakely's Red Gum would be considered to be part of the EEC of box gum woodlands, both of which species occur in this community.
C2. Fuzzy Box – Ribbon Gum – Blakely's Red Gum Grassy Woodland	24.6	12.8 (52%) Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	Though the overstorey is intact, most of the understorey in the mapped units is dominated by *Eragrostis curvula* (African Lovegrass) which is listed as a KTP (Invasion by Perennial Exotic Grasses) on the TSC Act. This is an unusual and undescribed assemblage type that is probably unique to the region between Deepwater and Tenterfield.
C3. New England Tea-tree – Pungent Bottlebrush – Swamp Tea-tree Wet Heath	1.5	1.5 (100%) Montane Peatlands & Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands & Australian Alps Bioregions	EEC	-	This community has been affected by past grazing and clearing activities and regular fire. These disturbance activities are known to negatively affect the formation of peat. Some erosion has occurred though the centre of these wet heaths within the Nature Reserve.
C4. Derived Grassland (Red Grass – Wiregrass)	127.5	32.6 (28.5%) Aspects of this community resemble two TECs: 1. Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion 2. White Box Yellow Box Blakely's Red Gum grassy woodlands*	EEC EEC	- CE	Much of this assemblage is dominated by species listed as a KTP (Invasion of Exotic Perennial Grasses) on the TSC Act and includes dense swards of *Eragrostis curvula* (African Lovegrass), *Andropogon virginicus* (Whiskey Grass) and *Hyparrhenia hirta* (Coolatai Grass). It is highly important that the spread of these introduced grasses is not exacerbated.

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C5. Derived Grassland (Wire Grass – Bamboo Grass)	1.6	0 (-)	-	-	Highly disturbed areas commonly dominated by the introduced *Hyparrhenia hirta* (Coolatai Grass) which is listed as a KTP (Invasion of Exotic Perennial Grasses) on the TSC Act. Found on highly disturbed and exposed areas associated with the railway cutting.
C6. Carex Fen	6.9	6.9 (100%) Aspects of this community resemble two TECs: 1. Carex Sedgelands of the New England Tableland, Nandewar, Brigalow Belt South & NSW North Coast Bioregions*	EEC	-	There may be difficulty in determining which TEC this assemblage falls within without on-ground work. Fens are sensitive to small changes in groundwater flow.
		2. Montane peatlands & swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands & Australian Alps Bioregions	EEC	-	
C7. Broad-leaved Stringybark – Rough-barked Apple – Blakely's Red Gum Woodland	200.1	11.9 (5.9%) Aspects of this community resemble White Box Yellow Box Blakely's Red Gum grassy woodlands*	EEC	CE	
C8. Blakely's Red Gum – Rough - barked Apple – Fuzzy Box Grassy Woodland*	42.2	39.3 (93.1%) Aspects of this community resemble two TECs: 1. White Box Yellow Box Blakely's Red Gum grassy woodlands*	EEC	CE	Small open patches within the intact mosaic are dominated by *Eragrostis curvula* (African Lovegrass). Care should be taken not to spread this invasive species that is listed as a KTP (Invasion by Perennial Exotic Grasses). Most of this community would be included within the Box – Gum Grassy Woodlands TECs. Furthermore, most of the area mapped as this entity is of very high quality.
		2. Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	

Community	Total Mapped Extent (ha)	TEC Extent (ha) (% of total mapped extent)	Conservation Status		Comments
			TSC Act*	EPBC Act*	
C9. Broad-leaved Stringybark – Mountain Banksia – Apple Box Shrubby Woodland and Forest	48.6	4.2 (8.5%) Aspects of this community resemble: Ribbon Gum - Mountain Gum - Snow Gum grassy open forest/woodland of the New England Tableland Bioregion	EEC	-	Much of this assemblage has been cleared within the study area though a reasonable area remains in very good condition. It is within this community that the extant population of the Endangered *Pimelea venosa* is found.
C10. Black Pine – Caley's Ironbark – Kurrajong Shrubland, Shrubby Woodland & Dry Rainforest	18.9	0 (-)	-	-	The threatened *Acacia pycnostachya* (Bolivia Hill Wattle) is more commonly found in this community than any other and at times forms a dominant overstorey on some rocky slopes.

*** EEC = Endangered Ecological Community under the TSC Act; CE = Critically Endangered Community under the EPBC Act.**

Table 5-2 Threatened plant species recorded in the study area

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Callitris endlicheri	Black Cyprus Pine	-	3	Usually found on stony hills or ridges.	**Confirmed** This species was commonly recorded within the New England Tea-tree – Pungent Bottlebrush – Swamp Tea-tree Wet Heath community, as well as the Black Pine – Caley's Ironbark – Kurrajong Shrubland, Shrubby Woodland and Dry Rainforest community, and was also recorded within the Broad-leaved Stringybark – Rough-barked Apple – Blakely's Red Gum Woodland community.
Almaleea cambagei	Torrington Pea	V	E1	Wet heath and acid swamp, and along watercourses on granite, above 900 m altitude.	**Possible** Watercourses within the study area provide potentially suitable habitat for this species. The broad distribution of this species is known to include the vicinity of the study area.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Acacia pycnostachya	Bolivia Wattle	V	V	Dry sclerophyll forest, open woodland and dry heath. Occurs amongst granite outcrops, on hillsides at altitudes of 700 to 900 m. Soil types range from sandy and skeletal on exposed outcrops, to shallow sandy loams in less exposed sites.	**Confirmed** A large population of this species was recorded within an area of Rock Outcrop Shrubland. Occasional individuals of this species were also found scattered through the Blakely's Red Gum – Rough-barked Apple – Fuzzy Box Grassy Woodland community. Potential habitat within the site occurs elsewhere within dry sclerophyll communities with granite outcrops.
Eucalyptus boliviana	Bolivia Stringybark	-	V	Low dry sclerophyll woodland on gritty sandy soils over granite and among outcropping boulders.	**Possible** The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops. This species is known only from the Bolivia Hill Nature Reserve and nearby locations.
Homoranthus croftianus	Bolivia Homoranthus	-	E1	Open exposed situations in shrubland and low woodland on granitic outcrops.	**Possible** The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll woodland on granite outcrops. This species is known only from the Bolivia Hill region.
Arthraxon hispidus	Hairy Jointgrass	V	V	Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.	**Possible** The study area provides potentially suitable habitat for this species, particularly along waterways in sclerophyll communities. The broad distribution of this species is known to include the study area.
Boronia boliviensis	Bolivia Hill Boronia	-	E1, 3	Dry sclerophyll forest and low shrublands amongst granite boulders, and heaths on granite outcrops.	**Possible** The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops and rock outcrop shrubland. This species is known only from the Bolivia Range.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Pimelea venosa	Bolivia Hill Pimelea / Bolivia Riceflower	E	E1, 3	Granite outcrops among granite boulders in skeletal or black sandy soil. Vegetation ranges from relatively more open woodland to shrubland to open grassland, on the western side of Bolivia Hill.	**Confirmed** One population of this species was found within the Broad-leaved Stringybark – Mountain Banksia – Apple Box Shrubby Woodland and Forest community. This is the only known extant population of this species. Potential habitat within the site occurs elsewhere within the woodland communities featuring granite outcrops.
Acacia pubifolia	Velvet Wattle	V	E1	Rocky granite hillsides, in sandy, stony or loamy soil in eucalypt-scrub woodland or forest.	**Unlikely** Although potentially suitable woodland habitat for this species is present within the site, this species is not known to occur in the vicinity of the study area.
Boronia granitica	Granite Boronia	E	V	Grows on granitic soils or screes amongst rock outcrops, often in rock crevices. It has been found in dry sclerophyll forests, woodlands and heathlands on mostly shallow soils.	**Possible** The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest with granite outcrops. The broad distribution of this species is known to include the study area.
Callistemon pungens	Pungent Bottlebrush	V	-	Grows in or near rocky watercourses, usually in sandy creek beds on granite or sometimes on basalt.	**Confirmed** Found as a shrub within community C3. Habitat restricted to heath swamp and wetlands
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	Known from a range of habitats, including swamp-heath and woodland.	**Unlikely** Although potentially suitable woodland habitats are present within the study area, the distribution of this species is not known to encompass the study area.
Diuris pedunculata	Small Snake Orchid	E	E1	Grows on grassy slopes or flats. Often on peaty soils in moist areas. Also on shale and trap soils, on fine granite, and among boulders.	**Possible** The study area provides potentially suitable habitat for this species, specifically, peat soils supporting wet heath. The predicted distribution of this species encompasses the study area.
Eucalyptus nicholii	Narrow-leaved Black Paperbark	V	V	Dry grassy woodland, on shallow soils of slopes and ridges.	**Possible** The study area provides potentially suitable habitat for this species, specifically, dry sclerophyll forest. The predicted distribution of this species encompasses the study area.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Haloragis exalata subsp. velutina	Tall Velvet Sea-berry	V	V	Damp places near watercourses, and in steep rocky slopes of gorges.	**Unlikely** Although watercourses within the study area may provide potentially suitable habitat for this species, the broad distribution of this species is not known to include the study area.
Lepidium peregrinum	Wandering Pepper-cress	E	E1	Open riparian forest.	**Unlikely** Although watercourses within the study area may provide potentially suitable habitat for this species, the broad distribution of this species is not known to include the study area.
Streblus pendulinus	Siah's Backbone	E	-	Warmer well-developed rainforests, gallery forest and seasonal rainforest, chiefly along watercourses.	**Unlikely** The study area does not provide suitable rainforest habitat.
Thesium australe	Austral Toadflax	V	V	Grassland or woodland, often in damp sites.	**Possible** The study area provides potentially suitable habitat for this species, specifically, grasslands and woodlands. This species has previously been recorded from the Bolivia Hill region.
Tylophora linearis	-	E	V	Dry scrub and open forest.	**Unlikely** Although the study area provides potentially suitable dry sclerophyll habitat, the known distribution of this species does not encompass the study area.
Tylophora woollsii	Cryptic Forest Twiner	E	E1	Moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins.	**Unlikely** Although the study area provides potentially suitable moist habitat, the known distribution of this species does not encompass the Study Area.

***Note: EPBC Act Status: E=Endangered; V=Vulnerable; M=Migratory. TSC Act Status: E4A=Critically Endangered Species; E1=Endangered Species; V = Vulnerable Species; 3 = Category 3 Sensitive Species**

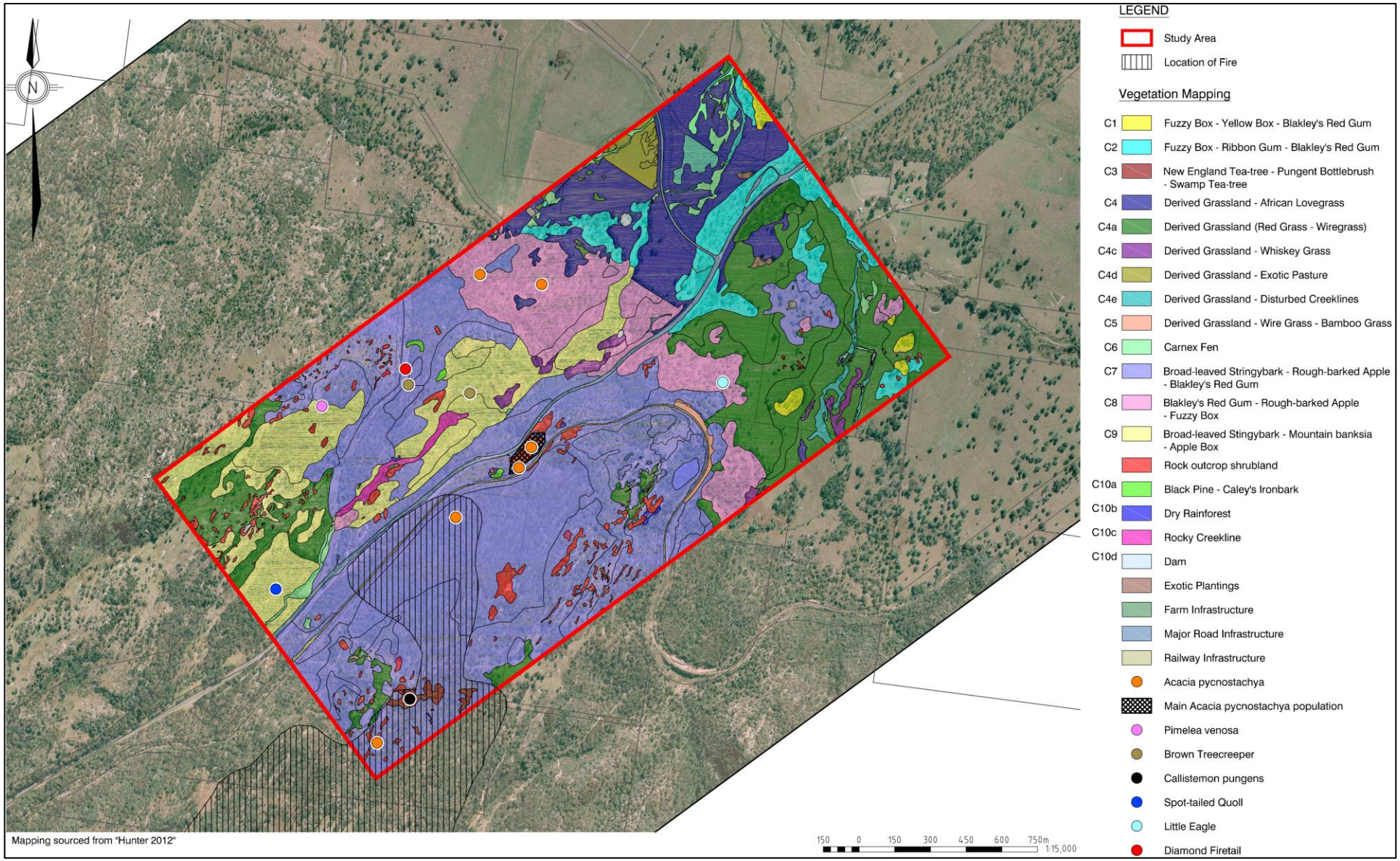


Figure 5-4 Vegetation biodiversity constraints of the study area

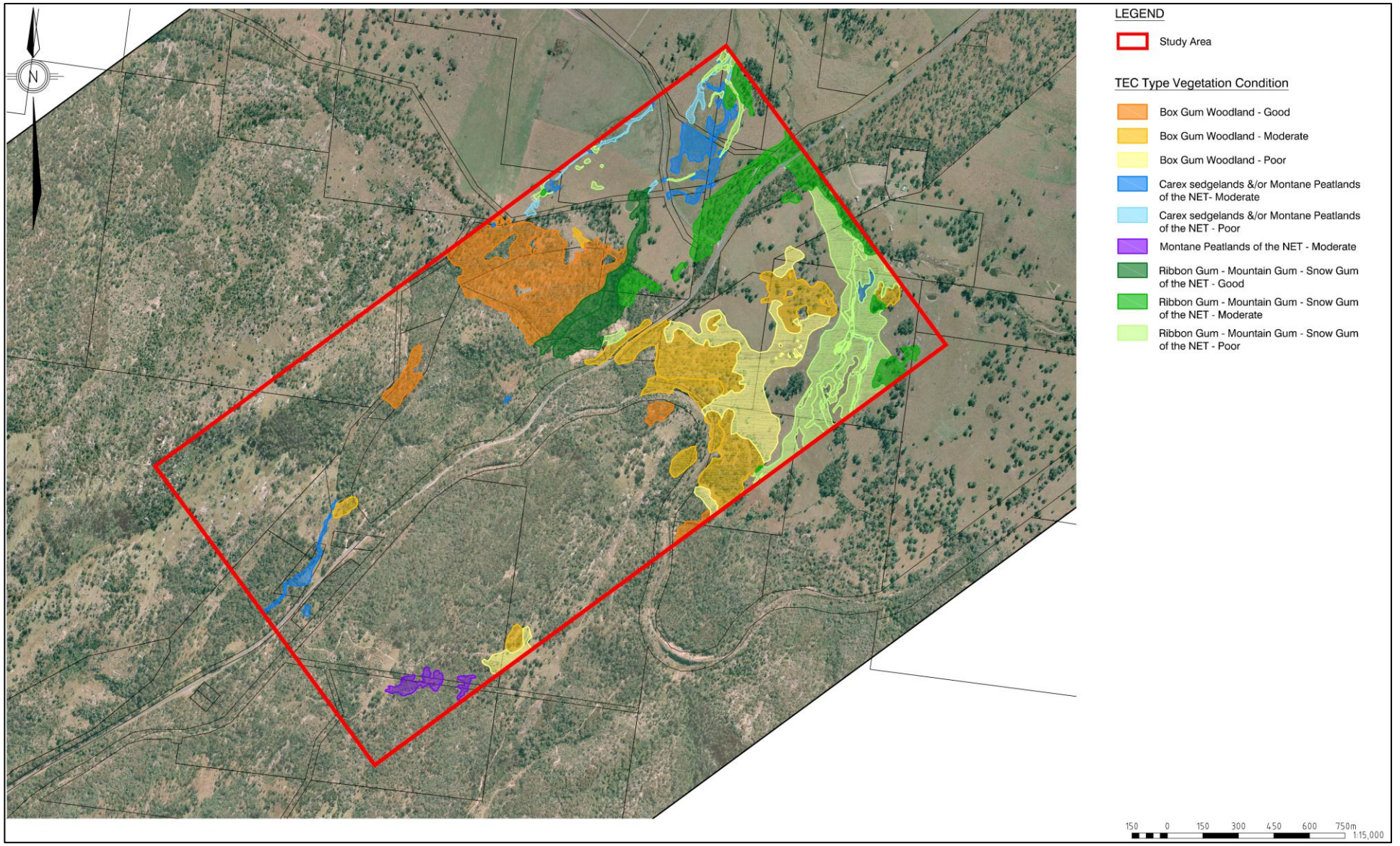


Figure 5-5 Map of threatened ecological communities in the study area and their condition

5.2.3.3 Fauna species

A review of available data collated for the desktop assessment indicated that there are a number of threatened fauna species previously recorded from within the study area or that are likely to occur based on the presence of potentially suitable habitat (**Table 5-3**).

A total of 115 fauna species were recorded during the field surveys a complete list of which has been provided in Cardno (2013a; **Appendix D**). This comprised 105 native species and 10 introduced species. Diversity was greatest within the bird group with a total of 58 native and one introduced species. A total of nine native species of reptile and nine amphibian species (including one introduced species) were also recorded from the study area. A single native species of crustacean was also recorded during the field surveys. A number of mammals were recorded, a relatively large proportion of which were exotic species.

An assessment of the likelihood of occurrence within the study area of threatened fauna species that have been reported as occurring, or potentially occurring, within 10 kilometres of the study area is provided in **Table 5-3. Table 5-3** presents the findings of the assessment along with specific comments where appropriate regarding habitat requirements for specific species.

Considering the survey records by vegetation community type, community C9 (see **Figure 5-4**) showed the greatest diversity of those communities surveyed. C3 had the lowest faunal diversity, however this is due to the community only being surveyed for native frog species.

It is also noted that the Endangered Tusked Frog population of the Nandewar and New England Tableland Bioregions is known to occur (or have occurred) in that part of the Border Rivers-Gwydir Catchment Management Region, which encompasses the study area. However, there are no records of the Tusked Frog (*Adelotus brevis*) within Atlas of NSW Wildlife search results for the study area, and no Tusked Frogs were recorded during field surveys. In this respect the formal NSW Scientific Committee listing of this population notes that "*The New England Tablelands and Nandewar population of Tusked Frog represents a distinct and disjunct high-elevation population that is at the western limit of the species' range in NSW. Given the apparent lack of records from this population in the last 25 years, its numbers are likely to be reduced to a critical level, if it is not already extinct.*" Given the above facts and circumstances, the Tusked Frog is considered to be unlikely to occur within the study area.

5.2.3.4 Fauna habitat

Assessments of fauna habitat were also undertaken to assist the assessment of potential impacts, recording features such as hollow trees, fallen logs, boulders, caves and grasses. A comprehensive overview of the survey findings are provided in **Appendix D**. The habitat assessments indicate that the quality and condition of fauna habitats is variable across the study area. The majority of the survey sites were found to have a well-developed vegetation community that was in most instances well connected to the surrounding landscape. While there was evidence of weed invasion within the sites, levels of infestation were generally low and did not detract from the overall value of the area as habitat for native fauna. Possibly due to the rocky, shallow soils of the study area none of the sites were considered to have a well-developed or dense shrub or groundlayer; however an abundance of rocks, fallen logs and leaf litter would compensate somewhat for the protection and cover usually afforded by vegetation.

A general decline in habitat quality was recorded below Bolivia Hill, towards the north-eastern section of the study area. This was found to be associated with lower elevations and a more 'plain-like' position within the landscape. The relatively poor habitat condition recorded for the survey sites in this part of the study area is primarily driven by the isolation and fragmentation effects of the existing highway and the surrounding agricultural pastures, that have been substantially cleared. However, weed infestation and clearing have also contributed to a reduced overall condition. One of the sites recorded as being of low quality at the time of the survey was located within a portion of the Bolivia Hill NR that had been recently subjected to an uncontrolled fire, although that microhabitat features such as boulders and rock crevices remained as did many of the hollows in unburnt canopy trees. Consequently, once there is vegetation regrowth the habitat quality of the burnt area is expected to increase.

The nature and availability of micro-habitat features was found to be reasonably consistent across the study area. The dominant fauna habitat features are driven by the underlying geology with an abundance of boulders, rocks, crevices, outcrops and similar geological formations that provide fauna refugia.

Interspersing these ‘rock-based’ habitat features are well-developed and structured vegetation communities, which provide numerous hollows, fallen logs and substantial leaf-litter abundance all of which are important micro-habitat features for native fauna. Again, it is recognised that there was a decline in the abundance of boulders and rock crevices towards the lower elevation plains to the north and east of the study area. However, this part of the study area was found to support a number of important micro-habitat features, the most prevalent of these being a well-developed ground layer vegetation and hollow bearing trees, which would be expected to (in part) compensate for the absence of rocks and boulders, supporting small terrestrial mammals despite the prevalence of invasive flora species in parts. The hollow bearing trees would serve as suitable nesting and roosting sites for hollow dependant fauna, though the relatively isolated and fragmented nature of these patches means that they are more likely to support the more gregarious and disturbance tolerant bird groups (ie parrots) and common arboreal mammals (ie Common Brush-tailed possum).

Table 5-3 Threatened terrestrial fauna species recorded in the study area

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Frogs					
Philoria sphagnicolus	Sphagnum Frog	-	V	High moisture levels. Found in Sphagnum Moss beds or seepages on steep slopes. Habitat occurs in rainforest and wet sclerophyll forest. Burrow in loose, moist soil or moss, under leaf litter in soaks/seepages, or may use cracks/cavities next to small waterfalls.	**Likely** There are a number of rocky well vegetated watercourses within the Study Area most notably south east of Sites A1, B2 and A3 and associated with communities C7 and C9.
Mixophyes balbus	Stuttering Frog	V	E1	Typically found in association with permanent streams through temperate and sub-tropical rainforest and wet sclerophyll forest. Outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor.	**Possible** Permanent sections of the watercourses below sites A1, B2 and A3 support appropriate habitat again these areas are associated with communities C7 and C9.
Reptiles					
Underwoodisaurus sphyrurus	Border Thick-tailed Gecko	V	V	Dry sclerophyll open forest and woodland. Preference for canopy cover between 45-60%, medium rock cover and high litter cover. Shelter sites include rocks, decaying logs, bark, and litter in rocky rubble. Usually shelters on litter substrate, shaded by nearby vegetation.	**Likely** All sites surveyed, with the exception of B3 and A4 support appropriate habitat. However, within the suitable sites there may only be small pockets that could be considered most suitable. The eastern facing bases of rock mounds, cliffs or crevices at sites A2 and B2 (Communities C7 and C9) would be considered most suitable. A single record from previous surveys has been made at the southern extent of the study area.
Delma torquata	Collared Delma	V	-	Normally inhabits eucalypt-dominated woodlands and open-forests. Suitable habitats are commonly associated with exposed rocky outcrops on ridges or slopes in vegetation communities dominated by Narrow-leafed Ironbark.	**Possible** Study area supports appropriate habitat features notably Site A1, A2 and B2 but the range of this species does not extend this far south and no vegetation communities supported Narrow-leafed Ironbark. Most closely aligned communities include C7 and C9.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Elseya belli	Bell's Turtle	V	V	Shallow to deep pools in upper reaches or small tributaries of major rivers in granite country. Occupied pools are most commonly less than 3m deep with rocky or sandy bottoms and patches of vegetation. Most typically uses narrow stretches of rivers or streams 30 - 40m wide. Nests are dug out in riverbanks of sand or loam.	**Unlikely** Very limited areas of possibly suitable habitat and this species has not been found in this area previously. Generally restricted to the headwaters of river systems to the north and south of the study area.
Birds					
Hieraaetus morphnoides	Little Eagle	-	V	Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used. Nests in tall living trees within a remnant patch.	**Confirmed** A single individual was recorded overflying site B4. The entire study area would be considered suitable habitat for various life stages of this species.
Glossopsitta pusilla	Little Lorikeet	-	V	Forages primarily in the canopy of open Eucalyptus forest and woodland, yet also finds food in Angophora, Melaleuca and other species. Riparian habitats are used. Isolated flowering trees in open country are used eg paddocks, roadside remnants and urban trees. Nests in hollows in the limb or trunk of smooth-barked Eucalypts.	**Likely** Much of the study area supports the required habitat for this species particularly those areas with a higher abundance of hollow bearing trees, (ie A1, A2, B2, B4 and A3) which fall within Communities C7, C8 and C9.
Tyto novaehollandiae	Masked Owl	-	V, 3	Lives in dry eucalypt forests and woodlands. Often hunts along the edges of forests, including roadsides. Roosts and breeds in moist eucalypt forested gullies, using large tree hollows or sometimes caves for nesting.	**Likely** The study area supports the range of habitat resources required to support this species. Those communities within the study area that contain suitable hollows are expected to be, primarily communities C7, C8 and C9.
Stagonopleura guttata	Diamond Firetail	-	V	Open grassy woodland, heath and farmland or grassland with scattered trees.	**Confirmed** A single individual was recorded from within the study area within Site A2, which is within Community C7.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	-	V	Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest. Mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey. Fallen timber is an important habitat component for foraging. Hollows in standing dead or live trees and tree stumps are essential for nesting.	**Confirmed** A number of individuals were recorded from sites A1, A2 and B2 which are within Communities C7 and C9. However, all communities within the study area are likely to provide habitat resources for this species from time to time.
Anthochaera phrygia	Regent Honeyeater	E, M	E4A	Dry open forest and woodland, particularly Box-Ironbark woodland and riparian forests of river Sheoak and Mistletoe. Regularly occur in remnant trees or patches of woodland in farmland, partly cleared agricultural land and riverine forest. Usually nest in the canopy of forests or woodlands, and in the crowns of tall trees, mostly eucalypts.	**Likely** The study area supports the range of habitat resources required to support this species. Most particularly the well-developed canopies within communities C7, C8 and C9.
Dasyornis brachypterus	Eastern Bristlebird	E	E1	Tall, dense, grassy ground-cover in open Eucalyptus forests or woodlands. The ground-layer vegetation is usually about 1.0–1.5m tall and fairly dense, providing about 65–90 coverage.	**Unlikely** Only site B3 and A4 support the required dense ground layer and these are otherwise likely to be too disturbed and small in area to support this species on a regular basis.
Erythrotriorchis radiates	Red Goshawk	V	E4A	Inhabit open woodland and forest, preferring a mosaic of vegetation types and are often found in riparian habitats along or near watercourses or wetlands. Preferred habitats include mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers.	**Unlikely** The study area supports some of the habitat features required but lacks a well-developed broad scale mosaic of habitats (ie clearly defined riparian habitat amongst Eucalypt woodland).

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Geophaps scripta scripta	Squatter Pigeon	V	E1	Occurs mainly in grassy woodlands and open forests and plains that are dominated by eucalypts. Has also been recorded in sown grasslands with scattered remnant trees, disturbed habitats (ie around stockyards, along roads and railways, and around settlements), in scrub and in acacia growth.	**Possible** This species has been recorded from within 40km of the study area. Site A2 (community C7) is located within a vegetation community listed as known habitat. A possible but unconfirmed sighting was made during the surveys.
Lathamus discolour	Swift Parrot	E	E1	Inhabits dry sclerophyll eucalypt forests and woodlands. Occasionally occurs in wet sclerophyll forests. In northern New South Wales, Narrow-leaved Red Ironbark, Forest Red Gum forests and Yellow Box forest are commonly utilised. Occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations.	**Possible** The entire study area supports the requisite habitat however surveys during profuse flowering would be required to increase detectability.
Leipoa ocellata	Malleefowl	V, M	E1	Predominantly inhabit mallee communities, preferring the tall, dense and floristically-rich mallee found in higher rainfall areas. Prefers habitats with a dense but discontinuous canopy and dense and diverse shrub and herb layers. Breeding habitat characterised by light soil and an abundant leaf litter.	**Unlikely** The study area does not support areas of floristically rich mallee.
Rostratula australis	Australian Painted Snipe	V	E1	Generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans. Typical sites include those with rank emergent tussocks of grass, sedges, rushes or reeds, or samphire. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	**Unlikely** While there are areas of open water within the study area they generally lack the intact and dense fringing vegetation expected for this species.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Mammals					
Dasyurus maculatus	Spotted-tailed Quoll	E	V	Prefers mature wet forest habitat. Suitable den sites include hollow logs, tree hollows, rock outcrops and caves. Require large areas of relatively intact vegetation to forage.	**Confirmed** This species was only recorded from within site A1 on two separate occasions. However the critical habitat resources (rock crevices, ground hollows for denning and available prey species) present within A1 (community C9) are comparable to that which occurs through the entire study area excluding the lower plain slopes. Past observations of this species along with the findings of this assessment are considered to indicate that the study area and the immediately surrounding landscape supports a functional, possibly important, population of this species.
Falsistrellus tasmaniensis	Eastern False Pipistrelle	-	V	Prefers moist habitats, with trees taller than 20m. Generally roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings.	**Likely** The mountainous regions with steep cliff faces (ie below site A2 in community C7) and those areas associated with Bolivia Hill (ie B1 also in C7) within the Study Area support the required habitat for this species. Further, echolocation calls which may be attributed, but not definitively, to this species were recorded from detectors located within all of the communities within the study area.
Miniopterus schreibersii oceanensis	Eastern Bentwing Bat	-	V	Caves are the primary roosting habitat, but also use derelict mines, storm-water tunnels, buildings and other man-made structures.	**Confirmed** Definitive echolocation calls were recorded at detectors located within all of the major vegetation communities surveyed.
Vespadelus troughtoni	Eastern Cave Bat	-	V	A cave-roosting species that is usually found in dry open forest and woodland, near cliffs or rocky overhangs; has been recorded roosting in disused mine workings. Occasionally found along cliff-lines in wet eucalypt forest and rainforest.	**Possible** While no significant cave sites were recorded from this survey it is likely that they occur, particularly within the vertical outcrop below site A2 (community C7 and C9) with both of these communities supporting the requisite vegetation for foraging.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Chalinolobus dwyeri	Large-eared Bat	V	V	Roosts in cave entrances, cliff crevices, old mine workings and in the disused, bottle-shaped mud nests of the Fairy Martin (*Petrochelidon ariel*), frequenting low to mid-elevation dry open forest and woodland close to these features. Requires a combination of sandstone cliff/escarpment to provide roosting habitat that is adjacent to higher fertility sites, particularly box gum woodlands or river/rainforest corridors.	**Unlikely** Elevation of the study area and the surrounding landscape likely precludes the presence of this species.
Nyctophilus corbeni	South-eastern Long-eared Bat	V	V	Occurs in a range of inland woodland vegetation types, including box, ironbark and cypress pine woodlands. Moister woodland of various eucalypt species with a distinct shrub layer frequently adjacent to watercourses. Roosts in tree hollows, crevices, and under loose bark.	**Unlikely** Study area supports the habitat features required to support this species. However current known and predicted range ceases approximately 50km west of the study area.
Petrogale penicillata	Brush-tailed Rock Wallaby	V	E1	Occupy rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges. A range of vegetation types are associated with habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest.	**Possible** The study area, particularly within Bolivia Hill NR and the higher slopes of sites B2 and B4 (communities C8 and C9) supports the specific habitat requirements for this species.
Phascolarctos cinereus	Koala	V	V	Inhabit a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by species from the genus Eucalyptus. Spend most of their time in trees, but will descend and traverse open ground to move between trees.	**Possible** Despite an abundance of Eucalypt species the only recognised 'food' tree recorded within the study area was *Eucalyptus viminalis* (Manna Gum) which was recorded from within community C2. However the trees within the study area could be considered a potentially suitable for both foraging and resting. In addition to this there has been a past recorded sighting of this species within 10km of the study area.

Scientific Name	Common Name	Conservation Status*		Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act		
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Can be found in dry and wet sclerophyll forests to coastal heaths and scrubs. Dense understorey with occasional open areas is essential, and may consist of grass-trees, sedges, ferns or heath, or of low shrubs of tea-trees or melaleucas. A sandy loam soil is also a common feature. Dig small holes in the ground.	**Unlikely** Generally recorded from more coastal environments east of the Great Dividing Range.
Pseudomys novaehollandiae	New Holland Mouse	V	-	Found from coastal areas and up to 100km inland on sandstone country. Deeper top soils and softer substrates are preferred for digging burrows. Inhabits open heathland, open woodlands with heathland understoreys and vegetated sand dunes.	**Unlikely** May be within or very edge of range for this species however key habitat requirement of deep topsoil is absent from the majority of the study area.
Pseudomys oralis	Hastings River Mouse	E	E1	Variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops. Nests may be in either gully areas or ridges and slopes.	**Possible** The study area supports the required habitat resources for this species including specific micro-habitat characteristics such as fallen timber and rock crevices (notably C7, C8 and C9). Individuals have been recorded from within protected reserves 20km from the study area.
Pteropus poliocephalus	Grey-headed Flying Fox	V	V	Occur in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	**Likely** Though not recorded from these surveys the study area supports the required habitat resources particularly for foraging (ie densely treed areas of all woodland sites ie A1, A2 and B2 which are associated with communities C7 and C9. Surveys conducted over a number of seasons would likely detect their presence. It is recognised that there is only one known roost site within the vicinity of the study area and this is located 60km to the south east.

***Note: EPBC Act Status: E=Endangered; V=Vulnerable. TSC Act Status: E4A=Critically Endangered Species; E1=Endangered Species; V = Vulnerable Species; 3 = Category 3 Sensitive Species**

5.2.3.5 Fauna corridors

Due to the location and size of the study area it is likely that it forms part of fauna movement corridors on both a local and regional scale. **Figure 5-6** shows the general direction of these expected movements though it should be noted that this is based on a broad assessment of the surrounding landscape and specific corridors, such as any patterns of movement across the road corridor, could only be further delineated by detailed and specific investigations targeting specific fauna (eg spotted-tailed quoll or macropods).

Despite the likely barrier effects of the New England Highway, the primary local movement corridor for fauna is expected to be northwest to southeast, linking the Study Area with the broader Bolivia Hill NR and areas of intact vegetation to the northwest. Local fauna movements are likely to occur in a north to northeast direction through the Study Area to areas of intact vegetation to the north. An unnamed tributary of Splitters Swamp Creek flows south to north in the northern section of the study area and is traversed by the existing highway alignment. This tributary ultimately joins Deepwater River and as such, this tributary and associated riparian zone is expected to play an important role in fauna movements through the study area and ultimately the surrounding landscape.

There appears to be no dedicated safe fauna passage infrastructure (eg dedicated culverts, directional fencing etc) incorporated into the design of the existing section of highway through Bolivia Hill.

5.2.3.6 SEPP 44 Koala habitat

The entire Tenterfield LGA, which encompasses the study area, is listed under the *State Environmental Planning Policy No.44 – Koala Habitat Protection* (SEPP 44 Koala). Although RMS is generally not bound by the provisions of SEPP 44 (as ISEPP removes development consent requirements), the principles of SEPP 44 were considered to assess the potential impacts of the proposal on the Koala (*Phascolarctos cinereus*).

Section 4 of SEPP 44 defines 'core koala habitat' as an area of land with a resident population of koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population.

Section 4 of SEPP 44 defines 'potential koala habitat' as areas of native vegetation where the trees of the types listed in Schedule 2 constitute at least 15% of the total number of trees in the upper or lower strata of the tree component.

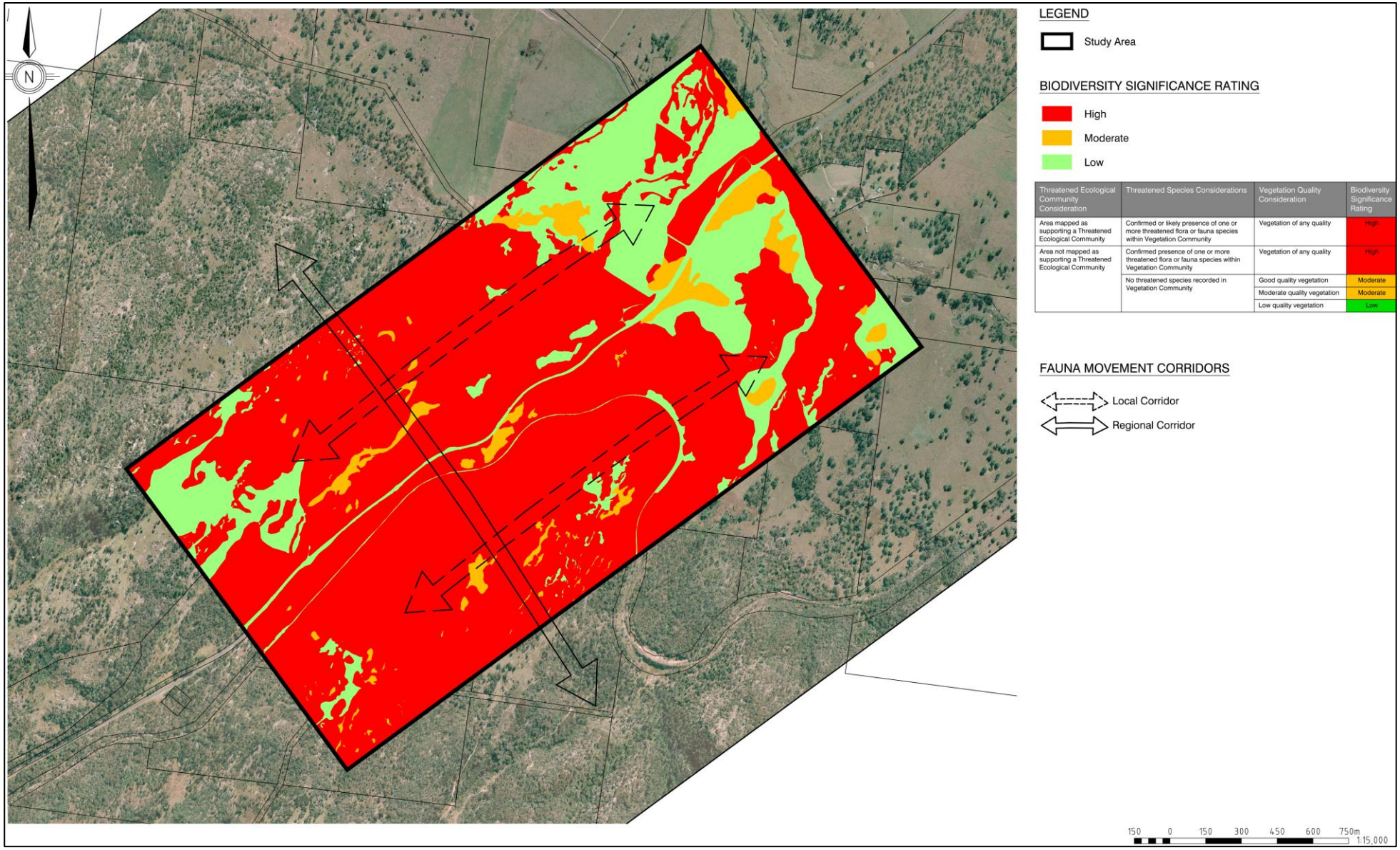
The surveys undertaken did not record any core koala habitat within the study area. In addition, the results of the flora surveys indicate that the majority of the study area is unlikely to support potential koala habitat. Only one species of Eucalypt listed in Schedule 2 of SEPP 44, was recorded from within the study area. This species is *Eucalyptus viminalis* (Manna Gum), and was recorded from within community C2. The results of the survey indicate that this species may be co-dominant or a secondarily dominant species within the community. The lack of SEPP 44 core or potential Koala habitat notwithstanding it should be taken into consideration that the study area does support a large number of Eucalypt species and recorded sightings have been made of the Koala within 10 kilometres of the study area. Consequently, the area may serve as a link between areas of more suitable habitat and may at times support resting or sheltering Koalas as they move between areas of habitat external to the study area.

5.2.3.7 Summary of terrestrial biodiversity significance

Based on the survey and assessment results, the study area either supports or is likely to support:

- Four endangered ecological communities (refer **Table 5-1** and **Figure 5-5**)
- Four threatened flora species (refer **Table 5-2** and **Figure 5-4**)
- Twelve threatened fauna species (refer **Table 5-3**).

An assessment of the overall biodiversity significance of the habitat contained within different sectors of the study area was undertaken based on consideration of the presence of threatened ecological communities, the presence of threatened species and the overall condition of the vegetation communities. **Figure 5-6** illustrates the distribution of biodiversity significance of the study area.



Threatened Ecological Community Consideration	Threatened Species Considerations	Vegetation Quality Consideration	Biodiversity Significance Rating
Area mapped as supporting a Threatened Ecological Community	Confirmed or likely presence of one or more threatened flora or fauna species within Vegetation Community	Vegetation of any quality	High
Area not mapped as supporting a Threatened Ecological Community	Confirmed presence of one or more threatened flora or fauna species within Vegetation Community	Vegetation of any quality	High
	No threatened species recorded in Vegetation Community	Good quality vegetation	Moderate
		Moderate quality vegetation	Moderate
		Low quality vegetation	Low

Figure 5-6 **Fauna corridors through the study area**

5.2.4 Aquatic biodiversity

Preliminary desktop analysis indicates that there are several ephemeral creeks surrounding the study area and a gully that exists adjacent to the New England Highway that carries runoff towards Brickyard Creek and subsequently into Deepwater Creek. As noted in **Table 5-3**, there is potential for frogs, waterbirds and fish listed as Endangered or Vulnerable under the TSC and/or EPBC Acts to occur within these waterways. Route options which traverse or are in close proximity to these waterways are more likely to have impacts on aquatic ecology and this has been considered in the assessment of route options outlined in **Chapter 7**.

The initial desktop assessment involved a review of the relevant Commonwealth, state and local government databases containing information concerning flora, fauna, vegetation communities and other environmentally relevant features. There are also several scientific reports and management plans of relevance to the study area and the surrounding landscape that were reviewed and considered as part of the assessment.

Specifically, the following resources are relevant to the study area:

- EPBC Act Protected Matters Search Tool (using a 10x10 km polygon around the study area)
- NSW FM Act list of threatened, endangered and protected fish species in NSW
- NSW Bionet Wildlife Atlas (using a 10x10 kilometre polygon around the study area)
- OEH Critical Habitat Register.

Based on the findings of the desktop review, a field survey was conducted from late February to March 2013, and involved:

- Assessments of aquatic habitat value
- In situ water quality sampling
- Aquatic macroinvertebrate sampling
- Finfish and freshwater crayfish/yabbie sampling
- Surveys of aquatic macrophytes.

The sampling sites adopted in the field survey included:

- Brickyard Creek upstream (BC US) – existing highway crossing with bridge
- Confluence of Brickyard Creek and Swamp Creek (BC CON) – downstream of the study area
- Tributary 3 (TRIB 3) – located at the base of Bolivia Hill
- Tributary 4 (TRIB 4) – located halfway down Bolivia Hill
- Tributary 5 (TRIB 5) – located in the upstream extent of the tributary.

Five sites were surveyed as that was deemed sufficient to represent the various habitats within the study area. While locating safe access points to the Tributary, swamplands habitat was located just upstream of the study area that was unlike habitat elsewhere in the study; hence the inclusion of Site TRIB 5 in the study area. Downstream of the study area is expected to be impacted by the proposed re-alignment works. Therefore, a site was selected downstream (BC CON) in order to provide accurate information on the nature of these potential impacts.

The detailed methodology for the terrestrial biodiversity impact assessment is provided in Cardno (2013b; **Appendix E**). The location of the sampling sites is shown in relation to the study area in **Figure 5-7**.

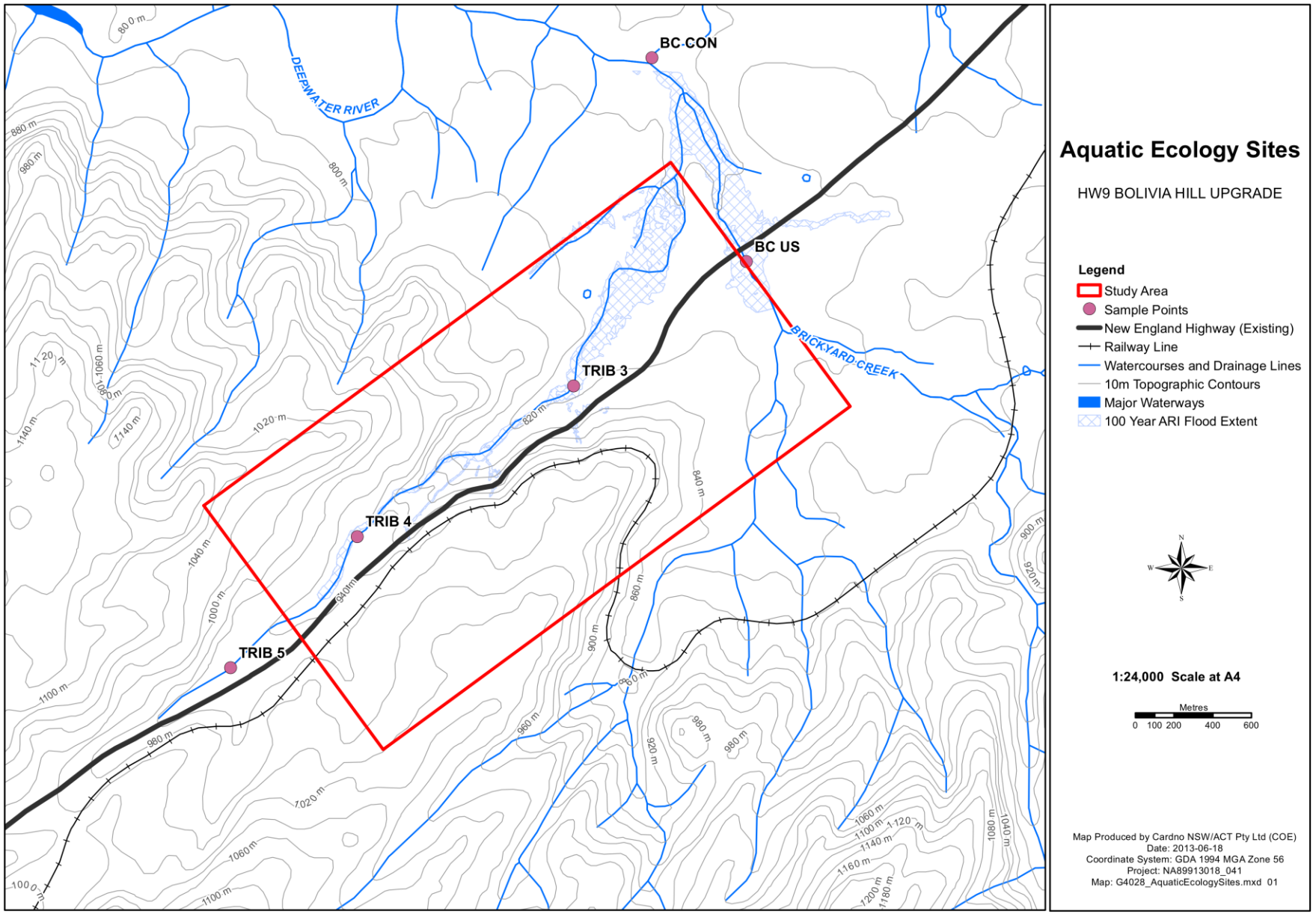


Figure 5-7 Aquatic biodiversity sampling sites

5.2.4.2 Aquatic species and populations

A search of the NSW Bionet Wildlife Atlas identified a large number of species protected under the TSC Act and/or the EPBC Act that could occur, or have previously occurred, within 10 kilometres of the study area. These included:

- Eight species of flora associated with aquatic habitats
- Nine species of aquatic fauna
- One endangered population
- Two threatened ecological communities.

The protected, threatened and endangered flora and fauna species associated with aquatic habitats identified in the Bionet search are listed in **Table 5-4**. An assessment of the likely presence of each species within the study area was conducted. It is noted that some of these species, the endangered population, and the communities have all previously been considered in the assessment of terrestrial biodiversity in **Section 5.2.3**. Hence, they are not addressed in this section.

The giant dragonfly, an endangered species under the TSC Act, is the third largest dragonfly in Australia and one of the largest dragonflies in the world. The giant dragonfly is found along the east coast of NSW from the Victorian border to northern NSW, including the study area. They live in permanent swamps and bogs with some free water and open vegetation. The main threats to the giant dragonfly are:

- Changes to natural fire regimes
- Clearing and development of land resulting in habitat loss and/or degradation
- Weed invasion
- Decreased water quality through pollution
- Eutrophication and sedimentation
- Impacts on swamp hydrology from factors such as construction of works.

The NSW Bionet Wildlife Atlas search also identified one endangered population protected under the EPBC Act and associated with aquatic habitat that could occur or have previously occurred within 10 kilometres of the study area:

- Tusked Frog (*Adelotus brevis*) population in the Nandewar and New England Tableland Bioregions.

This population is thought to be locally extinct in the study area, as discussed in **Section 5.2.3.3**.

Three species of fish were found within the study area: Australian smelt (*Retropinna semoni*), mountain galaxids (*Galaxia olidus*) and eastern mosquito fish (*Gambusia holbrooki).* In addition, a longneck turtle (*Chelodina longicollis*) was recorded from Brickyard Creek. Mountain galaxids are a common native fish of highland creeks, whereas eastern mosquito fish are an exotic species listed under the NSW FM Act as a noxious pest. Mosquito fish (invasive) were found at both Brickyard Creek sites but not at the Tributary sites. No protected, endangered or vulnerable fish species were recorded during the field survey.

Table 5-4 Threatened aquatic fauna species recorded in the study area

Scientific Name	Common Name	Conservation Status*			Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act	FM Act		
Flora species associated with aquatic habitats						
Almaleea cambagei	Torrington pea	E	V	-	See **Table 5-2**.	**Possible** (see **Table 5-2**).
Diuris pedunculata	Small snake orchid	E	E	-	See **Table 5-2**.	**Possible** (see **Table 5-2**).
Thesium australe	Austral toadflax	V	V	-	See **Table 5-2**.	**Possible** (see **Table 5-2**).
Euphrasia orthocheila subsp. *peraspera*	Tenterfield eyebright	E	-	-	See **Table 5-2**.	**Possible** (see **Table 5-2**).
Frogs						
Philoria sphagnicolus	Sphagnum frog	V	-	-	See **Table 5-2**.	**Likely** (see **Table 5-2**).
Insects						
Petalura gigantea	Giant dragonfly	-	E	-	The giant dragonfly is found along the east coast of NSW from the Victorian border to northern NSW, including the area of the proposed alignment. They live in permanent swamps and bogs with some free water and open vegetation.	**Likely** There is known critical habitat resources for the giant dragonfly within the study area.
Fish						
Tandanus tandanus	Freshwater catfish	V	-	V	Freshwater catfish are found in a wide variety of habitats, including rivers, creeks, lakes and billabongs. They generally prefer sluggish or still waters. Water temperatures of around 24^{o}C may induce spawning.	**Unlikely** The waterways of the study area are not of sufficient depth, and ponds are not of sufficient size, to support freshwater catfish.

Scientific Name	Common Name	Conservation Status*			Critical Habitat	Likelihood of Occurrence
		EPBC Act	TSC Act	FM Act		
Maccullochella peeli	Murray cod	V	-	E	Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams (such as those found in the upper western slopes of NSW), to slow-flowing, turbid rivers and billabongs. Within this range of habitats, Murray cod is usually found near complex structural cover such as large rocks, snags, overhanging vegetation and other woody structures and is frequently found in the main channel and larger tributaries or rivers. They are sometimes found in floodplain channels when they contain water, although this usage appears limited.	**Unlikely** Given the small size of the waterways surveyed and the known habitat of the species, it is unlikely to be found in the study area.
Ambassis agassizii	Olive perchlet	-	-	E	Inhabit rivers, creeks, ponds and swamps. They are usually found in slow-flowing or still waters, often near overhanging vegetation or amongst logs, dead branches and boulders. They often congregate around suitable shelter (eg large woody debris and vegetation) during the day but disperse during the night to feed on micro-crustaceans and insects, including larvae.	**Unlikely** The species distribution is limited only to a few known sites in the Darling River drainage, not near the study area.
Mogurnda adspersa	Purple spotted gudgeon	-	-	E	Occur in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. They live among weeds, rocks and snags in rivers, streams and billabongs, where they feed on small fish, insect larvae, worms, tadpoles and some plant matter.	**Likely** There is known habitat for the purple spotted gudgeon within the study area and previous records of the species occurring within the general locality of the study area.
Bidyanus bidyanus	Silver perch	-	-	V	Silver perch prefer fast-flowing, open waters, especially where there are rapids and races, however they will also inhabit warm, sluggish water with cover provided by large woody debris and reeds.	**Unlikely** The habitats described within the study area do not suit the habitat requirements of this species.

***Note: EPBC Act Status: E=Endangered; V=Vulnerable. TSC Act Status: E=Endangered Species; V = Vulnerable Species. FM Act Status: E=Endangered Species; V=Vulnerable Species.**

5.2.4.3 Aquatic habitats

The general characteristics of the two watercourses surveyed in the field include series of small pools interspersed with small fast flowing creek channels. The survey was conducted shortly after a large rainfall event, it is likely that these creeks can be ephemeral in dry conditions (as was observed by other study team members in October 2012), and that during these times the pools act as refugia for aquatic species. The Brickyard Creek sites surveyed tended to have finer, sandy bed material, when compared to the Tributary sites, which were characterised by a higher proportion of pebbles, gravel and cobbles, with some rock outcropping in places.

The assessment of aquatic habitats found that Brickyard Creek generally low to moderate aquatic habitat value. The Brickyard Creek upstream site (BC US) was located upstream of the existing highway crossing of Brickyard Creek. The habitat assessment found that this site was impacted by historic clearing of riparian vegetation and adjacent agricultural activities. The riparian zone was sparsely vegetated with all *Eucalyptus* sp. (> 20 metres) and several smaller trees and shrubs, mainly *Salix* sp. and *Eucalyptus* sp. Ground cover consisted of grasses and weeds. Aquatic macrophytes were present in moderate densities, including the species *Paspalum* sp., *Juncus* sp., *Cyperus* sp., *Schoenoplectus* sp. and *Ludwigia* sp. Further downstream at the confluence of Brickyard Creek and Splitters Swamp Creek (Site BC CON), the banks were devoid of any riparian vegetation and there was evidence of unstable, eroding banks. Groundcover was densely populated by grasses. There were few instream macrophytes present, primarily *Paspalum* sp., *Juncus* sp., *Ranunculus* sp. and *Persicaria* sp.

The aquatic habitat assessment characterised all the Tributary sites as having moderate aquatic habitat value. Site TRIB 3 had sparsely distributed in-stream macrophytes were observed including, *Paspalum* sp., *Eleocharis* sp. and *Cyperus* sp. The riparian zone was densely covered in *Acacia* shrubs, grasses and herbs, with sparse *Eucalyptus* sp. trees interspersed. At site TRIB 4 a dirt road crossed the creek, impounding a large pool upstream. Land upstream of the dirt road crossing was cleared and in agricultural use, while land downstream had moderate cover of riparian vegetation consisting of grasses, shrubs and trees. Macrophytes were sparsely distributed, and included *Schoenoplectus validus*, *Paspalum* sp. and *Carex* sp. Weeds were densely abundant at ground level along the banks. *Eucalyptus* sp. and *Acacia* sp. were dominant shrubs and trees present. Two water dragons were also observed during the survey. Site TRIB 5 consisted of swamplands, including several small pools, narrow creeks and channels. The highway was located adjacent to the right bank. The vegetation consisted mainly of swampland with dense emergent growth, comprising *Carex* sp. Some *Typha* sp., *Paspalum* sp. are present with other grasses also present. The riparian zone consisted of woodlands comprising mainly *Eucalyptus* sp., *Acacia* sp., and *Banksia* sp.

The water quality in these watercourses was generally compliant with the ANZECC/ARMCANZ (2000) guidelines for aquatic ecosystem health for south-east Australian waterways, noting that turbidity levels were elevated, thought to be due to the recent rainfall in the catchment.

The aquatic macroinvertebrate sampling conducted provides an indication of the general 'health' of the watercourses. The macroinvertebrate taxa collected during this field survey are indicative of a degraded ecosystem, with many pollution tolerant taxa present. A total of 48 macroinvertebrate taxa were recorded from the 10 samples collected during the aquatic macroinvertebrate sampling. The minimum number of taxa represented in an individual sample was 11 at Site TRIB 3 and the maximum was 25 at Site TRIB 4.

5.2.4.4 Fish passage

Fish were found at all sites except for TRIB 5, indicating that any obstructions currently present downstream of Site BC US and Site TRIB 4 are not currently acting as barriers to fish passage.

5.2.4.5 Summary of aquatic biodiversity significance

In general, the study area is classified as having moderate aquatic biodiversity significance due to the likely or possible presence of some species of aquatic species of conservation significance, specifically the purple spotted gudgeon. Habitat that supports the giant dragonfly where it occurs within the study area would be classed as having high significance. In general, the watercourses located adjacent to agricultural lands have lower aquatic biodiversity significance due to impacts of agricultural activities on habitat extent and quality.

5.2.5 Climate and air quality

Based on available data from the closest operating Australian Bureau of Meteorology (BoM) monitoring station located near Tenterfield (Signal Station AWS 056032) approximately 30 kilometres north of the study area, the following climatic statistics are indicative of the study area:

- Temperature
  - Annual mean maximum temperature of 21.4°C
  - Annual mean minimum temperature of 8°C
  - January is the hottest month, with a mean maximum temperature of 27.1°C
  - July is the coldest month, with a mean minimum temperature of 1°C.
- Minimum temperatures
  - The lowest temperature recorded at the signal station is –10.6°C (July 2006)
  - The annual mean lowest temperature recorded between 1965-2012 is –6.9°C
  - Sub-freezing temperatures have been recorded from May to November, with the lowest temperatures occurring in June – August.
- Humidity
  - Annual mean relative humidity is 75 per cent at 9am and 55 per cent at 3pm
  - June has the highest mean relative humidity, with a 9am mean of 82 per cent
  - September has the lowest mean relative humidity, with a 3pm mean of 46 per cent.
- Rainfall
  - Annual mean rainfall is 852.1 millimetres, with a mean of 81.5 rain days per annum
  - January is the wettest month, with a mean rainfall of 115.7 millimetres
  - August is the driest month, with a mean rainfall of 43.7 millimetres.
- Wind
  - Annual mean wind speed at 9am is 8.8 kilometres per hour and 13.1 kilometres per hour at 3pm
  - August has the highest mean average wind speed of 14.4 kilometres per hour at 3pm
  - July has the lowest mean average wind of 6.7 kilometres per hour at 9am
  - Average annual wind direction blows in a north-east direction.

As indicated by the community engagement survey responses (**Sections 3.5.2.1** and **3.5.3.2**), low temperatures during the winter months (particularly July) have the potential to create black ice along the road as its surface temperature drops, resulting in dangerous driving conditions. Summary statistics from the BoM indicate that between April and October, temperatures at the Tenterfield Signal Station (at 838 metres) can drop to below 0°C, as per the following monthly lowest temperature statistics:

- 5^{th} percentile for April is –1.7°C
- 5^{th} percentile for May is –6.4°C
- 5^{th} percentile for June is –8.4°C
- 5^{th} percentile for July is –9.8°C
- 5^{th} percentile for August is –7.9°C
- 5^{th} percentile for September is –6.0°C
- 5^{th} percentile for October is –2.8°C

The following information is drawn substantively from Vaisala (2009) who prepared an analysis of road surface temperature for the *Great Western Highway - Mount Victoria to Lithgow Preliminary Environmental Assessment,* which is at a similar altitude to Bolivia Hill.

In addition to low temperatures during the winter months, there are several other factors that can influence the road surface temperatures (RSTs) and may cause black ice during the winter months.

- **Time of day** – the maximum RST normally occurs in the early afternoon and the minimum occurs around dawn. Directly after sunset the RST falls quickly, but its decline will level off so that during the latter part of the night there is little variation of RSTs.
- **Solar radiation** –incoming solar radiation varies throughout the winter in proportion with the total amount of daylight and height of the sun in the sky. Minimum solar input occurs on the shortest day (21 June) but the actual incident solar radiation at one place is also dependent on cloud cover and 'sky view factor'.
  - *Cloud cover* – clouds reflect and absorb solar radiation, thus the amount of direct solar radiation reaching the surface is reduced. They absorb heat not only from above but also from below due to re-radiation from the earth's surface. This absorbed heat is then re-radiated and at night this can significantly offset surface cooling (Vaisala, 2009).
  - *Sky view factor* – relates to the amount of "visible sky" and is used to determine the maximum incoming solar radiation that could conceivably occur, compared to that of the actual. It varies from 0.0 when there is no visible sky (eg inside a tunnel) to 1.0 when there are no visible obstructions (eg an open hilltop). According to Vaisala (2009), the sky view factor depends upon tree and building cover, which reduce the incoming solar radiation to the surface via shading.
- **Seasonal variation** – as the height of the sun and angle of incidence of incoming solar radiation changes, the effect of the sky view factor will change with the seasons. Additionally, the amount of foliage present on the trees will also influence the sky view factor in the winter because as trees lose their leaves, more long wave radiation will escape at night and the rate of cooling will increase (Vaisala, 2009). Therefore, the distribution of RST can be variable at the winter margins (eg October compared to June or July), when solar input is that much greater due to increasing hours of sunlight and the increased angle of the sun. These factors can trigger some sections of open road with high sky view factors to absorb enough solar radiation during the daytime to offset their normally rapid cooling regime after sunset.
- **Latitude** – the length of days and the height of the sun are both affected by latitude and are important influences on the amount of solar radiation reaching the surface during daylight hours (eg a road section that has a high sky view factor will receive greater solar input). In higher latitudes, if all other factors are equal, such a stretch of road could be expected to display relatively low RSTs due to unrestricted cooling after dark (Vaisala, 2009). Conversely, in lower latitudes where the angle of incidence of solar input is higher and the days are longer, there may be sufficient heat absorbed during the day to offset the cooling after dark. As the study area is in a mid-latitude location the latitude is unlikely to influence the RST.
- **Altitude** – in general, the higher the altitude the lower the road minimum temperature because of the decrease in air temperature with the height that occurs in a normal, unstable atmosphere (Vaisala, 2009). The environmental lapse rate (the fall of air temperature with height above sea level) is usually about 6ºC per 1000 metres in altitude (Vaisala, 2009), and the RSTs could be expected to decline with altitude at a similar rate. The altitude of the Tenterfield Signal Station 838 metres and has recorded a lowest temperature of –10.6°C. As the height over the study area ranges up to 1225 metres, colder temperatures may be expected in the study area in comparison to the temperatures recorded at the Tenterfield Signal Station.

  Frost hollows can cause the lowest temperatures to be recorded in valley bottoms, especially on clear and calm nights due to either the formation of inversions and/or the pooling of cold air. A frost hollow will occur where a slope is sufficiently steep, such as where the current highway drops steeply to the west near the central ridge, causing drainage to take place and resulting in lower RSTs.

- **Topography** – overnight a road surface cools by radiation. The topography controls radiative cooling from the surface by influencing the sky view factor, thereby limiting the amount of long wave radiation that can escape. The effect of radiative heat loss to the environment is further reduced by trees, cloud cover, traffic and cuttings. These features reflect, absorb and re-emit radiation from the road back to the surface, thereby offsetting radiation loss from the road surface and maintaining temperatures. Therefore, during the night, roads lined with trees, roads passing through cuttings, under bridges and in tunnels will tend to stay warmer than more exposed sections (Vaisala, 2009).

It should also be considered that sheltered roads may warm more slowly than more exposed roads, as early morning solar radiation cannot reach the road surface. This can be an important factor if, for example overnight conditions lead to the formation of 'hoar' frost on the road surface and surrounding fields. After sunrise, these hoar frost deposits are melted or sublimated by the incident solar radiation on exposed road sections (Vaisala, 2009).

In shaded sections where solar radiation is unable to penetrate directly to the surface, RSTs may remain below freezing and early morning traffic can then compact the hoar frost into ice. Hence, areas with a low sky view factor can be more hazardous for a longer period of time than exposed sections if the RST falls below 0ºC.

With respect to air quality, in the immediate vicinity of the New England Highway vehicle exhaust emissions containing carbon monoxide (CO), nitrogen oxides (NO_x), and sulfur dioxide (SO_2) are likely to be elevated in the roadside environment. However, specific data for roadside air quality is not available.

The study area is located in the Tenterfield LGA which is predominantly comprised of of low to medium density or rural residential land and parkland, therefore, the overall regional air quality is expected to be generally high. The National Pollutant Inventory identifies the most commonly reported pollutants for the Tenterfield LGA as:

- Nitrogen
- Phosphorus.

5.2.6 Bush fire

In the summer of 2002/03, 90 per cent of the Bolivia Hill NR was subject to wildfire (NPWS, 2011). The area had not been burnt by a wildfire since 1965. Selected areas were burnt every three to four years prior to reserve gazettal to manage pasture in the northern cleared end of the reserve (NPWS, 2011). Areas affected by fire were recorded during the field surveys for this study and are shown on **Figure 5-4**.

According to Tenterfield Shire Council's Bushfire Prone Land Map (2004), all of the potential route options would traverse through bushfire prone land. A map of the bushfire risk in the study area is provided in **Figure 5-8**. The following classifications are provided by the Rural Fire Service for bush fire prone lands identified in the figure:

- Light orange coloured areas are 'Vegetation Category 1', which is the most hazardous vegetation category
- Yellow coloured areas are 'Vegetation Category 2', which is the smaller, more isolated pockets of vegetation which are of a lesser hazard than the light orange vegetation category
- Dark orange coloured areas are bushland that is classified as 'Vegetation Buffer 100m & 30m'. These are the areas in which developments and people are most likely to be affected by a bush fire burning in the vegetation (yellow or light orange) areas. The dark orange area extends for a distance of 100 metres from the 'light orange' vegetation category 1 areas and for a distance of 30 metres from the 'yellow' vegetation category 2 areas.

All routes selected for the shortlist options and the design of the preferred route, should take into consideration the bushfire risk to the area.

5.2.7 Existing major infrastructure and utilities

Utility and service infrastructure are present in the study area. This infrastructure is described below and shown in **Figure 5-9**.

5.2.7.1 Main Northern Railway

The Main Northern Railway line was the original rail transport route between Sydney and Brisbane. The railway corridor runs roughly parallel to the highway for approximately half the project length before veering to the east. The line is currently disused.

5.2.7.2 Telecommunications

Telstra buried local cable runs parallel and to the west of the highway north of the project area. These cables veer to the west and cut the north-western corner of the study area.

5.2.7.3 Electrical transmission lines

An Essential Energy power line traverses the north-eastern side of the study area.

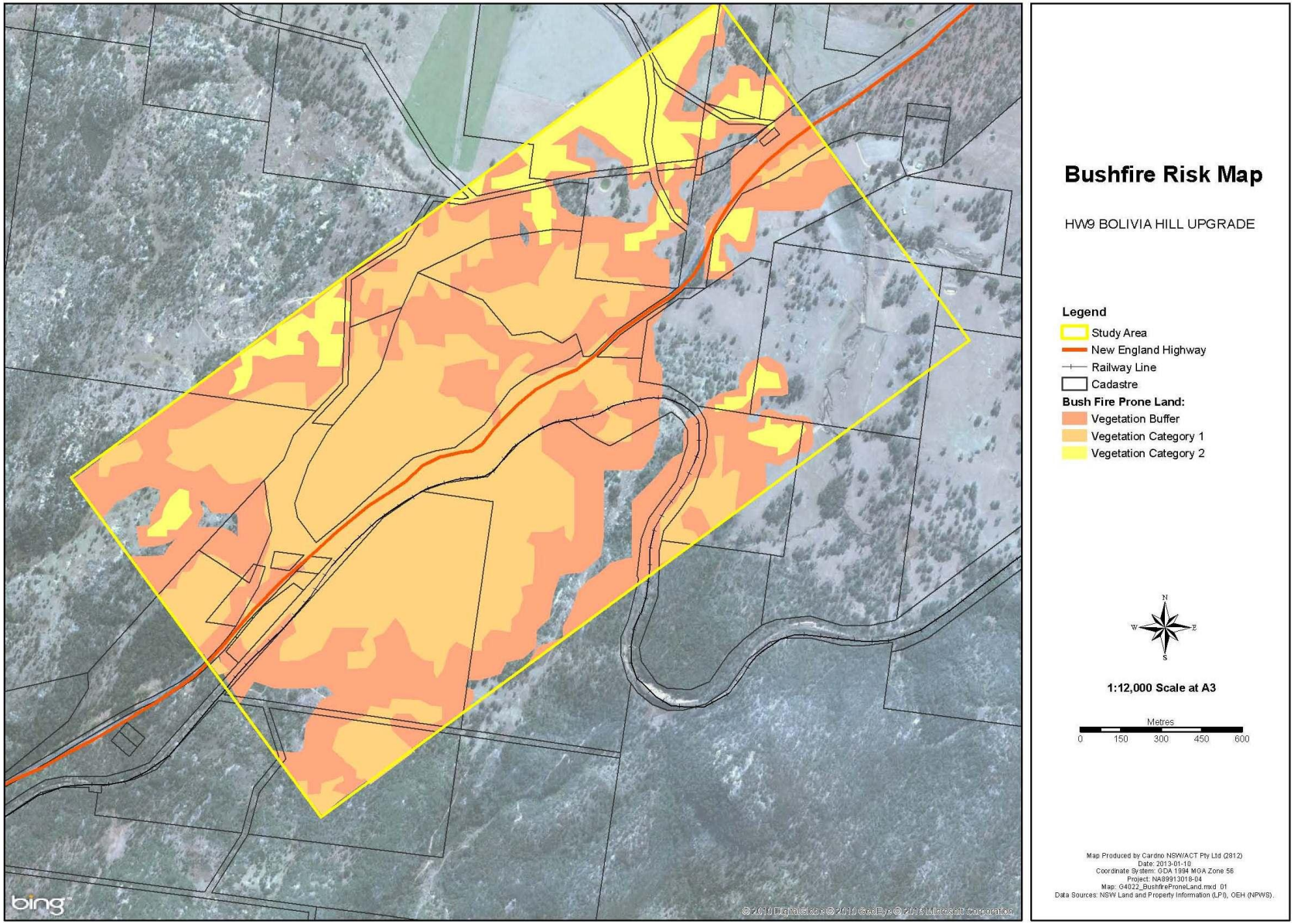


Figure 5-8 **Bushfire risk of the study area**

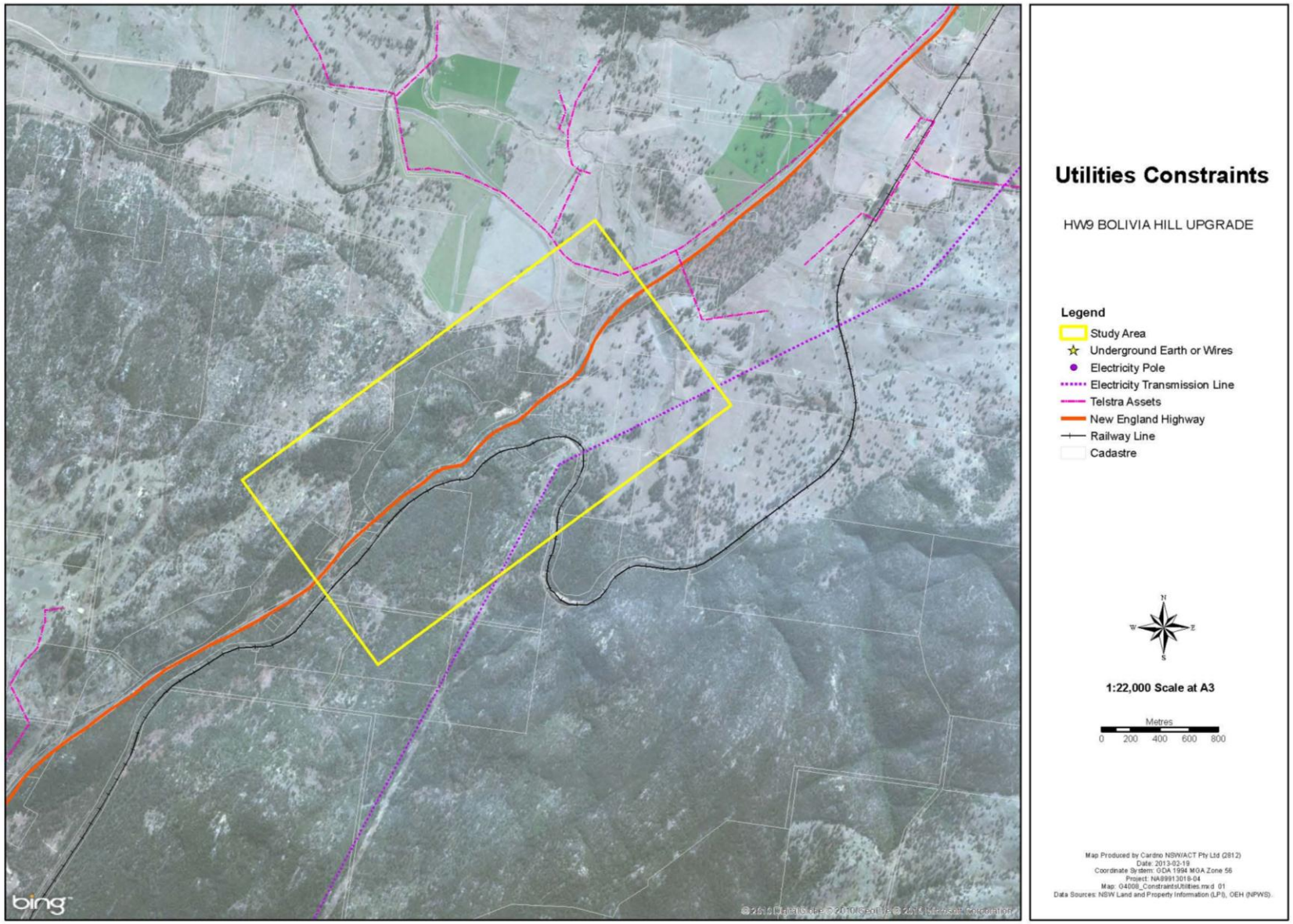


Figure 5-9 **Existing major infrastructure and utilities**

5.3 Social and cultural environment

Niche Environment and Heritage Pty Ltd (Niche) participated in the study team to assess both Aboriginal and non-Aboriginal cultural heritage in the study area and input into the route options assessment process. This section describes the findings of their desktop and field investigations into the cultural heritage aspects of the study area.

5.3.1 Aboriginal heritage

An assessment of potential constraints associated with Aboriginal cultural heritage for the route selection and design process was conducted based on a combination of desktop and surveys of the heritage of the study area. The findings are reported in Niche's (2013a) *Aboriginal Archaeological Assessment Report* (**Appendix F**).

The assessment was conducted in accordance with the following guidelines:

- Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010a)
- Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales (DECCW, 2010b)
- Procedures for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI) (RMS, 2011).

The main objective of the assessment was to identify the location of Aboriginal sites, objects or places to seek to avoid those locations for any route option.

The archaeological assessment involved the following tasks:

- Desktop review of previous studies and reports relevant to the study area
- Search of the Aboriginal Heritage Information Management System (AHIMS) maintained by the OEH to identify known Aboriginal objects and sites within the study area
- Search of the NSW State Heritage Register (SHR), the NSW State Heritage Inventory (SHI) and Local Environmental Plan Heritage Schedules
- Search of the World Heritage List, the National Heritage List (NHL), the Commonwealth Heritage List (CHL) and the Register of the National Estate (RNE)
- Search of the National Native Title Register
- Consideration of the landscape context and land use history
- Site surveys to assess archaeological potential of the study area
- Consultation with the Moombahlene Local Aboriginal Land Council (LALC) in accordance with Stage 2 of PACHCI.

More detailed information on the adopted methodology is provided in Niche (2013a; **Appendix F**).

5.3.1.1 Places of known or reported Aboriginal significance

The register searches revealed no sites of known archaeological significance of relevance to the study area, except for one record returned from the AHIMS search. The record was for a ceremonial site, although it is located further to the north-east and well outside of the study area (see **Figure 5-10**).

No native title claims or registrations exist over the land within the study area.

5.3.1.2 Landscape context

Many fauna species exist in the study area that may have been utilised by Aboriginal people for food and other resources. Fauna species that would have comprised food resources include Eastern grey kangaroo (*Macropus giganteus*), brush-tailed rock wallaby (*Petrogale penicillata*), eastern pigmy possum (*Cercartetus nanus*), spotted-tail quoll (*Dasyurus maculatus*), yellow-bellied glider (*Petaurus australis*), squirrel glider (*Petaurus norfolcensis*), Brush-tailed phascogale (*Phascogale tapoatafa*), Koala (*Phascolarctos cinereus*), Emu (*Dromaius novaehollandiae*) as well as many species of birds, fish, reptiles and amphibians.

Many species within the vegetation communities are also known to have been used by Aboriginal people in the past. Some old growth trees occur in close proximity to the proposed route options. Where remnant native vegetation occurs, the vegetation may have significance to contemporary Aboriginal people as an example or link between the landscape of today and that inhabited by their ancestors. Brickyard Creek and its tributary would have provided a varied and rich range of resources including fish, bird, mammal, reptile and amphibians.

5.3.1.3 Previous studies

Based on current archaeological studies, occupation of the New England Tablelands dates back to approximately 9000 years. Archaeological dates from an archaeological excavation at the Graman A2 rock shelter, located approximately 80 kilometres north-east of Glen Innes, confirms Aboriginal occupation has occurred in the region during the Holocene (AMBS, 2010). Other archaeological sites suggesting long occupation of the area are Graman B1 (c. 5400 BP), Bendemeer 2 (c. 5000BP) and Moore Creek rock shelters 4 and 6 (c. 4000 BP).

McBryde (1974) has conducted extensive archaeological research in the region including a systematic field survey and targeted excavation aimed at providing evidence to reconstruct human occupation in the region. McBryde's (1974) field survey located the remains of both Bora grounds and stone arrangements that were interpreted as the archaeological remains of ceremonial sites. A bora ground, registered on the AHIMS (see **Section 5.3.1.1** and **Figure 5-10**), is located within five kilometres of the subject area. McBryde's (1974) survey also located evidence of past artistic life in the form of rock art sites and geometric carving on trees. The rock art in the region is usually painted or drawn (pictographs) onto granite surfaces, such as the vertical faces of boulders or in rock shelters or overhangs. Rock engravings (petroglyphs) do exist, especially in the western part of the region but they are generally less common than painted or drawn art (McBryde, 1974).

In 1995, Telstra Australia commissioned a study (Griffiths, 1995) to conduct an archaeological survey between the towns of Deepwater and Tenterfield in northern NSW. The assessment predicted that site types in the region might include; quarries, open campsites, scarred trees and ceremonial/bora sites (Griffiths, 1995); however, the survey did not find any Aboriginal heritage sites.

In 2008, Hudson undertook an archaeological investigation further north on the outskirts of Tenterfield, for members of the Moombahlene LALC. The assessment located:

- Two rock art sites
- Two scar trees
- One possible burial site
- One potential archaeological deposit (PAD) (Hudson, 2009).

Both rock art sites are pecked engravings on granite outcrops located near a creek (Hudson, 2009). The possible burial site is a large earthen mound oriented east–west (Hudson, 2009). The presence of rock art and ceremonial sites suggests that the area is highly significant to the local Aboriginal people (Hudson, 2009).

To the south, Australian Museum Business Services (AMBS, 2010) completed a regional desktop Aboriginal cultural heritage study for Glen Innes Severn Council that identified 70 Aboriginal cultural heritage sites within the Glen Innes LGA. The site types recorded included, open campsites, scarred trees, isolated finds, stone arrangements, bora/ceremonial sites, burials, natural mythological sites, axe grinding grooves, water holes and rock art sites (AMBS, 2010).

The results of these studies confirm that Aboriginal people were active in the region and that a broad range of site types are likely to occur within the study area.

5.3.1.4 Ethnohistory

Much of the information about Aboriginal people in the Northern Tablelands comes from early historical sources and some provide accounts of first contact between European explorers and Aboriginal people, although the sources are often fragmentary and many are biased.

The study area is located on the border of the Jukambal tribes' traditional land and the Ngarabul tribes' traditional land. The Jukambal people lived from Glen Innes and north-east towards Drake, Tenterfield and near Wallangarra. The Ngarrabul (also spelled Ngoorbul, Nugumbul, Narbal or Narbul) people are the traditional owners of the land around the Glen Innes region, including Bolivia; their territory included Glen Innes, Deepwater, to Bolivia Station and to the Mole River in the north.

There is evidence, supported by oral history, which suggests the Aboriginal people of the Northern Tablelands moved through the landscape seasonally. In 1842, Oakes, the commissioner of Crown Land for the Macleay and Clarence districts wrote that the natives traversed the landscape to the coast in the season of fishing and to the interior during more favourable conditions for hunting.

The Ngarrabul territories were defined by places in the physical landscape and were guarded, although some movement between territories was sanctioned at times. Tribal boundaries were indicated by marking trees while marked stones would indicate the boundaries of hunting grounds or fishing waters (Campbell, 1978; Kerr *et al*., 1999). Evidence of trade and intermarriage between the Ngarrabul people and the Aboriginal groups in the Northern Tablelands exists in the material record. Stone traded from Graman and Moore Creek has been located in the Tablelands (AMBS, 2010).

Archaeological evidence and historic accounts suggest that ceremonies were often held by the Ngarrabul people on the flat ground of the river plains.

The first European to encounter Aboriginal people in the region was John Oxley, a European explorer, who entered the New England region in 1818. Oxley described the Aboriginal people in the New England region as having poor condition and physique compared to the large manly figures he encountered in the interior (Oxley, 1818). Oxley and later Cunningham both described the local Aboriginal people as flighty and were very often not able to interact with them, as they would disappear when approached by white men. Tension is reported between many of the original squatters and land owners and the native people (Walker, 1963).

In 1844, a massacre of Aboriginal people occurred at Bluff Rock. The massacre involved the Bolivia Station manager Edward Irby (**Section 5.3.2.2** notes further details of Bolivia Station), who found a shepherd had been attacked with spears and axes and left floating in the river. Edward and his brother, assisted by Charles Windeyer of the neighbouring Deepwater Station, pursued the local Aboriginal tribe to Bluff Rock and drove them over the edge. This resulted in the death of several men, women and children (New England Examiner, 1870). Another massacre occurred at Deepwater Station, also in 1844, which resulted in the death of seven Aboriginal men, four Aboriginal women and five Aboriginal children (AMBS, 2010).

Not all associations between the Aboriginal people of the New England region and European settlers were unpleasant. Many Aboriginal people were employed by station owners as permanent shepherds, stockmen and horse breakers and provisions of medicine and blankets was made available by the government in the early 1850's (Walker, 1963).

5.3.1.5 Aboriginal heritage survey findings

Based on review of previous archaeological assessments in the broader region, the topography and geology of the landscape and a search of the AHIMS register; it is likely that Aboriginal heritage sites occur within the study area.

Figure 5-10 shows a predictive model of areas with moderate and high potential for Aboriginal cultural heritage sites, prepared based on landform, hydrology, ethnographic and historic accounts and previous archaeological investigations. The predictive model suggests the site types most likely expected to occur within the subject area include:

- Open camp sites (artefact scatter)
- Isolated finds
- Rock art sites
- Scarred trees
- Ceremonial sites (bora grounds or stone arrangements).

The predictive model also suggests that other site types may be found in the study area, including burial sites, axe grinding groove sites, contact/historical sites and quarry sites.

The surface survey validated these predications by locating a number of sites (**Table 5-5**). The sites located during the surface survey were also located in the expected landforms with past occupational activity focused on and around the creek lines and lower slopes. The rock art site was located in the granite clusters along the ridgeline in the upper slope. The archaeological sites located during the field survey provide evidence of past Aboriginal occupation in the hinterlands environment. The site types located during the field survey indicate long term occupation and camping rather than evidence of traversing through the landscape or simply a transport corridor.

Table 5-5 Summary of sites located during the surface survey

Site	Feature(s)	Landform	Overall Significance
Bolivia Hill AS1	Artefact scatter and PAD	Creek line	Moderate
Bolivia Hill CMST1	Culturally modified scar tree	Creek line	Moderate
Bolivia Hill GG1	Grinding grooves site	Creek line	Moderate
Bolivia Hill RA1	Rock art site	Upper slope	Moderate
Bolivia Hill PAD1	PAD	Lower slope	Unknown
Bolivia Hill PAD2	PAD	Lower slope	Unknown
Bolivia Hill PAD3 (AS1)	PAD and artefact scatter	Creek line	Unknown
Bolivia Hill PAD4	PAD	Creek line	Unknown

Detailed site descriptions are provided in Niche (2013a; **Appendix F**). These sites have not been mapped in this report due to their sensitive nature. Site Bolivia Hill RA1 is located outside of the subject area while the remaining seven sites are located within the subject area.

5.3.1.6 Summary of Aboriginal cultural heritage significance

An assessment of the scientific values and significance of the sites against the Burra Charter (Australia ICOMOS, 1999) and the OEH guidelines (NPWS, 1997) (**Table 5-5**) was conducted, noting that further consultation with the local Aboriginal community would be required to confirm the cultural heritage significance. In addition, additional archaeological investigation would be required to confirm the significance of the PADs.

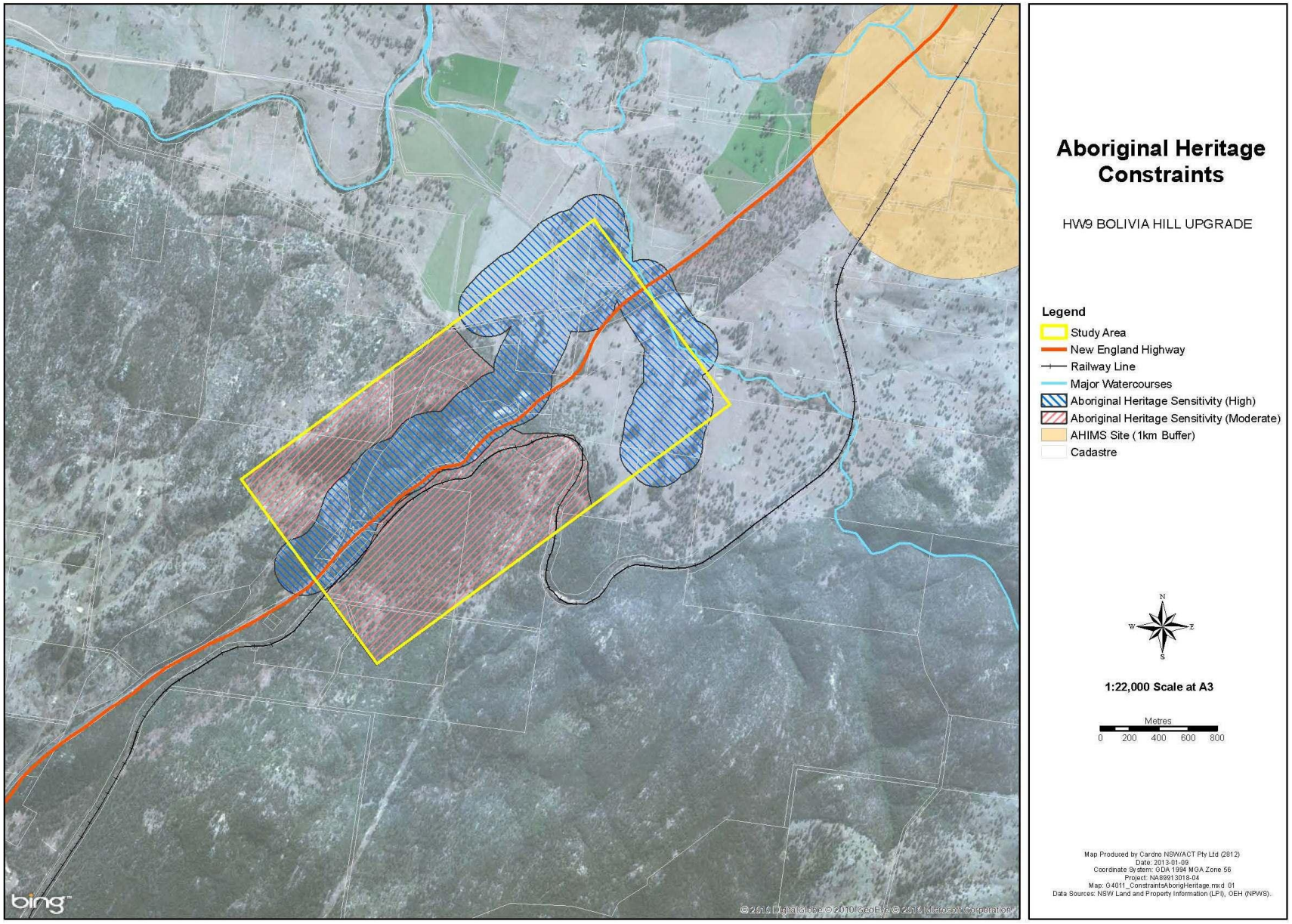


Figure 5-10 **Aboriginal heritage constraints in and around the study area**

5.3.2 Non-Aboriginal heritage

An assessment of potential constraints associated with historic heritage for the route selection and design process was conducted based on a combination of desktop and surveys of the study area. The findings are reported in Niche's (2013b) *Historic Heritage Assessment Report* (**Appendix G**).

The aim of this assessment was to identify whether non-Aboriginal heritage items occur, or are likely to occur, in the study area and assess their likely heritage significance. This will assist with the selection of a preferred route option for the proposed highway upgrade at Bolivia Hill.

The assessment was undertaken in accordance with the best practice standards outlined in the *NSW Heritage Manual* (DUAP, 1996) and included the following tasks:

- An initial desktop review of previous studies and reports relevant to the study area
- A search of the NSW SHR, the NSW SHI, Local Environmental Plan Heritage Schedules
- A search of the World Heritage List, the NHL, the CHL and the RNE
- Consultation with the Tenterfield and District Historical Society and field survey of the proposed route options (and 100 metre buffer)
- Additional detailed historical research, including the review of archival materials at the Mitchell Library, Crown Plans held by NSW Land and Property Information Section, and the National Library of Australia's digital archives.

More detailed information on the adopted methodology is provided in Niche (2013b; **Appendix G**).

5.3.2.1 Register searches

Searches of the NHL, CHL, RNE, SHR, SHI and the Tenterfield LEP (1996) on 22 October 2012, did not identify any heritage items located within or in close proximity to the study area. However, under the Tenterfield LEP (2013), gazetted on 9 April 2013, the Bolivia Station and outbuildings on Pyes Creek Road (Lot 14, DP751498) have been listed as having local heritage significance. It is noted, however, that this specific site is located outside of the 100 metre buffer placed around the route options and is therefore unlikely to be impacted by any of the route options considered.

5.3.2.2 Previous studies

Halliday (1988) reported that John Oxley was the first explorer to travel through the New England area, while travelling to Port Macquarie in 1818. Previous studies also note that Allan Cunningham was the first to have approached within 15 miles of modern day Tenterfield after discovering Darling Downs in 1827. In 1840, the Ogilvie brothers travelled through the area on their return journey to the Hunter River (Baldwin, n.d.). In 1893, Deepwater Station, to the south-west of the study area, was acquired. Archibald and Charles Windeyer were the original owners of Deepwater Station. William Collin, who later became Deepwater Station manager, took up the land for the Windeyer brothers in 1939 (Halliday, 1988).

The first recorded use of the Bolivia name was in 1840 when a South American squatter took up land between Deepwater and Tenterfield (NPWS, 2011). In 1843, Edward Irby took over Bolivia Station and utilised it for sheep and cattle (Halliday, 1988). A part of the study area encompasses the southern corner of Bolivia Station.

The Main Northern Railway Line, which runs through the south-eastern portion of the study area, was the original rail transport route between Sydney and Brisbane, primarily constructed by the Hunter River Railway Company (Halliday, 2004). It was the Cobb and Co. coaching company, however, which won the railway construction contract between Glen Innes and Tenterfield. Work began in 1884, however in the same year work between Deepwater and Tenterfield ceased due to strike action by the navvies due to a reduction in their wages. In 1884, work was delayed again as several thousand sleepers, along with other timber used in the construction of culverts and bridges were condemned. The railway line was eventually extended through Bolivia Hill and up to Tenterfield in 1886 (Halliday, 2004).

The development of the Main Northern Railway Line improved transport to the New England region. Where there had previously been more than 500 teams working the road between the tablelands and the coast, the railway line meant that these teams were significantly reduced and the speed and efficiency of transport was

greatly improved. The construction of the railway also saw the development of several new towns including Bolivia, Sandy Flat, Bungulla and Bluff Rock (Halliday, 2004).

The village at Bolivia Hill was on the western side of the railway line and extended along the gully at the foot of Bolivia Hill. The main road from Glen Innes to Tenterfield ran through the township and over the hill. Within the town were a number of businesses and services, including two hotels, two bakeries, two butchers shops, two general stores, two produce stores, two tobacconists, a barber, saddler, boot maker and a number of boarding houses. As the township became quite large, and probably also due to the bushrangers in the area, a police reserve was approved within the township. As many of the railway workers had brought their families to live in the town at Bolivia Hill it also became necessary for a school in the township, and a second school was established at Horseshoe Bend. Other features of the township included brickyards (on Bolivia Station near the highway) and a telegraph line. The Armidale to Tenterfield telegraph line ran near the railway.

Travelling Stock Routes (TSR) and Travelling Stock and Camping Reserves (TS&CR) were developed as wide pathways for the movement of stock from one place to another, often with wide verges for stock to graze. Many TSRs have fenced areas for camping with watering facilities for stock to drink (Smiles *et al*., 2011). It is thought that most TSRs were developed from Aboriginal travelling routes and that the camping reserves were originally Aboriginal camping grounds. Aboriginal travel routes connected food and water and the routes were along the least difficult terrain avoiding natural obstacles (Smiles *et al*., 2011). In many cases, a road for travellers passed down the middle of TSRs. Inns were positioned along TSRs catering for travellers, most of which have disappeared but some still survive, such as the Bolivia Inn on the New England Highway, which later operated as a boarding house and a post office (Halliday, 2004).

Three TSRs have been gazetted running through the centre of the study area:

- TSR 370 - Notified on the 8 January 1875 and extension Notified 8 May 1882
- TSR. 22252 - Notified 23 February 1895
- TS & CR 22242 - Notified 23 Feb 1895.

TSR 370 was replaced by TSR 22252. Both TSR 22252 and TS & CR 22242 are still current and are under the control of the rural lands board (pers. comm., Armidale Lands Office).

The Crown plan for TSR 22252 and TS & CR 22242 was surveyed on the 4 November 1898 and shows the TSR western boundary and the eastern boundary as the railway (Rhode, 1898). Only the northern end of the plan includes part of the study area, but it is quite clear that the area that was once the Bolivia Township by 1898 had become a camping ground TS & CR 22242 along the TSR.

TSRs were heavily used up until the late 1940s but with a series of wet years and the rise of motor transport, their usage began to decline. Recent years of drought have resulted in a rise in the usage of TSRs as they provide a place to graze and access to drinking water (Smiles *et al*., 2011).

The first main road through Bolivia Hill was an old bullock track known as Centre Ridge. The track was to the west of the current New England Highway and followed a steep spur in a direct route over the Bolivia Range. The route is used by the current Brisbane to Sydney telegraph line, and parts of the road are still visible today (Schiffmann *et al.,* 1988). The next road to be used was known locally as the Bullock Track and was located to the west of Centre Ridge Road. The Bullock Track was in use for about 40 years over which time improvements were carried out on the road. This road ran along the path of the TSR, and where both these roads met and became one road, is where the township of Bolivia was established. Both these roads were part of the Great Northern Road, which linked Sydney with Brisbane over the New England Tablelands.

In August 1928 the NSW main road system was reorganised and the Great Northern Road was gazetted as part of State Highway 9, it was renamed State Highway 9, the Great Northern Highway in May 1929. State Highway 9 stretched from Sydney to Tenterfield. On the 24 Mar 1933 State Highway 9 was renamed the New England Highway (Ozroads, 2013).

5.3.2.3 Non-Aboriginal heritage predictive model

The Tenterfield and District Historical Society provided very useful information on the following heritage items within the study area:

- Jackson's house site, Pye Creek Road – built by Bolivia Station in the 1910s and relocated in the 1980s
- The Public Watering Point / TSR adjacent to the current highway
- Quin Chee's Market Garden – established in the 1880s by a Chinese gardener named Quin Chee, who transported produce to Tenterfield on a horse and buggy
- Silver / lead mining and the presence of huts in the area
- Brickyard Creek, where clay was sourced for the Railway to make bricks
- A Cobb & Co track across Bolivia Hill
- A railway camp on the Horseshoe Bend
- Various memorials along the highway.

This information, along with the historical accounts, was used to scope the field survey. In addition, members of the Historical Society attended the field survey to assist in locating sites of heritage significance.

5.3.2.4 Non-Aboriginal heritage survey findings

The non-Aboriginal heritage survey was conducted in January 2013. A total of 14 non-Aboriginal heritage items were identified during the field survey (**Table 5-6** and **Figure 5-11**). Eleven of these sites are located within the study area. It should be noted that Sites 3, 11 & 13 are located outside the study area boundary.

An additional 11 sites were identified through detailed historical research following the completion of the field survey (**Table 5-7** and **Figure 5-12**). All of these sites are likely to be located within the study area, although further field survey would be required to confirm their locations.

Table 5-6 Summary of non-Aboriginal heritage sites located during the field survey

Site ID	Site name	Description	Condition / Integrity	Located within study area?
1	Angel memorial	Angel statue with bronze plaque.	Average	Y
2	Jackson's homestead site	Former homestead site. Two corrugated iron water tanks on timber stumps. Stone rubble and brick platform. A small 2m square concrete pad for former shed. Corrugated iron.	Average	Y
3	Drill holes in bullock track	Evidence of blasting in the1950s as preparation to use as a deviation road.	Average	N
4	Harry and Lenny memorial	Harry and Lenny written in white paint on rock face. Flowers in small vases attached to post and wire fence above rock face.	Average	Y
5	Hut remains	Corrugated iron collapsed roof above timber supports. Small pile of clay bricks 1m south of iron. Likely to be chimney remains. Structure appears to be a former timber hut.	Poor	Y
6	Johnson memorial	Two wooden crosses. One painted yellow one brown. Both for Graham Johnson our gentle giant 6-10-87 18-01-09.	Average	Y
7	Mine shaft	Rubble stone pile used to fill mine shaft. Site dimension is $2m^2$.	Average	Y
8	Former bridge	Concrete blocks noted on edge of rock face. Disturbed by later rubble retaining wall added to new bridge. No other remains evident.	Poor	Y

Site ID	Site name	Description	Condition / Integrity	Located within study area?
9	Quarry	Quarry in eroded area.	Average	Y
10	Quin Chee's market garden and well	Cleared area near creek and circular depression.	Poor	N
11	Stone rubble creek crossing	Large angular stones imported to form level creek crossing.	Average	Y
12	Timber creek crossing	Small crossing constructed of machine cut timber logs laid directly on ground.	Average	N
13	Timber bridge	Small timber bridge. Built on concrete and rubble approaches. Reinforced using large timber beams with timber decking.	Average	N
14	Telegraph line remains	Remains of 12 telegraph poles on the western side of the current highway alignment.	Poor	Y

Table 5-7 Summary of non-Aboriginal heritage sites located during historical research

Site ID	Site name	Description	Condition / Integrity	Located within study area?
15	Former Bolivia township	Crown Plans for Portions 2A, 5A, 6A-10A, 4A, and 3A.	Unknown	Y
16	Former house site	Crown Plan of Portion 105-107.	Unknown	Y
17	Brickyards	Crown Plan of Portion 12A-15A and Portion 113.	Unknown	Y
18	Culvert	Crown Plan of Portion 12A.	Unknown	Y
19	Police reserve	Crown Plan of Portion 112.	Unknown	Y
20	Former public school site and reserve	Crown Plan of Portion 116 and 117.	Unknown	Y
21	Travelling stock routes (two)	1905 Parish Map.	Unknown	Y
22	Bullock Track (west of current highway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
23	Former Road (current highway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
24	Former Road (adjacent to railway)	Crown Plan of Portion 2A, 5A and 6A-10A and CP4921-1603.	Unknown	Y
25	Telegraph line	1905 Parish Map & Crown Plan 4921-1603.	Unknown	Y

Detailed site descriptions are provided in Niche (2013b; **Appendix G**).

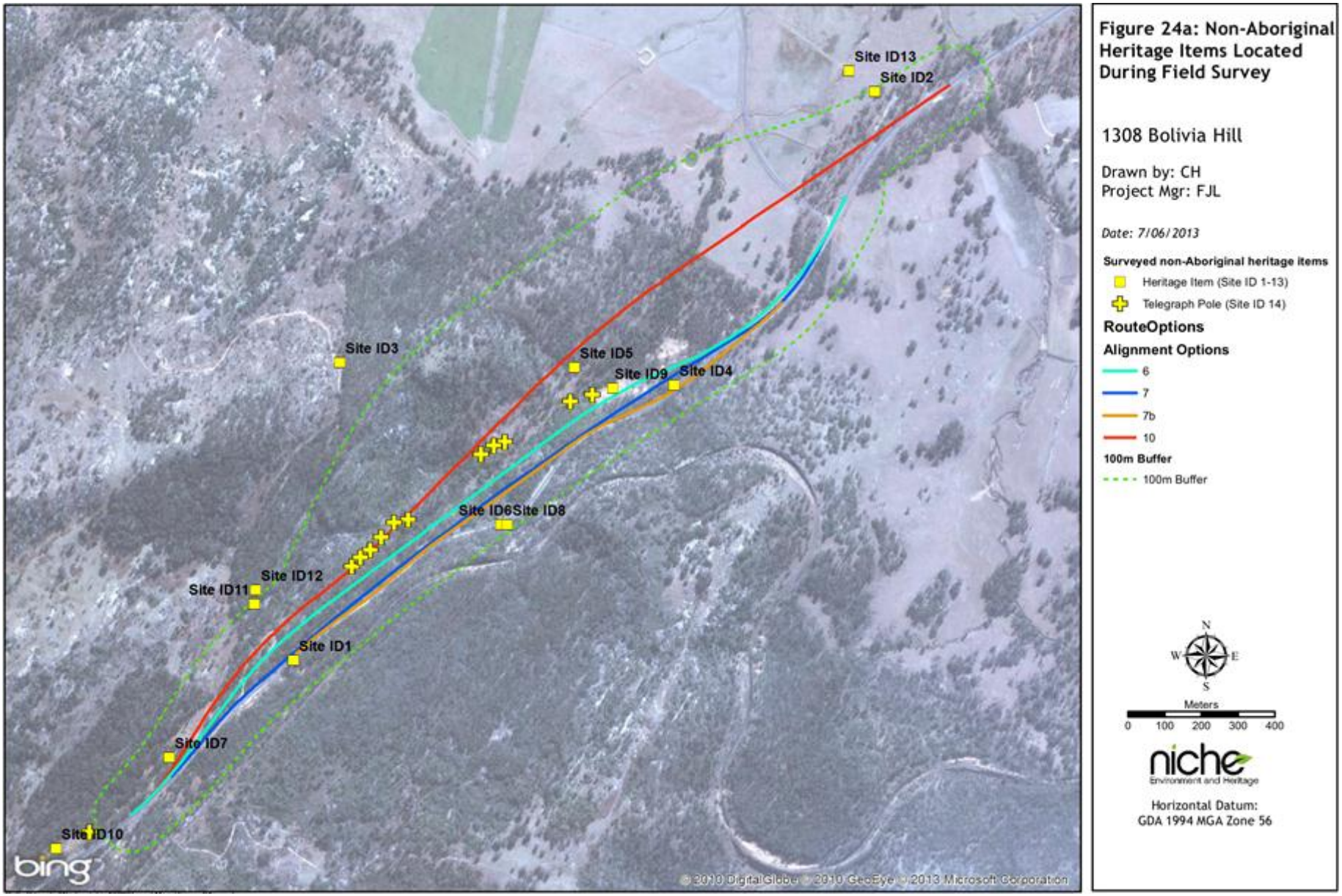


Figure 5-11 Non-Aboriginal heritage items located during the field survey

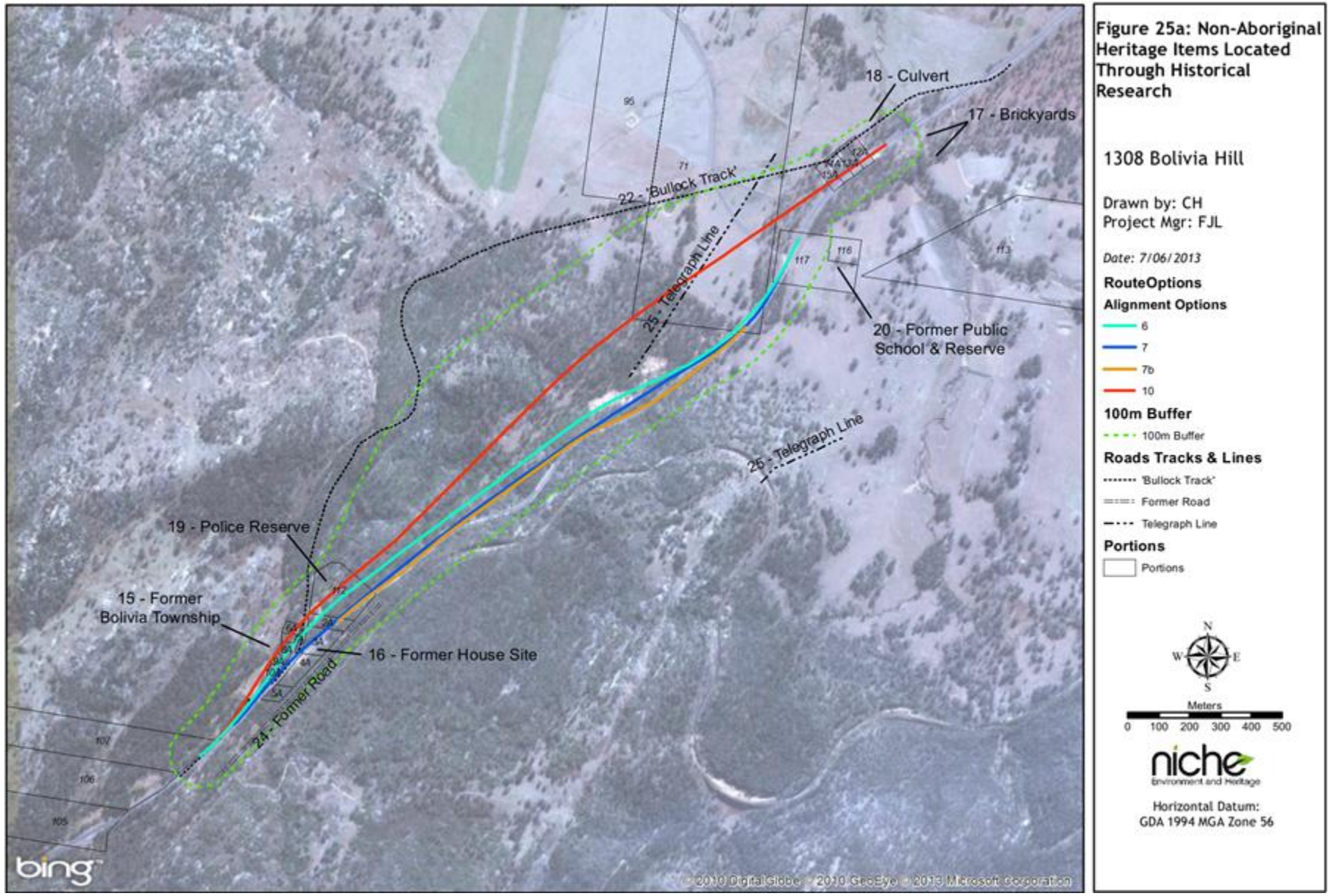


Figure 5-12 Non-Aboriginal heritage items located through historical research

5.3.2.5 Summary of non-Aboriginal heritage significance

An assessment of the scientific values and significance of the sites against the criteria provided in the *NSW Heritage Manual* (including the *Assessing Heritage Significance* Guideline) (DUAP, 1996).

These guidelines incorporate the aspects of cultural heritage value identified in the Burra Charter into a framework currently accepted by the NSW Heritage Council:

(a) An item is important in the course, or pattern, or NSW's cultural or natural history (or the cultural or natural history of the local area)

(b) An item has strong or special associations with the life or works of a person, or group of persons, of importance in the cultural or natural history of NSW (or the cultural and natural history of the local area)

(c) An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievements in NSW (or the local area)

(d) An item has a strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons

(e) An item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area)

(f) An item possess uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area)

(g) An item is important in demonstrating the principal characteristics of a class of NSW's:

- Cultural or natural places, or
- Cultural or natural environments (or a class of the local areas), or
- Cultural or natural places, or
- Cultural or natural environments.

Table 5-8 provides a preliminary significance assessment for the 20 heritage items located within the study area. Given that many of the sites have not been evaluated in the field, this assessment should be considered a preliminary guide only at this stage.

Table 5-8 Preliminary assessment of historic heritage significance

Site ID	Site name	Likely to satisfy the following criteria:	Likely level of significance
1	Angel memorial	(a), (d)	Local
2	Jackson's homestead site	(a), (e)	Local
4	Harry and Lenny memorial	(a), (d)	Local
5	Hut remains	(a)	Local
6	Johnson memorial	(a), (d)	Local
7	Mine shaft	(a)	Local
8	Former bridge	(a)	Local
9	Quarry	(a)	Nil
11	Stone rubble creek crossing	(a)	Local
12	Timber creek crossing	(a), (e)	Local
14/25	Telegraph line	(a)	Local
15	Former Bolivia township	(a), (b), (d), (e), (f), (g)	State and/or local
16	Former house site	(a), (e)	Local

Site ID	Site name	Likely to satisfy the following criteria:	Likely level of significance
17	Brickyards	(a), (b), (e), (f), (g)	Local
18	Culvert	(a)	Local
19	Police reserve	(a)	Local
20	Former public school site and reserve	(a)	Local
21	Travelling stock routes (two)	(a), (b)	Local
22	Bullock Track (west of current highway)	(a)	Local
23	Former Road (current highway)	(a)	Nil

Given its history of occupation and use, heritage items identified within the study area are generally considered locally significant for their historical heritage values, associative values, representative values, research potential and/or rarity. A wide range of items have been identified through field survey and detailed historical research. Further archaeological survey and investigation of the c1883 Bolivia township, former house site, police reserve, public school reserve, brickworks and culvert, however, would be required to determine their extent, condition and research potential. If substantially intact archaeological remains of Bolivia town have survived, they may be significant at a state level and careful management of the site and its heritage values would be required.

5.3.3 Demographics and social-economic profiles

An assessment of socio-economic profile of the study and potential impacts associated with the route selection and design process was conducted by Macroplan (2012) (**Appendix H**).

The location of the proposed upgrade is relatively isolated from existing townships and communities. The closest townships to the upgrade are Glen Innes (55 kilometres south) and Tenterfield (35 kilometres north). The proposal is, however, a part of a series of upgrades for the New England Highway with planning works initially focusing on a new bypass of Tenterfield and improvements to the Bolivia Hill stretch of road.

The LGAs of Glen Innes and Tenterfield are the most significant townships in proximity to Bolivia. The data in **Table 5-9** is for the State Suburb of Sandy Flats, which is the only information set from the 2011 Census that incorporates Bolivia.

Table 5-9 Census 2011 community profile data for Sandy Flat

Population by Age		Employment by Industry	
Age Cohort	2011	Industry	2011 Census
0-4	15	Agriculture, forestry and fishing	37
5-14	25	Construction	7
15-19	6	Manufacturing	6
20-24	11	Health care and social assistance	3
25-34	18	Other services	3
35-44	24	Inadequately described/Not stated	3
45-54	33	**Total**	**59**
55-64	36	**Median Age**	**48**
65-74	27	**Median Household Income ($/week)**	**670**
75-84	10		
85+	6		
Total	**211**	Note: Bolivia is included within the State Suburb of Sandy Flat.	

Source: Census 2011 Basic Community Profile, MacroPlan Dimasi

Analysis of Census 2011 Community Profile data indicates that the Glen Innes LGA has registered a decline in population over the most recent census period, between 2006 and 2011. Despite this decline, an outright increase in the LGAs population was experienced over the 10 years to 2011. The resident population in Tenterfield LGA has expanded at a faster rate than Glen Innes – albeit marginally over the three Census periods (ten years) to 2011. However, consistent in both regions has been a reduction in younger residents (ie between the ages of 0-19 years). This has accentuated 'ageing' within the region and signifies a lack of job opportunities for younger people.

In its current state, road safety at Bolivia Hill is poor. Narrow road corridors and uneven/unsafe road surfaces present an unsafe passage for vehicles. According to an RMS study, the New England Highway has been identified as the third most dangerous highway in NSW. Over the two years to 2010 the New England Highway registered approximately 12 fatalities and 135 total motor accidents. Over the decade to 2012, the Bolivia Hill section of the road was responsible for 13 crashes, resulting in four fatalities.

Improving the safety of Bolivia Hill will lead to improved safety conditions and travel efficiencies for vehicles travelling along this section of the New England Highway. Improved travel efficiency will increase vehicle flow and potentially increase usage along this route. Increased commercial vehicle usage can potentially be a catalyst for new and expanded business activity and thus employment in Glen Innes, Tenterfield and in regions served by the New England Highway.

It is expected that improvements to, and increased usage of the New England Highway would have potential to benefit business activity and local trade within the region. Those sectors of the economy that may potentially benefit from the upgrade works are retail, accommodation, food services and tourism sectors, which in turn will provide positive flow-on effects to other local industries. Overall, increased expenditure will support employment growth and output in the region.

As well as economic benefits, the upgrade also has potential to generate social benefits in the region. Improved employment prospects and new business growth will decrease the rate at which young residents are leaving the region and up-skill the existing local workforce. This in turn can promote investment in other sectors such as education and health.

Overall, having regard for the social and economic fabric of the region that the upgrade will serve and the broader set of road works that constitute the overall New England Highway upgrade, several potential economic, social and environmental benefits associated with the project have been identified:

- Improving the safety of the New England Highway and encouraging inland travel via the New England Highway
- Minimising congestion along this passage of roadway and improving the safety of travel
- Stimulation of the local economy – business and industry will benefit from the works. The improved road will provide a wider employment base for local residents particularly for younger residents
- Increased visitation and support for tourism and retail based employment.

Possible 'costs' associated with the Bolivia Hill upgrade project are limited, provided that the project is delivered within normal RMS budget constraints and therefore represents 'value for money' construction. Note that environmental costs will be separately assessed but it is expected that, given the relatively small scale of the project, these will either be minimal or can be addressed by construction techniques.

5.3.4 Visual amenity

The study area and its immediate surrounds are considered to have moderate visual significance by virtue of:

- Their visibility above the surrounding landscape
- The rugged, natural form of the landscape, comprising rocky outcrops, indigenous bushland and some natural creeklines
- The existence of visible physical evidence of the European heritage of the locality, specifically the remaining Main Northern Railway line
- The availability of opportunities for regional views from the study area.