UPGRADING THE PACIFIC HIGHWAY

Woolgoolga to Ballina Planning Alliance

UPGRADING THE PACIFIC HIGHWAY

Woolgoolga to Ballina Upgrade

Supplementary Biodiversity Assessment

FINAL

November 2013

NSW GOVERNMENT Transport Roads & Maritime Services

aurecon

SINCLAIR KNIGHT MERZ SKM

Contents

Table of figures

5. Supplementary surveys

This chapter outlines the supplementary surveys undertaken as a result of the critical review. These supplementary surveys were for:

- Threatened ecological communities (particularly listed rainforest communities) (refer to section 5.1).
- Threatened rainforest flora (refer to section 5.2).
- Threatened (non-rainforest) flora (particularly cryptic species) (refer to section 5.3).
- Pink Underwing Moth (refer to section 5.4).
- Koala (refer to section 5.5).
- Giant Barred Frog (refer to section 5.6).
- Oxleyan Pygmy Perch (refer to section 5.7).

The survey effort and results are detailed in the following sections.

5.1. Threatened ecological communities

This section documents the additional surveys undertaken of Lowland Rainforest communities, Littoral Rainforest communities, and other ecological communities.

5.1.1. Lowland Rainforest communities

5.1.1.1. Background

Further surveys were required to classify Lowland Rainforest patches into TSC Act listed or EPBC Act listed communities. This requirement was identified during the preparation of the EIS and additional surveys were undertaken at that stage. Nevertheless, the critical review identified that further survey was required.

The critically endangered Lowland Rainforest of Subtropical Australia was listed under the EPBC Act in November 2011. A methodology of identification and condition thresholds to be applied in the field were also made public at this time (Threatened Species Scientific Committee, 2011ba). Earlier surveys undertaken during the preferred route studies were not conducted using this field-based method. Instead, rainforest areas were assessed as the NSW TSC Act listed endangered ecological community of Lowland Rainforest on Coastal Floodplains.

The condition thresholds for identifying the critically endangered Lowland Rainforest of Subtropical Australia community listed under the EPBC Act focus on identifying patches that have greater functionality and are in high ecological condition. Condition thresholds and key diagnostic features have been specified in listing advice provided under the EPBC Act to help identify patches of the critically endangered community. The listing advice specifies the key diagnostic features of the community as:

- Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions, according to Interim Biogeographic Regionalisation for Australia (IBRA) version 6.1 (2004).
- The ecological community occurs on soils derived from basalt or alluvium, enriched rhyolitic soils, or basaltically enriched metasediments.
- The ecological community generally occurs at an altitude of less than 300 metres above sea level.

- The ecological community typically occurs in areas with high annual rainfall (greater than 1300 millimetres).
- The ecological community is typically more than two kilometres inland from the coast.
- The structure of the ecological community is typically a tall (20 metres to 30 metres) closed forest, often with multiple canopy layers.
- Patches of the ecological community typically have high species richness, including at least 30 woody species listed in Appendix A of the EPBC Act Lowland Rainforest of Subtropical Australia listing advice.

Table 5-1 Summary of EPBC Act threshold criteria for Lowland Rainforest of Subtropical Australia

Patch Type	A	B	C
(evidence of remnant vegetation and regeneration status)	Natural remnant evident by the persistence of mature residual trees from Appendix B of the EPBC Act Lowland Rainforest of Subtropical Australia listing advice	Some residual trees from Appendix B are present plus evidence of either; natural regeneration *1 AND/OR regeneration with active management *2	A non-remnant patch that has recovered through a) natural regeneration*1 AND/OR b) supplementary planting that has stature and quality that is reflective of the "Description" *3
	AND	AND	AND
Patch Size (excludes buffer zone)	≥ 0.1 ha	≥ 1 ha	≥ 2 ha
	AND	AND	AND
Canopy Cover (over entire patch)*4	Emergent/canopy/subcanopy*4 cover is ≥ 70%		
	AND		
Species Richness (over entire patch)	contains ≥ 40 native woody species*5 from Appendix A	contains ≥ 30 native woody species *5 from Appendix A	
	AND	AND	
Percent of total vegetation cover that is native *6 (use sample plot)	≥70% of vegetation *6 is native	≥50% of vegetation *6 is native	

Notes:

*1 Evidence of natural regeneration is shown by the presence of seedlings of a range of native species that did not originate through deliberate plantings.

*2 A patch that is actively managed has regular (eg every 1–2 years) on the ground human regenerative activity such as weed control or supplementary plantings.

*3 Closed canopy, 20–30 m tall, of representative species (eg white booyong, hoop pine, figs, brush box, yellow carabeen, red cedar, rosewood, white beech)

*4 Canopy cover (projective foliage cover) is estimated over the entire patch. When assessing the ecological community, the canopy includes the emergents and subcanopy (everything above 10 m tall). Canopy/sub-canopy includes all trees and vines (native and non-native).

*5 Woody species are trees, shrubs or vines that contain wood or wood fibres that consist mainly of hard lignified tissues. Excluded from woody species are graminoids, other herbs and non-woody vines.

*6 Total vegetation cover includes emergents/canopy/subcanopy and understorey and ground layers.

5.1.1.2. Supplementary survey

Spatial data was used to identify the patches of rainforest vegetation in the project area for the supplementary investigation. Those rainforest patches that were previously surveyed using the field-based method were excluded. This review identified some floodplain rainforest community patches in sections 1 and 3 that were not assessed using the field-based method. Some Lowland Rainforest patches in Section 10 that had not previously been accessed were also identified.

These rainforest patches were subsequently visited between 29 January to 15 February 2013 to apply the field-based method. The survey locations are mapped in Figure 5-1 for Section 1, Figure 5-2 for Section 3 and Figure 5-3 for Section 10 of the project.

Targeted surveys involved a plot-based field assessment to record native plant species richness, canopy cover and weed abundance. The number of plots completed was dependent on patch size. The plots are shown in Figure 5-3. While the survey was concentrated within the project boundary, it also extended up to 400 metres from the project boundary, as far as property access allowed. This provided a broader landscape assessment of the distribution and condition of this community and a means of assessing the magnitude of the impacts and the potential for possible offsets.

Field data were collected using a personal digital assistant (PDA—an electronic handheld information device) with global positioning system (GPS) capability to fix the site positions. Data were recorded using ArcPad™ v. 10.0 (ESRI®) loaded with relevant geographic information system (GIS) layers, high resolution aerial imagery and project footprint projection areas.

5.1.1.3. Results

The results of the targeted surveys for the Lowland Rainforest of Subtropical Australia community confirmed the findings of the EIS that this critically endangered community is restricted to sections 10 and 11. Other rainforest patches surveyed in sections 1 and 3 (refer to Figure 5-1 and Figure 5-2) were not consistent with the criteria for field identification provided under the EPBC Act. These patches of lowland rainforest were found to not meet the condition requirements as they have a lower floristic diversity and soil fertility. However, these patches are still listed under the TSC Act threatened ecological community Lowland Rainforest on Coastal Floodplains.

A total of 81.4 hectares of Lowland Rainforest (TSC Act listed) has been identified in the study area from targeted surveys up to 400 metres from the project boundary. The EIS assessment noted that the project would have an directly clear 10.3 hectares of Lowland Rainforest that would fit the criteria for listing on the TSC Act. Of these 10.3 hectares, 5.8 hectares would also fit the criteria for a critically endangered ecological community listing on the EPBC Act. These 5.8 hectares are found in six patches.

As a consequence of the additional survey (as well as the design refinement at Wardell interchange), the impact assessment for Lowland Rainforest communities has been revised from that provided in the EIS. This impact assessment is provided in Chapter 6.

The extent of the canopy of the Lowland Rainforest community that adjoins the project boundary in sections 10 and 11 was determined on-ground using trigostandard survey equipment and incorporated into the spatial database. The distribution and extent of this community is shown on Figure 5-3.

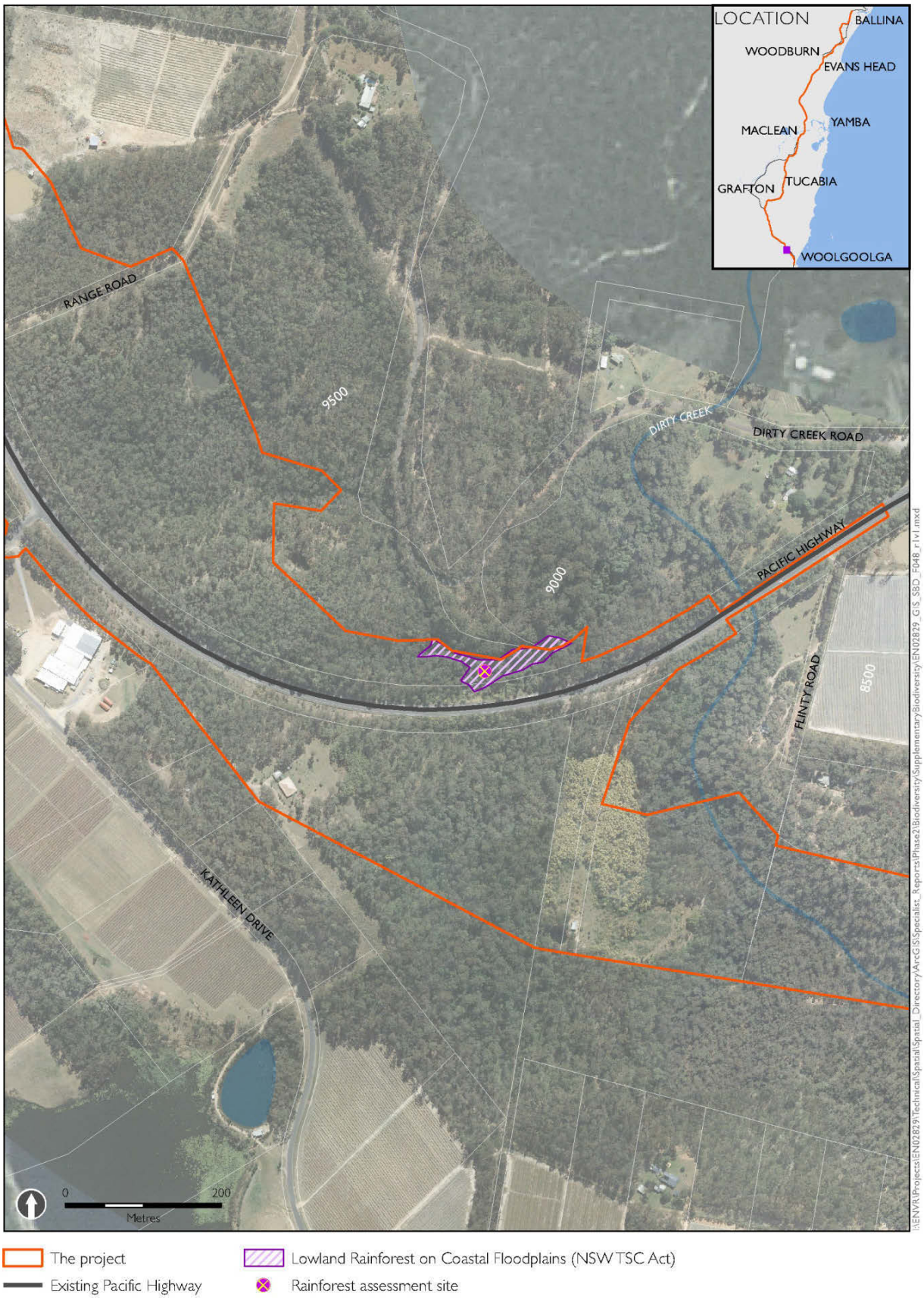

Figure 5-1 Location of assessed Lowland Rainforest patches – Section 1

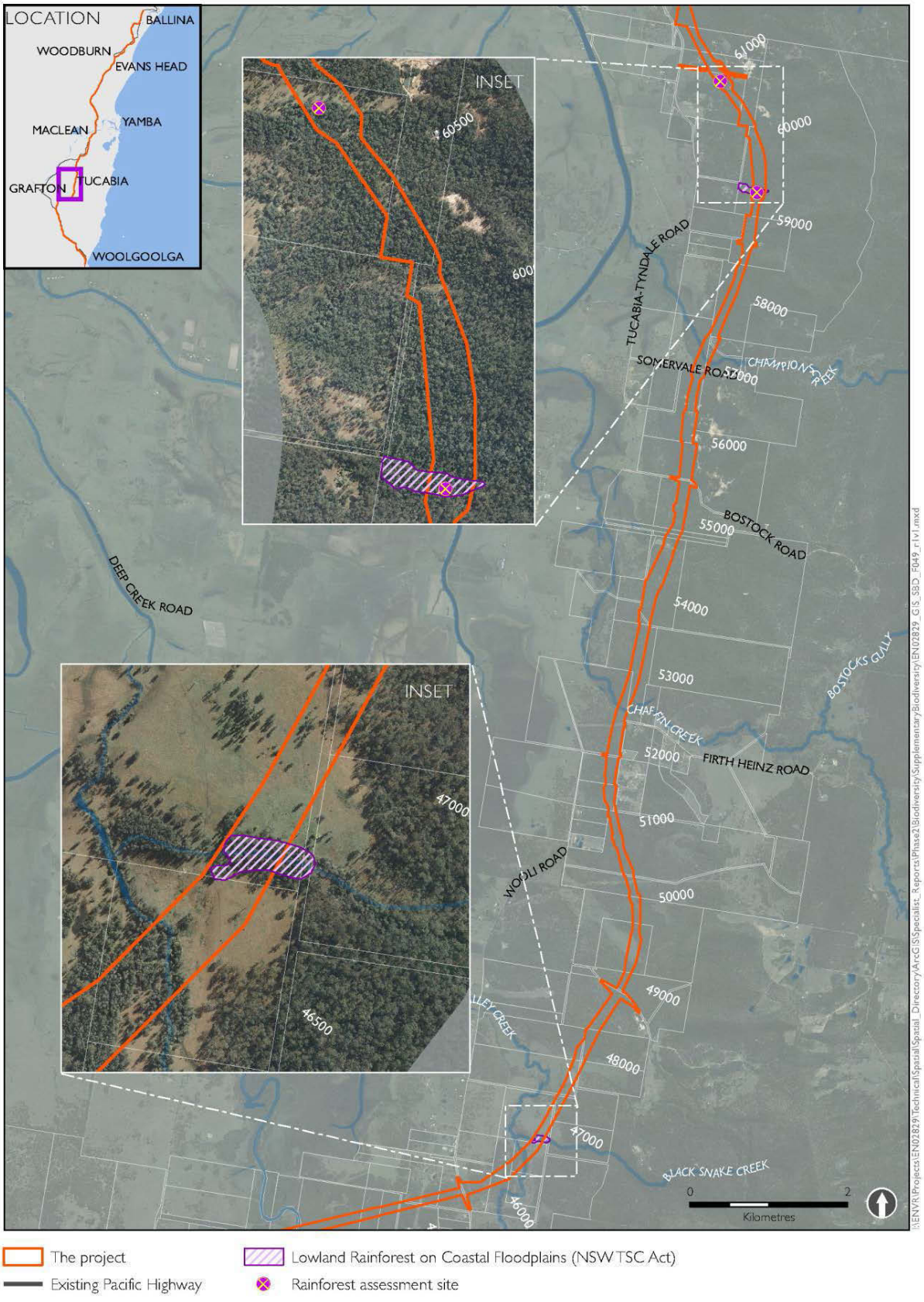

Figure 5-2 Location of assessed Lowland Rainforest patches – Section 3

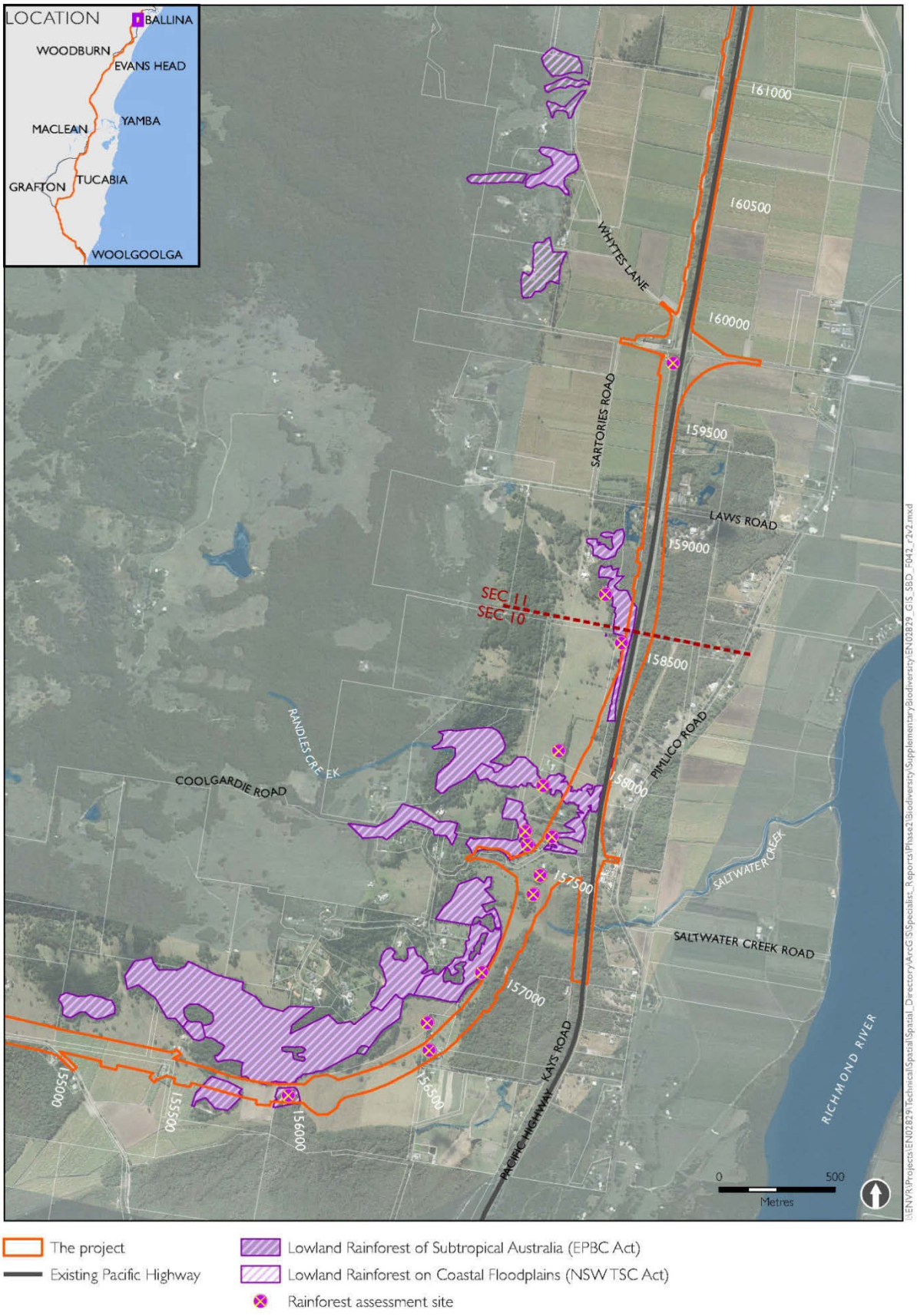

Figure 5-3 Location of assessed Lowland Rainforest patches – Section 10 and 11

5.1.2. Littoral rainforest communities

5.1.2.1. Background

Further surveys were required to classify Littoral Rainforest and Coastal Vine Thickets on Eastern Australia (listed under the TSC Act and EPBC Act) from Lowland Rainforest patches. A methodology of identification and condition thresholds to be applied in the field was also made public at this time (Threatened Species Scientific Committee, 2008afi).

The listed Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community is classified as critically endangered under the EPBC Act. It comprises those patches that meet all three condition thresholds described by the Threatened Species Scientific Committee, (2008afi). These are as follows:

- Small patches can be resilient and viable, but the minimum size of a patch needs to be 0.1 hectare.
- The cover of transformer weed species is 70 per cent or less. (Transformer weeds are highly invasive taxa with the potential to seriously alter the structure and function of the ecological community. This threshold recognises the relative resilience and recoverability of the ecological community to invasion by weed species.)
- The patch must have:
- At least 25 per cent of the native plant species diversity characteristic of this ecological community in that bioregion or
- At least 30 per cent canopy cover of one rainforest canopy (either tree or shrub) species, excluding Banksia and Eucalyptus species that may be part of the ecological community).

During surveys for Lowland Rainforest and during those undertaken for the assessment of the interchange at Wardell design refinement, a number of patches of Littoral Rainforest of Coastal Vine Thickets of Eastern Australia were identified as fitting these condition thresholds. As result, further more targeted surveys were undertaken for the Littoral Rainforest community patches within and outside of the project boundary in project sections 9 to 11 on relict sand dunes.

Littoral rainforest is mostly associated with the edges of marine environments, and occurs on sand dunes and soil derived from underlying rocks on headlands. Proximity to the ocean and associated wind shearing have a major influence on canopy structure and height. This community may also be present on relict sand dunes remote from substantial maritime influences, such as the areas of littoral rainforest within the project boundary. Maritime influences such as salt spray and wind shear are absent within the project boundary.

5.1.2.2. Supplementary surveys

Targeted surveys for this vegetation community involved a plot-based field assessment to record native plant species richness, canopy cover and weed abundance, as well as physical characteristics such as soil type and landscape position. The survey was concentrated within the project boundary but also extended beyond the boundary (substantially in a number of places) where property access was allowed. This provided a broader landscape assessment of the distribution and condition of this community and a means of assessing the magnitude of the impacts.

Field data were collected using a personal digital assistant (PDA—an electronic handheld information device) with global positioning system (GPS) capability to fix the site positions. Data were recorded using ArcPad™ v. 10.0 (ESRI®) loaded with relevant geographic information system (GIS) layers, high resolution aerial imagery and project footprint projection areas.

5.1.2.3. Results

Five patches of littoral rainforest were identified in sections 9, 10 and 11 within and adjoining the project boundary. These included several small patches surrounding Coolgardie Road in Section 10, a small patch within the existing road corridor in Section 11, and a large patch adjacent to the eastern side of the project in Section 9 in the Broadwater National Park. Two small patches of littoral rainforest were identified inside the boundary (refer to Figure 5-4) within sections 10 and 11 consistent with EPBC Act listed Littoral Rainforests of Coastal Vine Thickets of Eastern Australia. This community has been identified based on the dominant flora species and the soil type (quaternary sands).

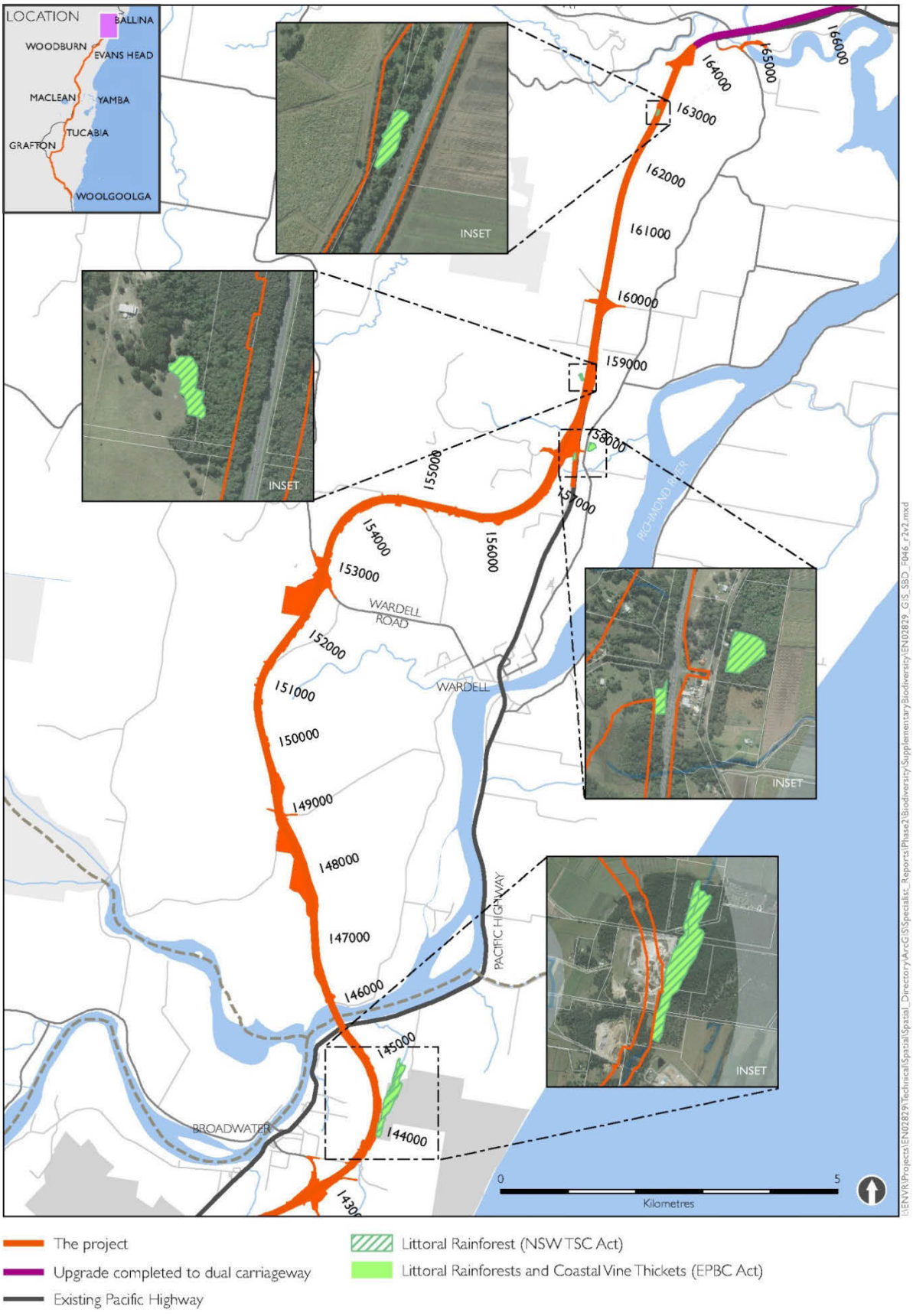

Figure 5-4 Littoral Rainforest patches – Section 9 and 11

5.1.3. Other ecological communities

5.1.3.1. Background

The critical review identified spatial gaps in project sections 1 and 2 in relation to the extent of mapping for some vegetation community areas and vegetation types. Lowland vegetation types, such as moist floodplain forests and riparian forests, were identified from the spatial data (using GIS) and assessed against survey effort to determine if further studies were required. A further survey was undertaken to ground-truth vegetation communities in selected areas across the project corridor as part of the supplementary threatened flora surveys (refer to Table 5-6).

5.1.3.2. Supplementary surveys

Supplementary flora and vegetation survey sites were identified from spatial data including aerial photography, topography and existing vegetation mapping. Particular focus was given to further delineating edges of threatened ecological communities, including Lowland Rainforest (refer to Section 5.1.1) and Coastal Cypress Pine Forest. Targeted surveys were conducted between 29 January and 15 February 2013. The areas surveyed are listed in Table 5-6 and mapped in Figure 5-5 to Figure 5-16.

The survey involved random meanders, with vegetation communities identified in the field by dominant canopy and understorey species, landscape position and soil types. This involved a re-survey of some vegetation communities identified in the EIS to provide updated information on their distribution and abundance. Delineation of vegetation community boundaries was undertaken using a mix of field survey data, topography and aerial photography interpretation.

Field data were collected using a personal digital assistant (PDA—an electronic handheld information device) with global positioning system (GPS) capability to fix the site positions. Data were recorded using ArcPad™ v. 10.0 (ESRI®) loaded with relevant geographic information system (GIS) layers, high resolution aerial imagery and project footprint projection areas.

5.1.3.3. Results

Ground-truthing of vegetation communities has led to the revision of information on the extent of communities and the overall impacts on habitats and vegetation. The results of the ground-truthing are provided in Table 5-2 (all communities) and Table 6-1 of Chapter 6 (threatened ecological communities) and mapped in Figure 5-5 to Figure 5-16.

An important finding is that the extent of the endangered Coastal Cypress Pine Forest of the North Coast Bioregion (listed under TSC Act) is substantially less than originally identified, with the majority of this community more closely aligned to Coastal Heath on Sands of the North Coast vegetation community. The extent of floodplain communities is also less than originally identified, as these communities were originally mapped in non-floodplain areas in some locations. Updated floodplain and elevation data has aided the delineation of these communities from non-floodplain vegetation.

The adjusted area of each BioMetric Vegetation Type that would be impacted by the project is provided in Table 5-2. These areas are based on the latest footprint, including design refinements, and the latest vegetation data (including data from the supplementary surveys).

Table 5-2 Direct loss to vegetation community types by project*

BioMetric vegetation association	EIS - direct loss (ha)	Revised - direct loss (ha)
Black Bean - Weeping Lilly Pilly Riparian Rainforest of the North Coast	1.4	1.7
Blackbutt - Bloodwood Dry Heathy Open Forest on Sandstones of the Northern North Coast	79.7	93.6
Blackbutt Grassy Open Forest of the Lower Clarence Valley of the North Coast	46.2	37.6
Coast Cypress Pine Shrubby Open Forest of the North Coast Bioregion	27.4	3.3
Coastal Floodplain Sedgelands, Rushlands, and Forblands	3.0	5.1
Coastal Heath on Sands of the North Coast	0.2	14.9
Flooded Gum - Tallowwood - Brush Box Moist Open Forest of the Coastal Ranges of the North Coast	2.0	1.4
Forest Red Gum - Swamp Box of the Clarence Valley Lowlands of the North Coast	73.9	53.7
Grey Gum - Grey Ironbark Open Forest of the Clarence Lowlands of the North Coast	48.2	69.5
Hoop Pine - Yellow Tulipwood Dry Rainforest of the North Coast	0.5	0.0
Mangrove - Grey Mangrove Low Closed Forest of the NSW Coastal Bioregions	1.5	5.8
Narrow-Leaved Red Gum Woodlands of the Lowlands of the North Coast	34.7	21.2
Needlebark Stringybark - Red Bloodwood Heathy Woodland on Sandstones of the Lower Clarence of the North Coast	58.2	58.6
Orange Gum (Eucalyptus bancroftii) Open Forest of the North Coast	11.5	5.6
Paperbark Swamp Forest of the Coastal Lowlands of the North Coast	49.5	64.5
Red Mahogany Open Forest of the Coastal Lowlands of the North Coast	46.2	42.0
Scribbly Gum - Needlebark Stringybark Heathy Open Forest of Coastal Lowlands of the Northern North Coast	71.9	66.2
Spotted Gum - Grey Box - Grey Ironbark Dry Open Forest of the Clarence Valley Lowlands of the North Coast	2.1	2.1
Spotted Gum - Grey Ironbark - Pink Bloodwood Open Forest of the Clarence Valley Lowlands of the North Coast	144.8	163.8
Swamp Box Swamp Forest of the Coastal Lowlands of the North Coast	28.5	19.0
Swamp Mahogany Swamp Forest of the Coastal Lowlands of the North Coast	44.2	47.6
Swamp Oak Swamp Forest of the Coastal Lowlands of the North Coast	56.2	43.1
Tallowwood Dry Grassy Forest of the Far Northern Ranges of the North Coast	53.0	54.4
Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	0.0	0.2
Turpentine Moist Open Forest of the Coastal Hills and Ranges of the North Coast	44.5	42.7
Wet Heathland and Shrubland of Coastal Lowlands of the North Coast	10.0	11.5
White Booyong - Fig Subtropical Rainforest of the North Coast	8.6	2.6
Cleared and Modified	870.1	891
Total approximate vegetation direct and indirect impacts (excluding cleared and modified habitats)	**947.9**	**931.7**

*Updated amounts follow ground-truthing and include design refinement as described in Chapter 3

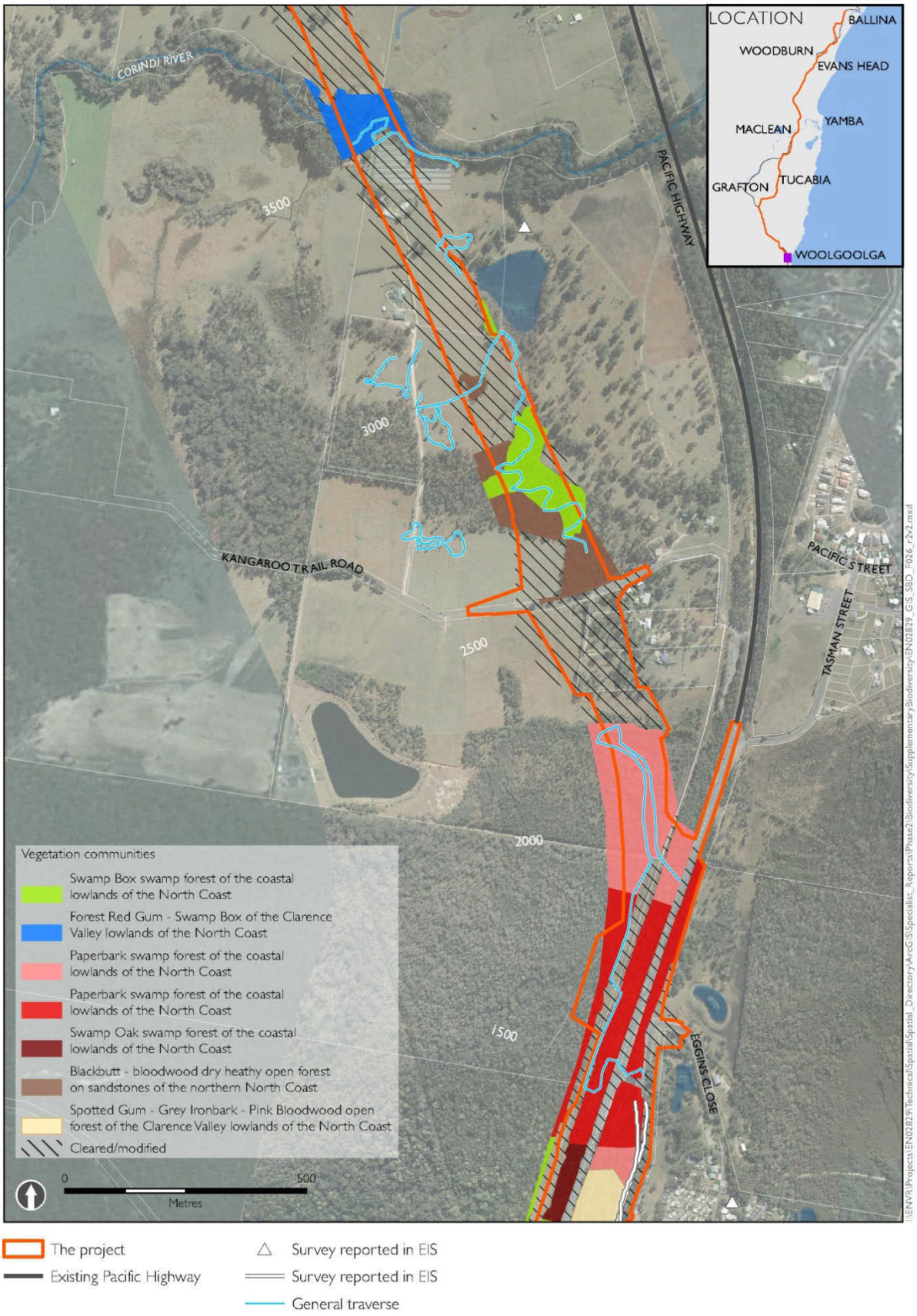

Figure 5-5 Survey locations and additional threatened flora populations map 1

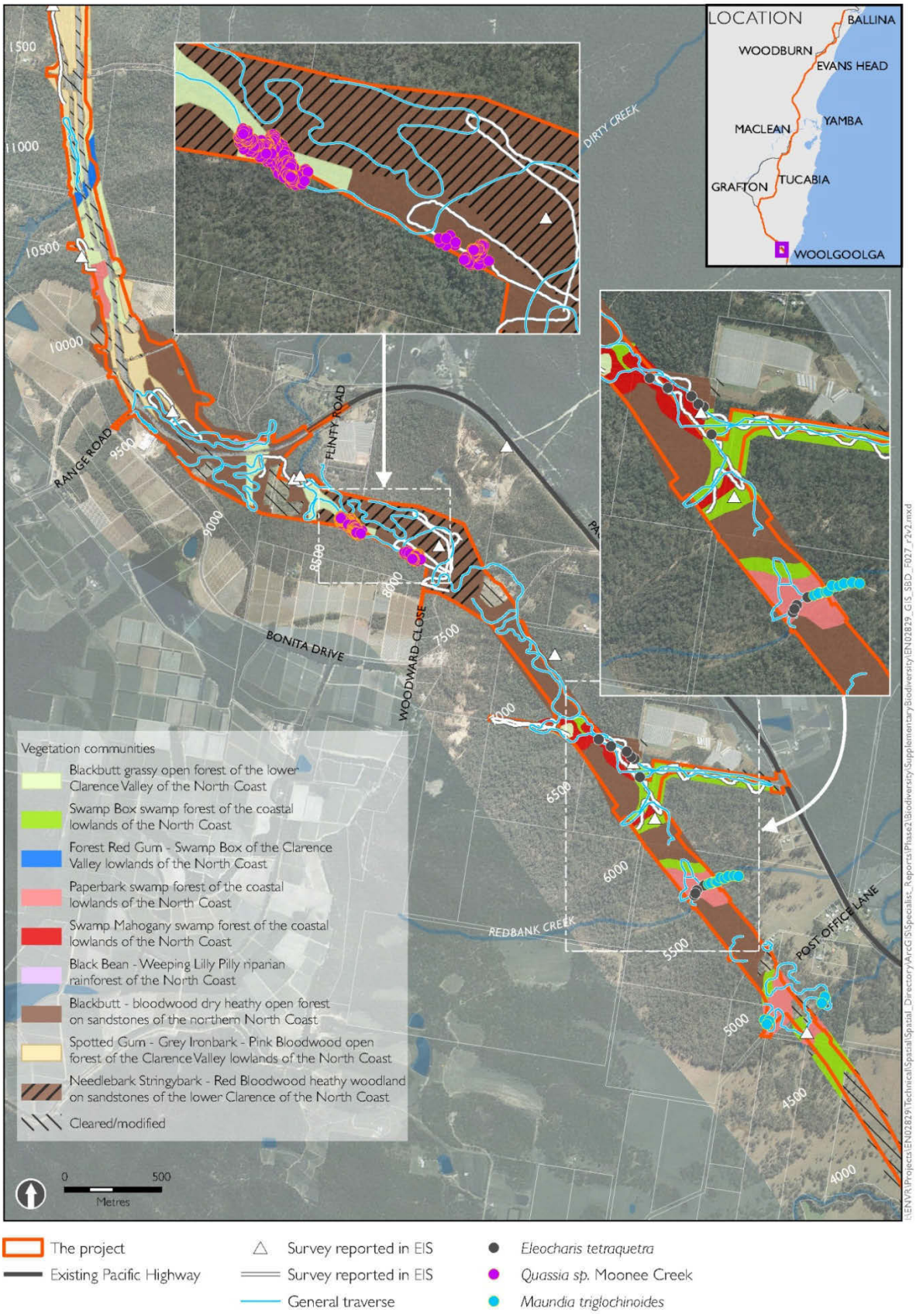

Figure 5-6 Survey locations and additional threatened flora populations map 2

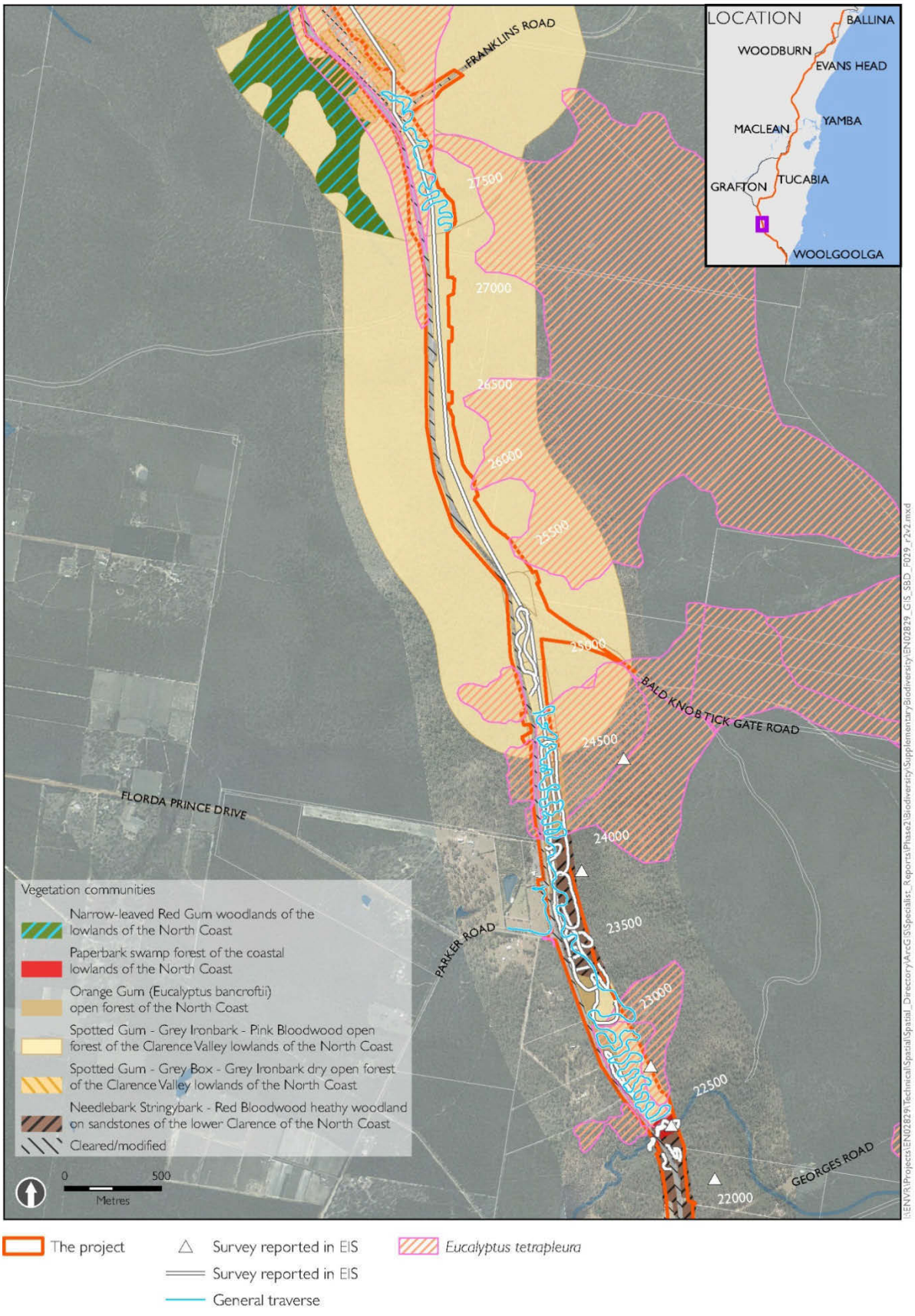

Figure 5-7 Survey locations and additional threatened flora populations map 3

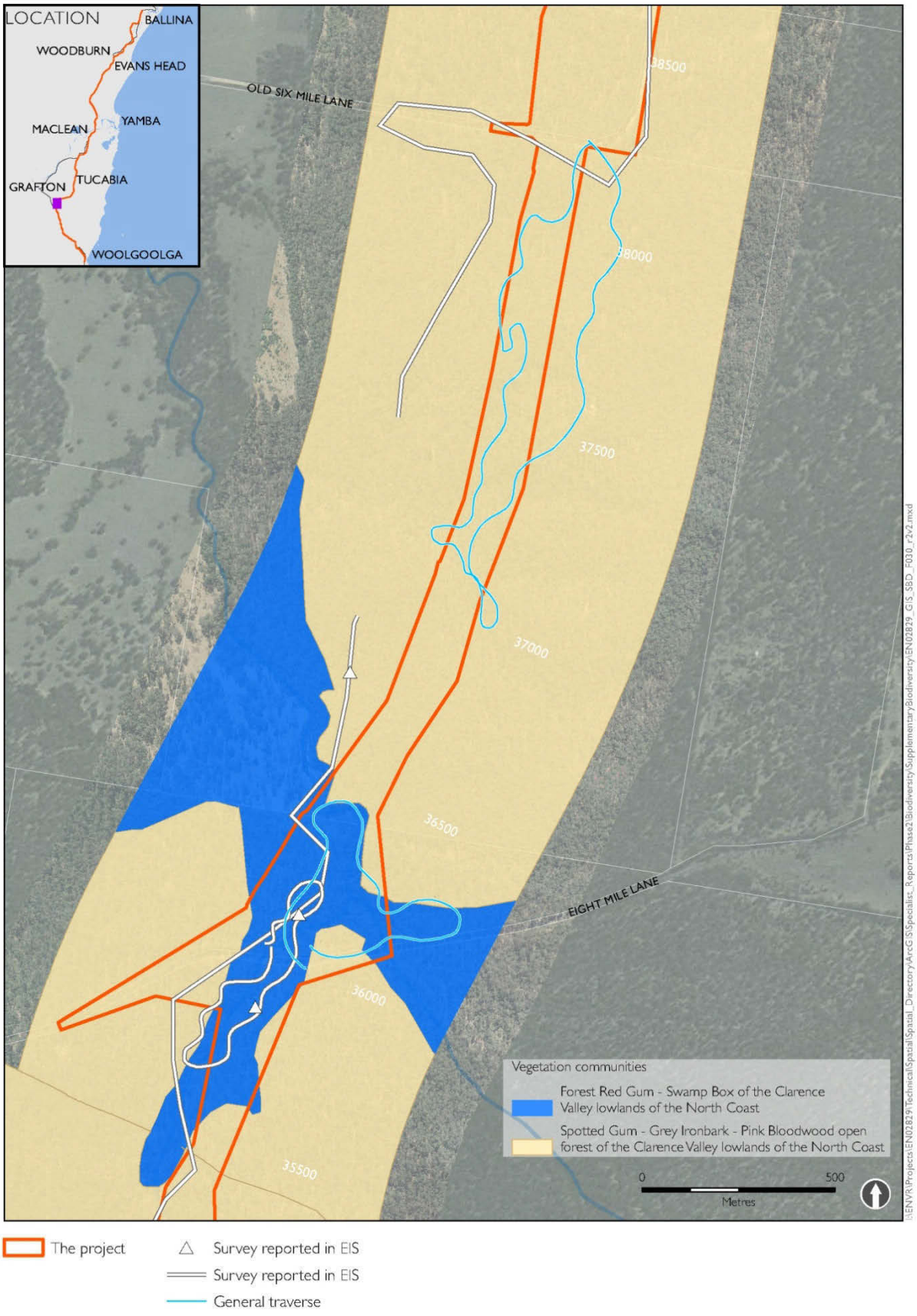

Figure 5-8 Survey locations and additional threatened flora populations map 4

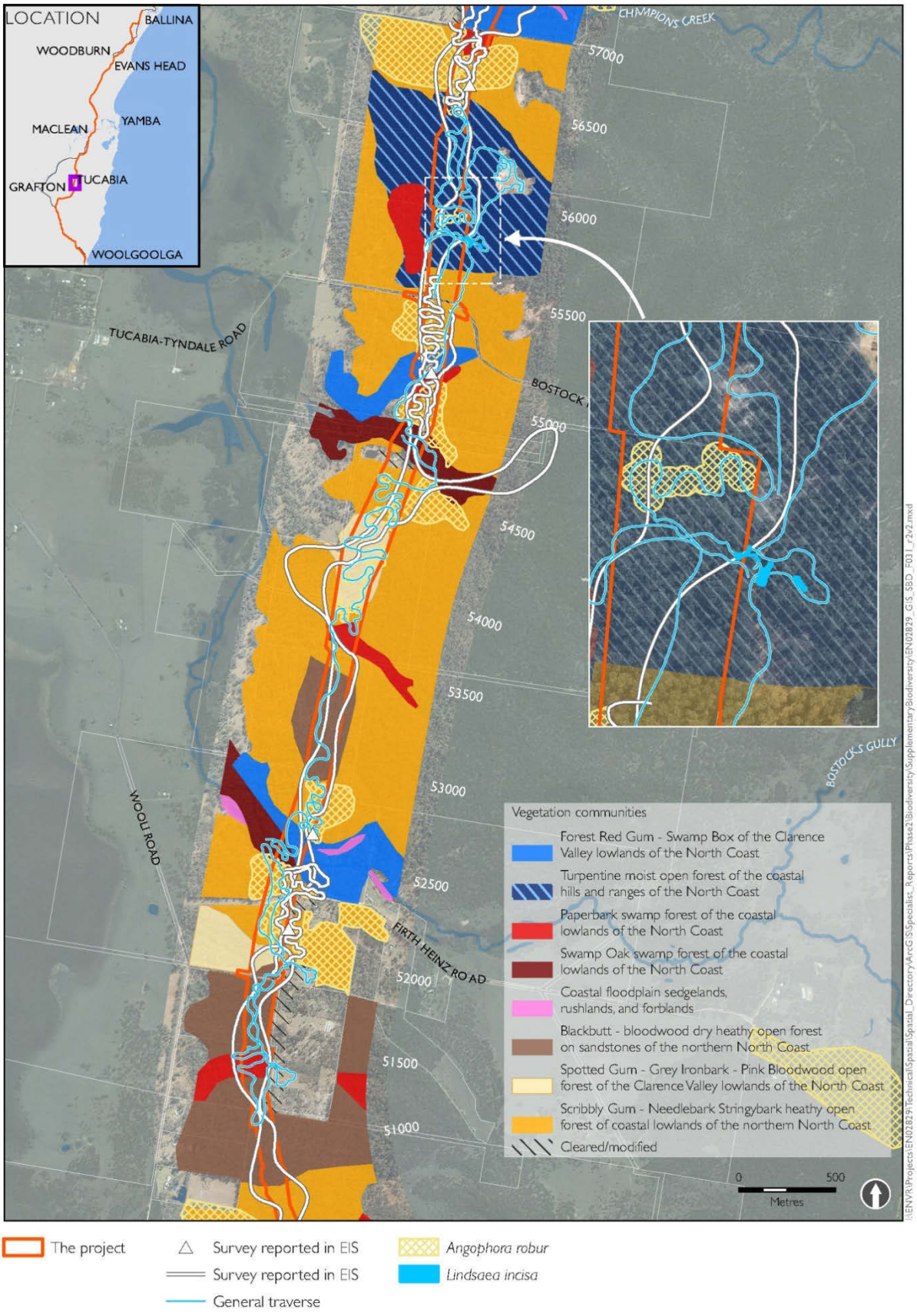

Figure 5-9 Survey locations and additional threatened flora populations map 5

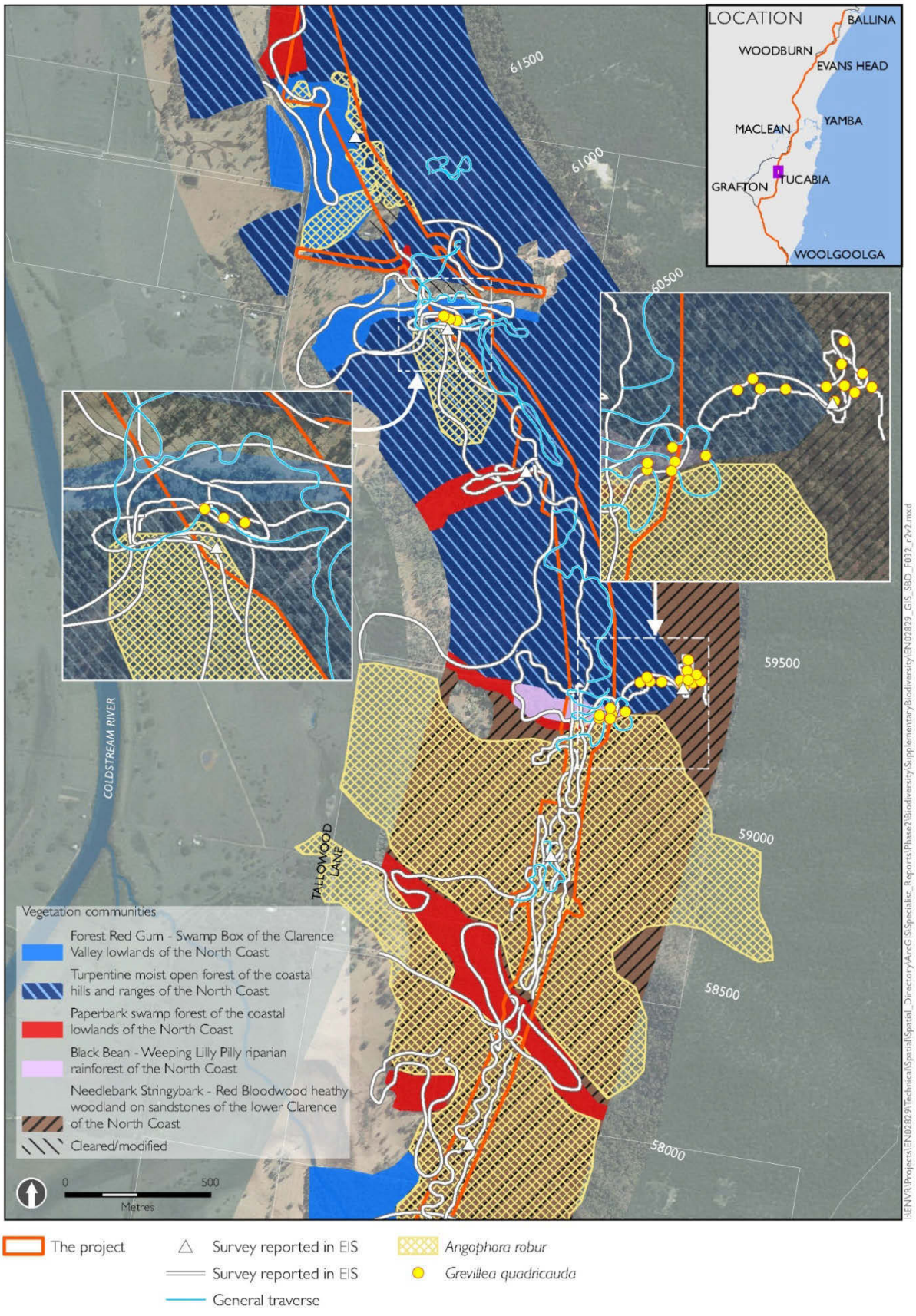

Figure 5-10 Survey locations and additional threatened flora populations map 6

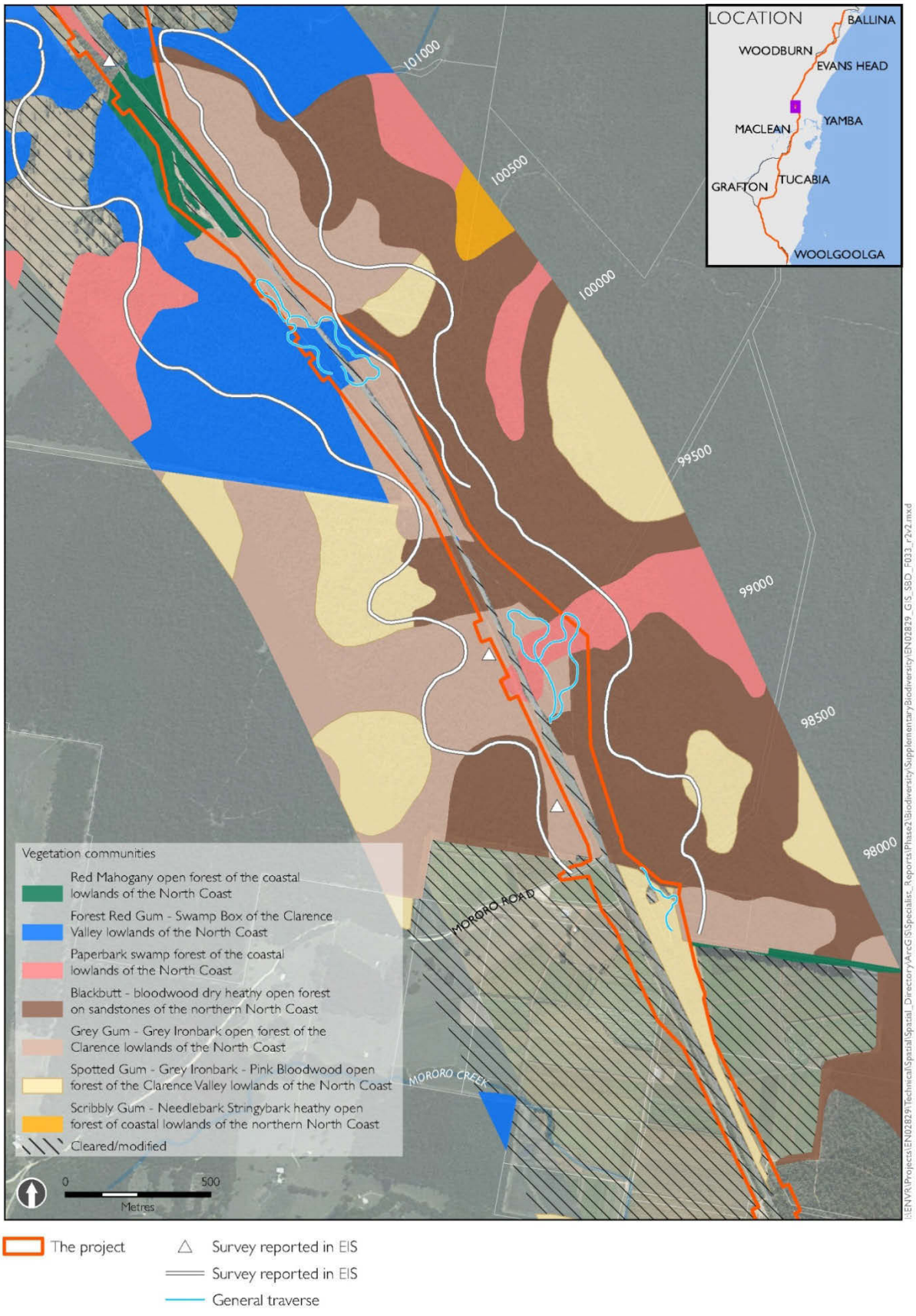

Figure 5-11 Survey locations and additional threatened flora populations map 7

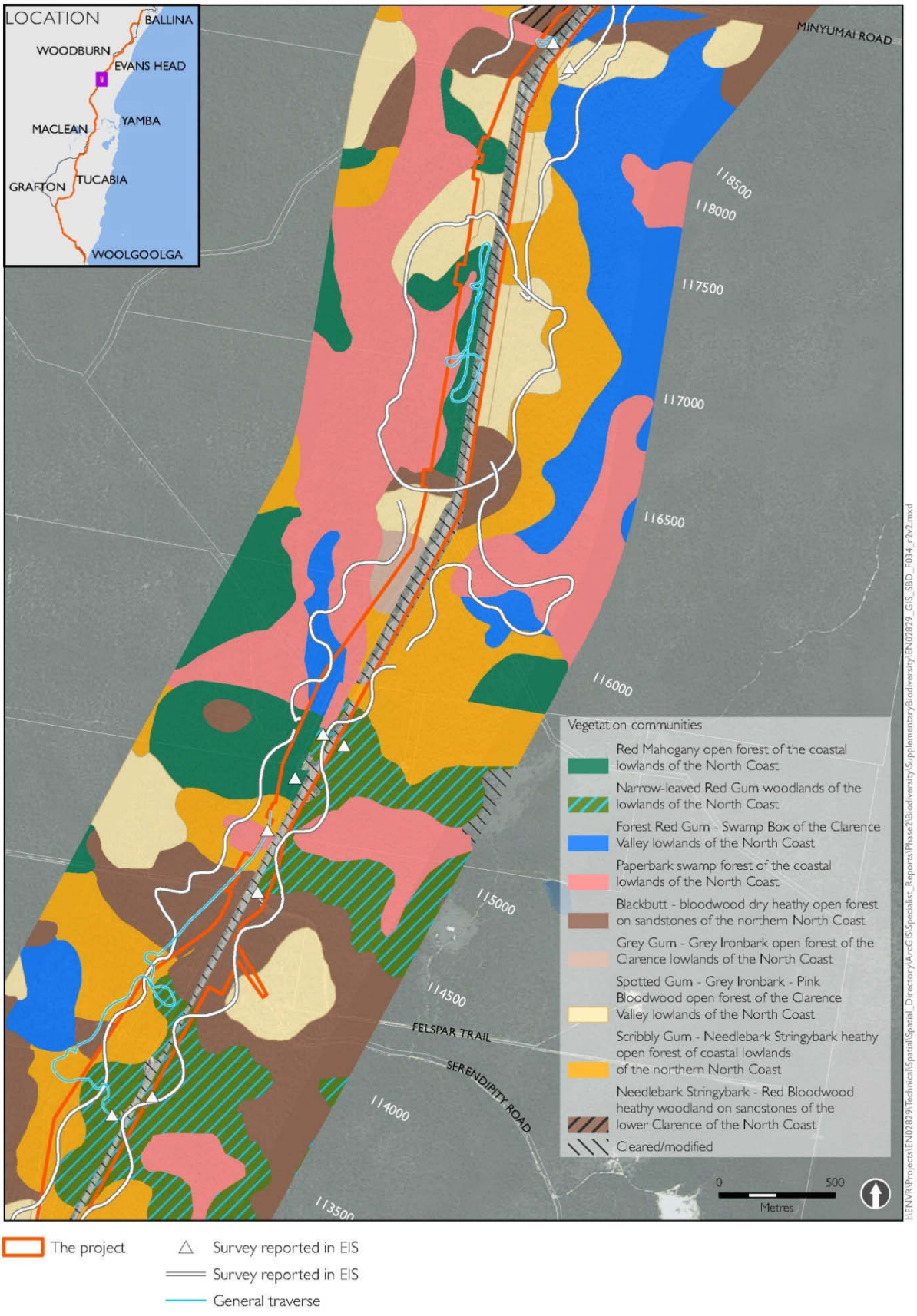

Figure 5-12 Survey locations and additional threatened flora populations map 8

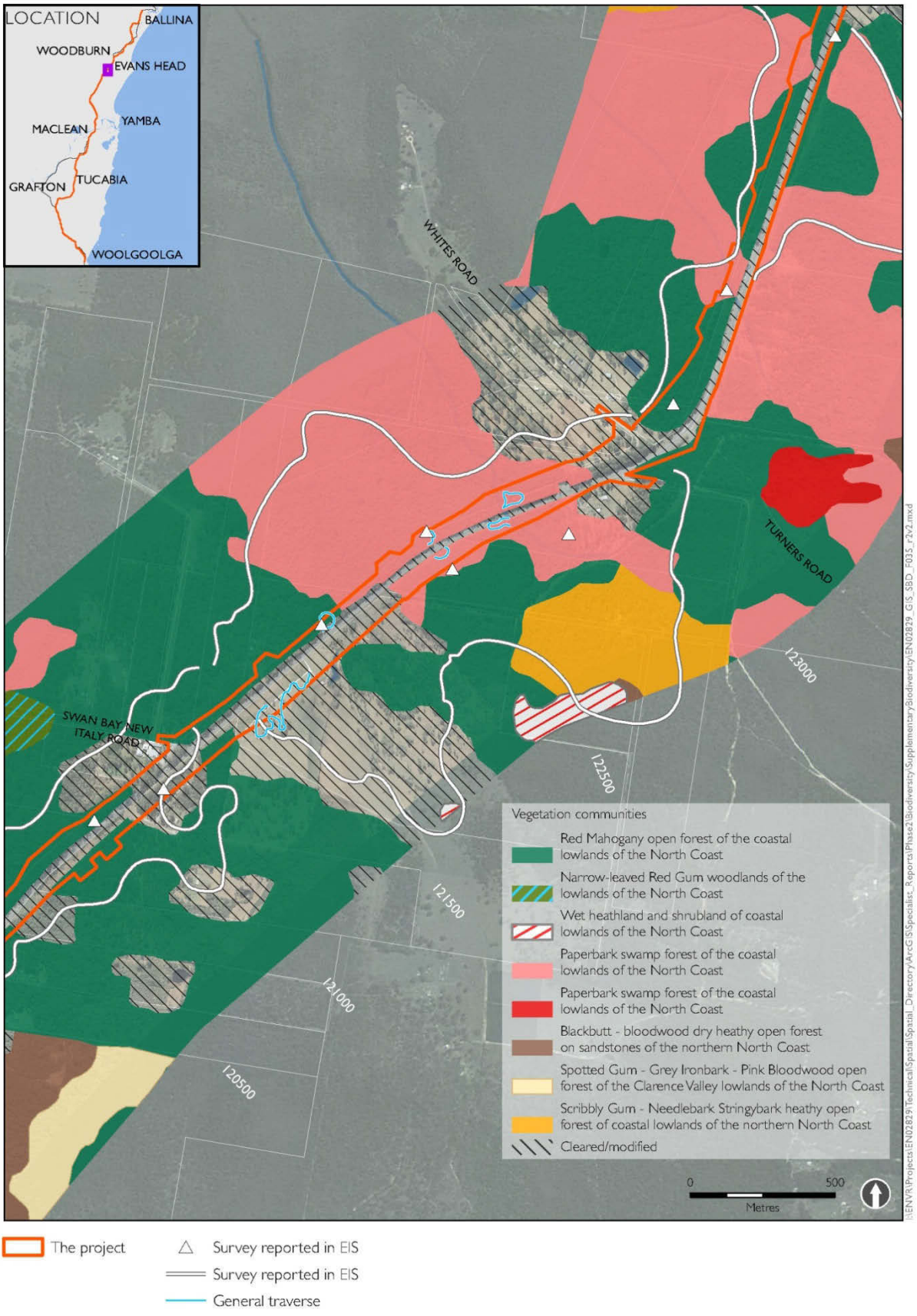

Figure 5-13 Survey locations and additional threatened flora populations map 9

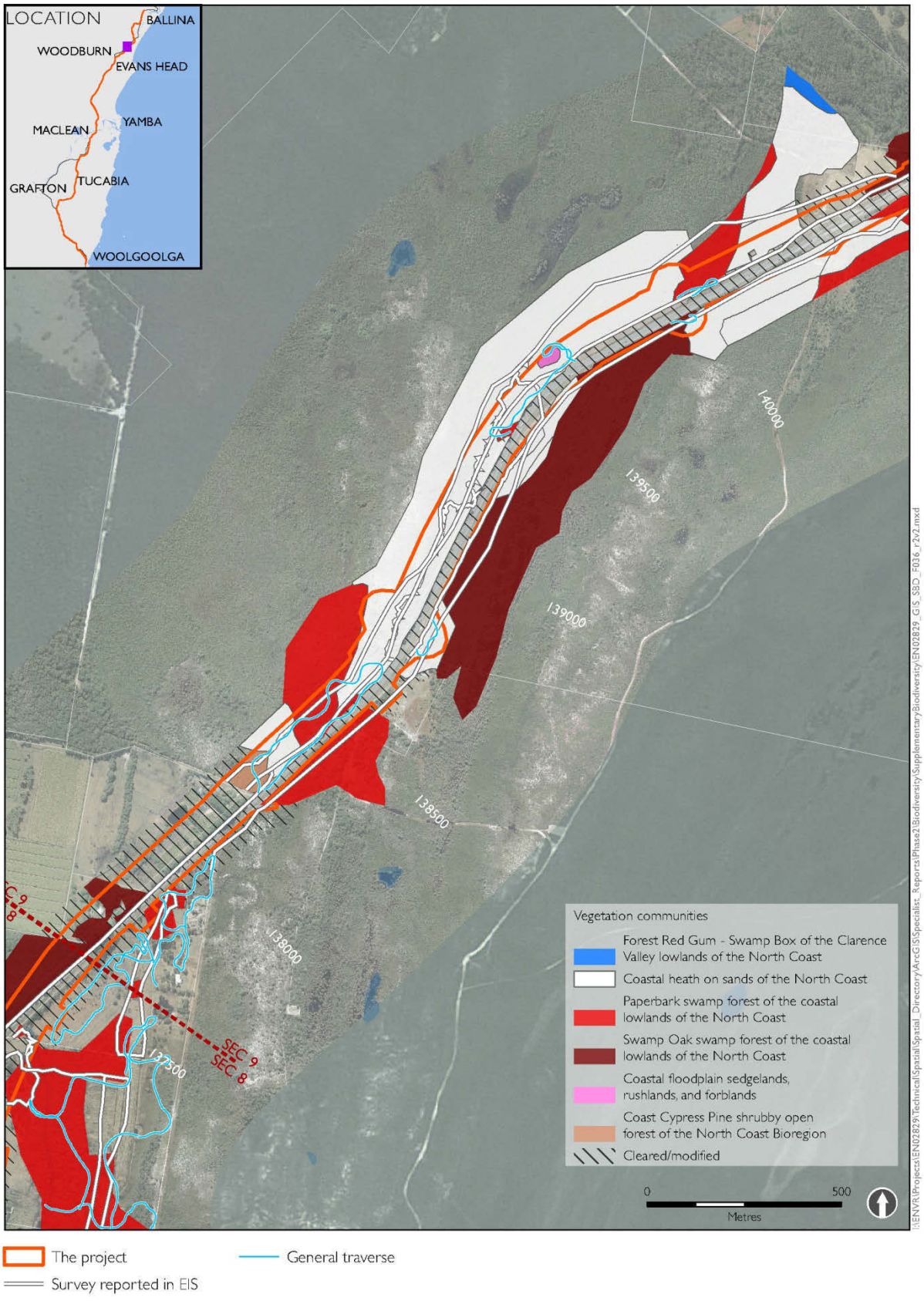

Figure 5-14 Survey locations and additional threatened flora populations map 10

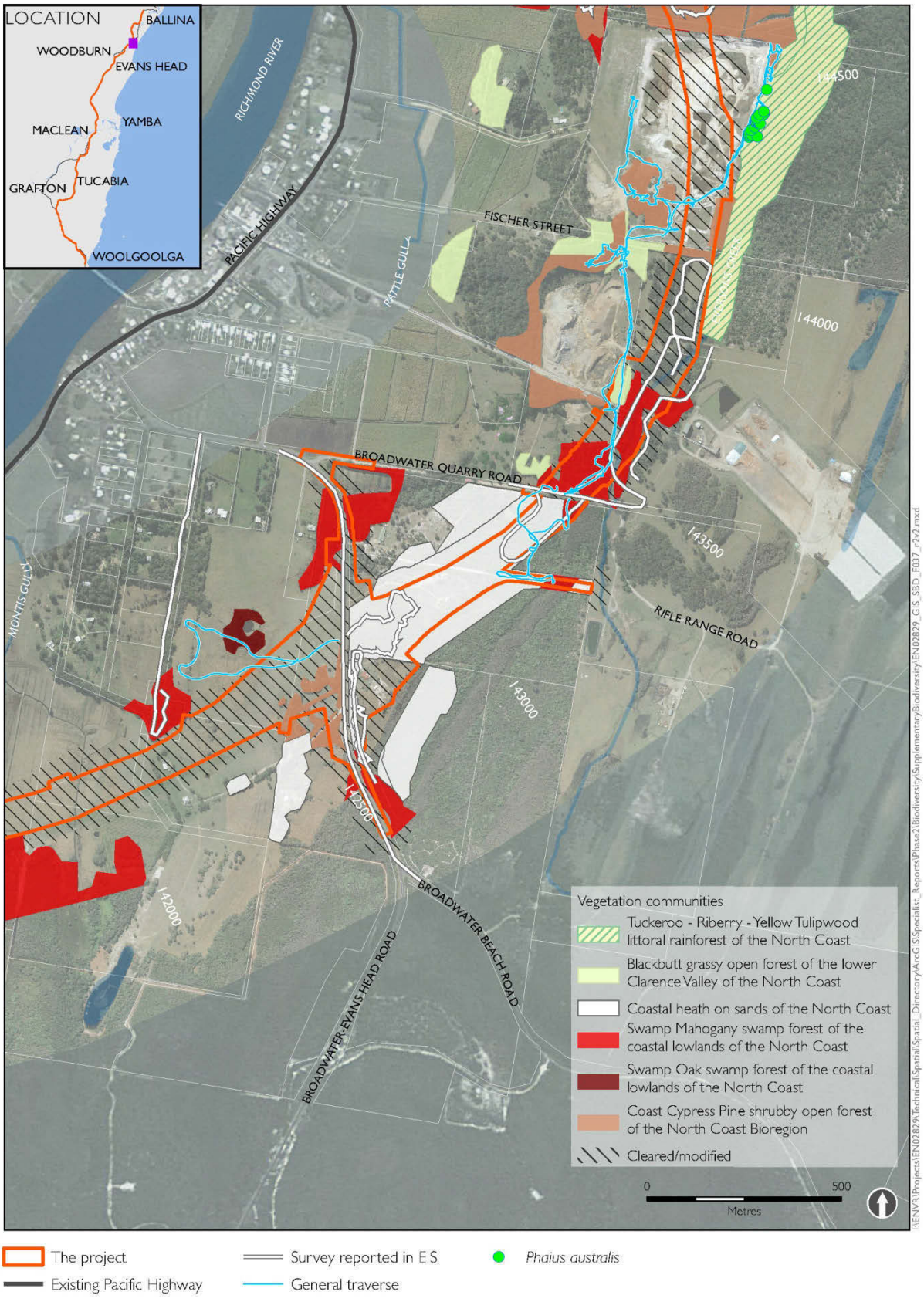

Figure 5-15 Survey locations and additional threatened flora populations map 11

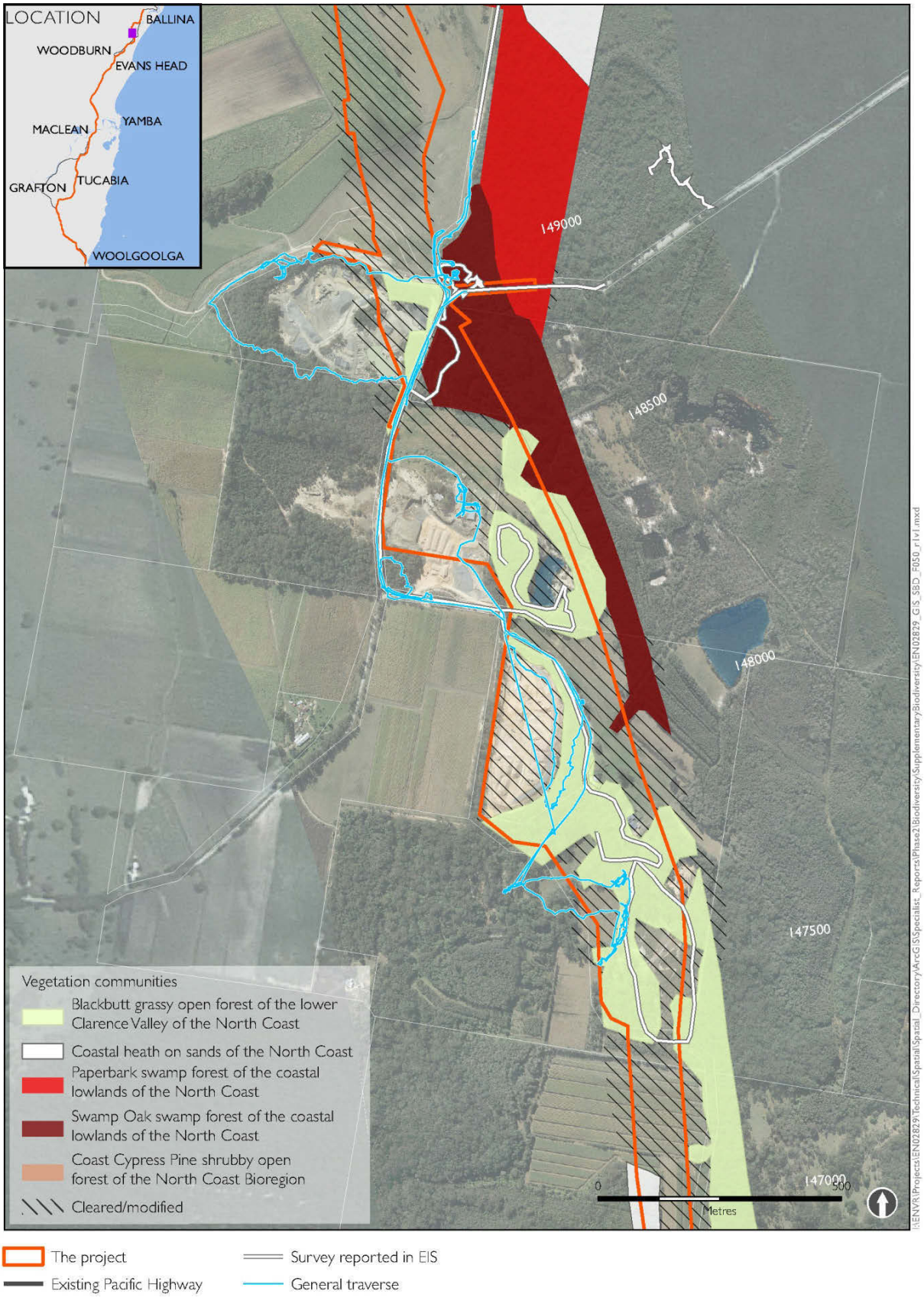

Figure 5-16 Survey locations and additional threatened flora populations map 12

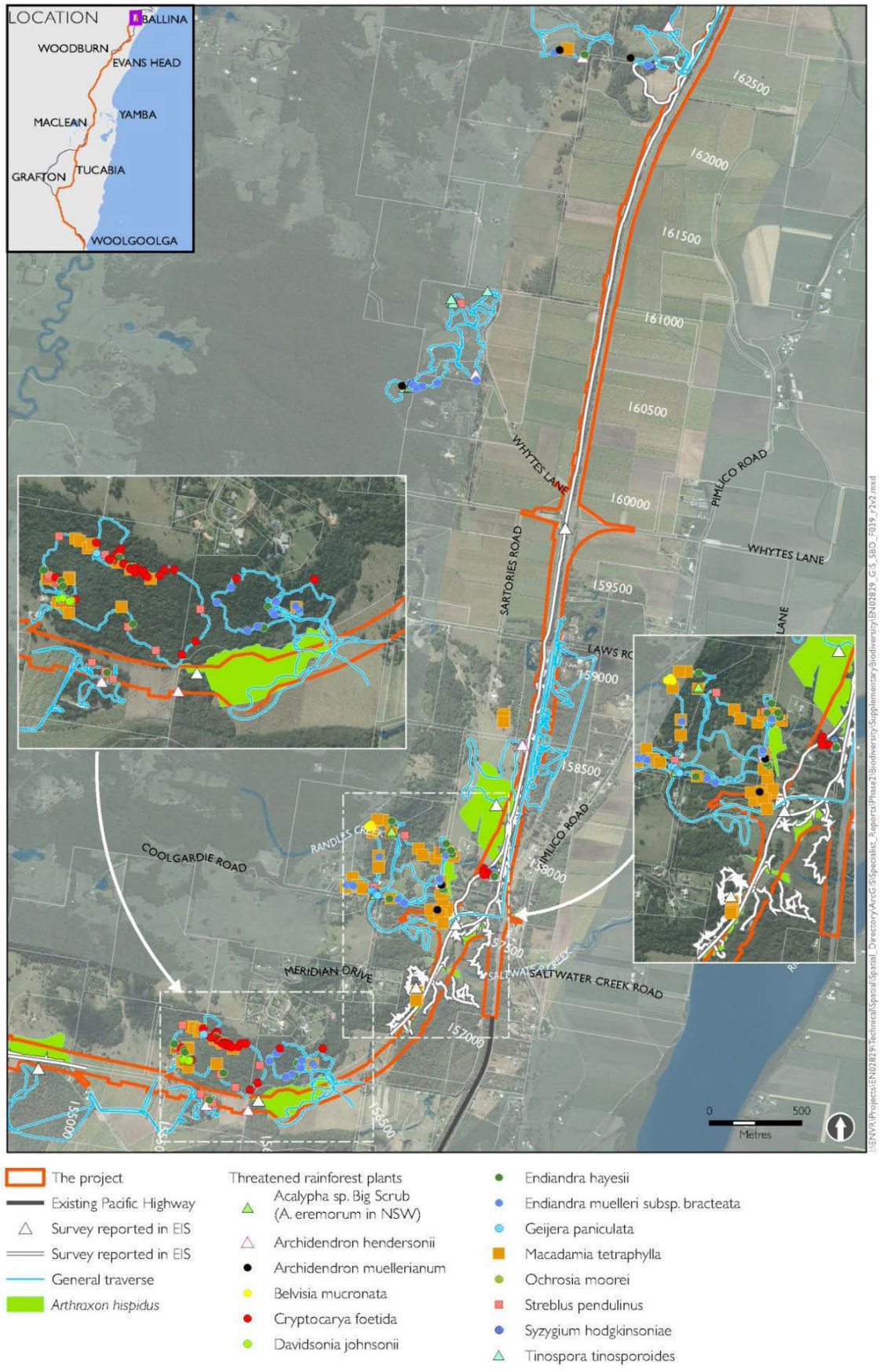

Figure 5-17 Survey locations and additional threatened flora populations map 13

5.2. Threatened rainforest flora

5.2.1. Background

The critical review identified that while threatened rainforest plant surveys were based on comprehensive coverage of potential habitat, there were a small number of sites in Section 10 where further surveys were required. The targeted survey of Lowland Rainforest patches in Section 10 provided an opportunity to survey these patches for threatened rainforest plants within and outside the project boundary to identify the extent of threatened plant populations that may be impacted by the project. The species targeted in the supplementary survey are shown in Table 5-3.

Table 5-3 Rainforest plant species targeted in supplementary surveys

Species	Common name	Status (EPBC Act)	Status (TSC Act)	No. of records within 10km
Acalypha eremorum	Acalypha	V	E	1
Acronychia littoralis	Scented Acronychia	E	E	39
Archidendron hendersonii	White Lace Flower	-	V	20
Baloghia marmorata	Marbled Baloghia	V	V	33
Belvisia mucronata	Needle-leaf Fern	-	E	7
Coatesia paniculata syn. *Geijera paniculata*	Axe-breaker	-	E	8
Cryptocarya foetida	Stinking Cryptocarya	V	V	47
Davidsonia jerseyana	Davidson's Plum	E	E	1
Davidsonia johnsonii	Smooth Davidson's Plum	E	E	3
Desmodium acanthocladum	Thorny pea	V	V	4
Diploglottis campbellii	Small-leaved Tamarind	E	E	10
Endiandra hayesii	Rusty Rose Walnut	V	V	10
Endiandra muelleri subsp. *bracteata*	Green-leaved Rose Walnut	-	E	6
Floydia praealta	Ball Nut	V	V	13
Fontainea oraria	Coastal Fontainea	E	CE	1
Gossia fragrantissima	Sweet Myrtle	E	E	13
Hicksbeachia pinnatifolia	Red Bopple Nut	V	V	1
Isoglossa eranthemoides	Isoglossa	E	E	1
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V	102
Myrsine richmondensis	Ripple-leaf Muttonwood	E	E	4
Owenia cepiodora	Onionwood	V	V	5
Ochrosia moorei	Southern Ochrosia	E	E	20
Parsonsia dorrigoensis	Milky Silkpod	E	V	3
Streblus pendulinus	Whalebone Tree	E	-	92
Syzygium hodgkinsoniae	Red Lily Pilly	V	V	26
Syzygium moorei	Durobby	V	V	5
Syzygium paniculatum	Magenta Lily Pilly	V	E	1
Tinospora tinosporoides	Arrow Head Vine	V	V	51
Tylophora woollsii	Tylophora	E	E	0

5.2.2. Supplementary surveys

5.2.2.1. Methods

Random meander traverses were conducted on foot at targeted locations within representative areas of vegetation communities in the study area following the methods outlined in the Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities Working Draft (Department of Environment and Conservation, 2004). Meander transect locations are shown on Figure 5-18.

Field data were collected using a personal digital assistant (PDA—an electronic handheld information device) with global positioning system (GPS) capability to fix the site positions. Data were recorded using ArcPad™ v. 10.0 (ESRI®) loaded with relevant geographic information system (GIS) layers, high resolution aerial imagery and project footprint projection areas.

As well as recording threatened species identified, similar non-threatened species were also recorded to show search effectiveness. Threatened species populations were directly counted where this was reasonably practical. For those species not easily identified in the field, specimens were collected and pressed and subsequently examined with the aid of more extensive literature. Specimens whose taxonomic identity remained ambiguous were sent to the NSW Herbarium for positive identification.

Points were logged on the GPS where the species was not observed within an area of suitable habitat. These were taken to be absence points and improved the accuracy of population estimates and reduced observer bias towards sites where the species was present.

5.2.2.2. Results

The supplementary surveys confirmed the results and assessment of impacts in the EIS biodiversity assessment. No additional threatened species were identified inside the project boundary. As expected, the widening of the search area beyond the project boundary revealed several threatened species not previously identified and increased the known population size for several other species, as shown in Table 5-3. Surveys undertaken for rainforest plants in a wider search area have provided additional insight into the extent of the local populations. The species listed in Table 5-4 represent those target species from Table 5-3 that were positively identified from the supplementary surveys. No new species that were not in the list of those targeted were identified during the survey (ie unexpected finds).

Table 5-4 Rainforest plant species recorded during targeted surveys

Species	No. of individuals recorded in project boundary	Total known population in study area
Acalypha eremorum (Acalypha)	0	71
Acronychia littoralis (Scented Acronychia)	1 (125 stems)	1 (125 stems)
Archidendron hendersonii (White Lace Flower)	0	20
Belvisia mucronata (Needle-leaf Fern)	0	53
Coatesia paniculata syn. *Geijera paniculata* (Axe-breaker)	0	25
Cryptocarya foetida (Stinking Cryptocarya)	13	88
Davidsonia johnsonii (Smooth Davidson's Plum)	0	1 (25 stems)
Endiandra hayesii (Rusty Rose Walnut)	3	30
Endiandra muelleri subsp. *bracteata* (Green-leaved Rose Walnut)	0	44
Macadamia tetraphylla (Rough-shelled Bush Nut)	1	99
Ochrosia moorei (Southern Ochrosia)	0	1
Streblus pendulinus syn. *S. brunonianus* (Whalebone Tree)	8	43
Syzygium hodgkinsoniae (Red Lilly Pilly)	0	8
Tinospora tinosporoides (Arrow-head Vine)	0	60

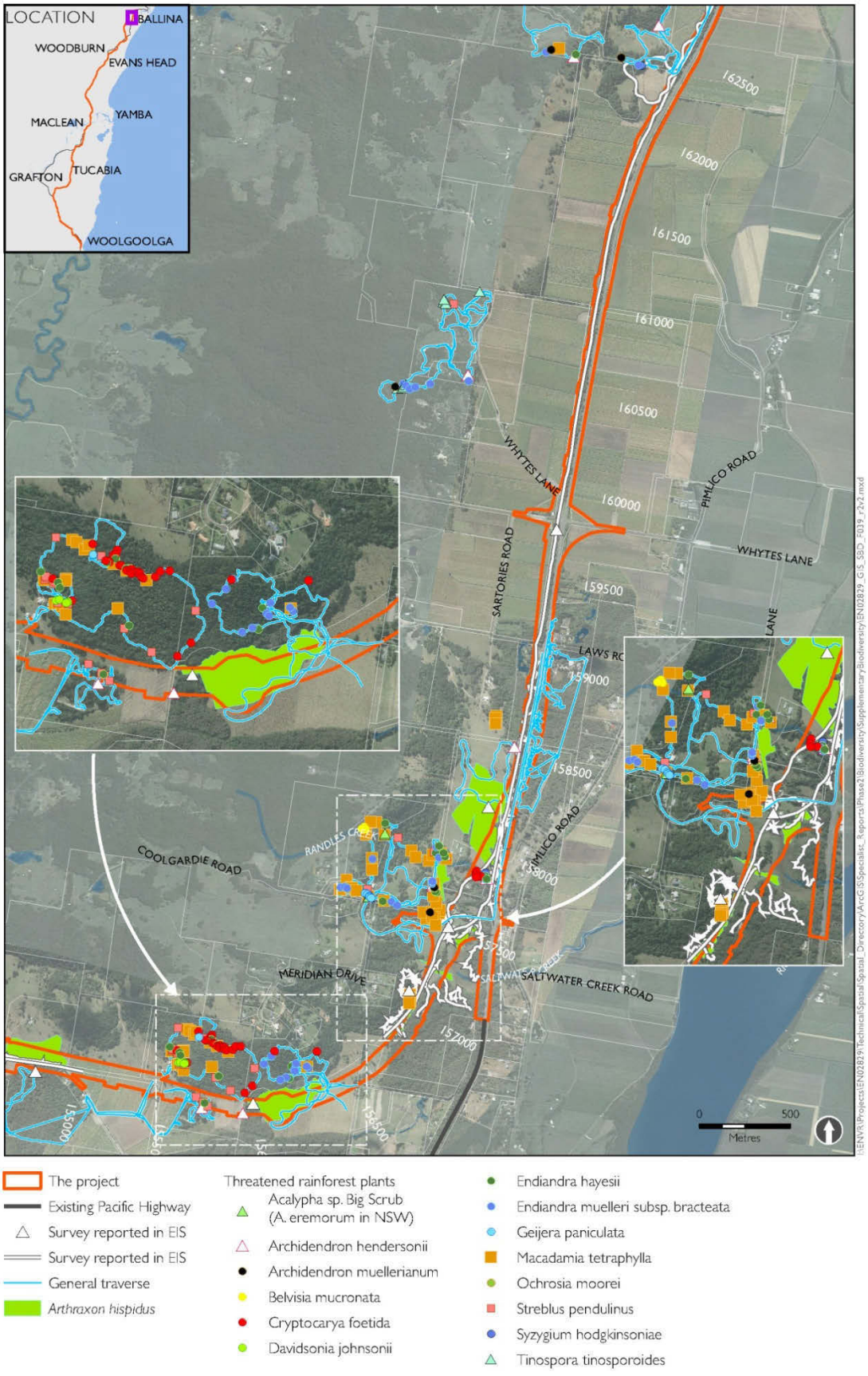

Figure 5-18 Threatened rainforest plants and survey locations (section 10 & 11)

5.3. Threatened (non-rainforest) flora

5.3.1. Background

The critical review identified that surveys used to inform the EIS biodiversity assessment were based on comprehensive coverage of potential habitat for threatened flora populations. Nevertheless, a small number of BioMetric Vegetation Types in sections 1 and 2 were identified as requiring further survey because spatial data from previous surveys could not be replicated and re-plotted for this assessment.

The limitations in spatial data in sections 1 and 2 meant some threatened flora sites were unable to be accurately and completely plotted in the EIS biodiversity assessment, with some site interpreted from text. Using a precautionary approach in the critical review, gaps in spatial data were assumed to indicate unsurveyed areas. Additional targeted surveys were planned in locations and vegetation types identified as having potential habitat for threatened flora. This was primarily around Wells Crossing and Corindi and in the following BioMetric Vegetation Types: Needlebark-Stringybark Open Forest, Swamp Box Swamp Forest and Blackbutt-Bloodwood Open Forest. Threatened flora species targeted in the supplementary surveys are listed in Table 5-5.

Table 5-5 Threatened flora species (non-rainforest) targeted in supplementary surveys

Species	Common name	Status (EPBC Act)	Status (TSC Act)	No. of records within 10 km
Allocasuarina defungens	Dwarf Heath Casuarina	E1	E1	5
Allocasuarina simulans	Nabiac Casuarina	V	V	0
Angophora robur	Sandstone Rough Barked Apple	V	V	48
Arthraxon hispidus	Hairy Joint-grass	V	V	5709
Boronia umbellata	Orara boronia	V	V	18
Bothriochloa biloba	Lobed Blue Grass	V	-	0
Cryptostylis hunteriana	Leafless Tongue Orchid	V	V	1
Eucalyptus glaucina	Slaty Red Gum	V	V	4
Eucalyptus tetrapleura	Square fruited Ironbark	V	V	240
Grevillea masonii	Mason's Grevillea	E1	E1	0
Grevillea quadricauda	Four-tailed Grevillea	V	V	7
Hibbertia marginata	Bordered Guinea Flower	V	V	28
Leucopogon confertus	Torrington Beard-heath	E1	E1	3
Marsdenia longiloba	Slender Marsdenia	V	E1	14
Melichrus hirsutus	Hairy Melichrus	E1	E1	24
Quassia sp. 'Moonee Creek'	Moonee Quassia	E1	E1	70
Oberonia titania	Red-flowered King of the Fairies	V	V	1
Paspalidium grandispiculatum	N/a	V	V	9
Phaius australis	Southern Swamp Orchid	E1	E1	12
Prostanthera palustris	Swamp Mint Bush	V	V	8
Prostanthera cineolifera	Singleton Mint Bush	V	V	0
Rutidosis heterogama	Heath Wrinklewort	V	V	7

Species favouring low, wet habitats, such as Hairy Joint Grass (*Arthraxon hispidus*), Southern Swamp Orchid (*Phaius australis*), Swamp Mint Bush (*Prostanthera palustris*) and *Eleocharis tetraquetra,* had been targeted in previous surveys. However, these surveys were conducted during sub-optimal conditions (dry climatic periods between 2006 and 2007). More favourable conditions (wetter, high rainfall periods) between 2010 and 2013 resulted in a large influx of Hairy Joint Grass in Section 10. This species was identified in the EIS biodiversity assessment but was not previously identified in the preferred route studies. Based on this knowledge, further targeted surveys focused on Hairy Joint Grass and the other moisture-dependent threatened species in key areas, particularly in sections 1–2 and 8–11 where previous records of these species have been noted.

5.3.2. Supplementary surveys

5.3.2.1. Methods

Targeted surveys were conducted between 29 January and 15 February 2013 inside the project boundary in areas considered to potentially support habitat for threatened species and in areas not covered in the previous surveys. The areas surveyed are listed in Table 5-6 and mapped in Figure 5-5 to Figure 5-16. The survey involved random meanders through suitable habitat. Where a threatened species was encountered, more detailed survey was conducted to record the distribution and abundance of the population using either direct counts or plots/transects to estimate plant density. This involved a re-survey of some threatened populations and vegetation communities identified in the EIS to provide updated information on their distribution and abundance.

Table 5-6 Areas subject to supplementary flora surveys

Section	Location/habitat description	Survey outcomes
1	Swamp forest habitats in Wedding Bells State Forest and adjacent private property to north	Ground-truthing of vegetation and adjustment of vegetation boundaries
1	Forested areas between Kangaroo Trail Road, Corindi Beach and Corindi Creek	Adjustment of threatened ecological community boundaries and cleared lands
1/2	Wet and dry forests between Post Office Lane, Corindi Beach and Range Road, Dirty Creek	Three new threatened flora populations were discovered and adjustment of threatened ecological community boundaries, assessment of lowland rainforest on eastern side of highway
2	Swamp forest areas at Halfway Creek	No threatened populations observed
2	Wells Crossing Flora Reserve	Detailed surveys of *Eucalyptus tetrapleura* to determine number of individuals in the footprint
3	Forested areas between Eight Mile Lane and Aerodrome Road	Adjustment of threatened ecological community boundaries
3	Forested areas between Firth Heinz Road, Pillar Valley and Bostock Road, Tucabia	Additional individuals of *Angophora robur*, adjustment of threatened ecological community boundaries
3	North of Bostock Road, Tucabia	Additional individuals of *Angophora robur*, and an additional population of *Lindsaea incisa* adjacent to the project footprint
3	North of Tallowwood Lane, Tucabia	Assessment of Lowland Rainforest
6	Mororo State Forest	Adjustment of threatened ecological community boundaries
7	Tabbimobile State Forest	Adjustment of threatened ecological community boundaries
8	North of New Italy	Adjustment of threatened ecological community

Section	Location/habitat description	Survey outcomes
		boundaries
9	Broadwater National Park	Adjustment of threatened ecological community boundaries
9	Surrounding Broadwater - Evans Head Road	Adjustment of threatened ecological community boundaries

5.3.2.2. Results

Several additional threatened flora populations were recorded inside or adjacent to the project boundary, including populations not previously identified in the EIS. The findings from the supplementary targeted surveys are shown in Table 5-7.

Table 5-7 Results of targeted threatened flora surveys

Species	Status (EPBC/TSC Act)	Project Section	No. individuals reported in project boundary	Total known population in study area
Angophora robur (Sandstone Rough-barked Apple)	V	3	7,056	125,076
Arthraxon hispidus (Hairy Joint-grass)	V	10	8.4 ha	21.3 ha
Eleocharis tetraquetra (Square-stemmed Spike-rush)	-/E1	1	6 population clusters	11 population clusters
Eucalyptus tetrapleura (Square-fruited Ironbark)	V	2	760	159,629
*Grevillea quadricauda (*Four-tailed Grevillea)	V	3	8	218
Lindsaea incisa (Slender Screw Fern)	-/E1	3	0.4 ha	2.7 ha
Marsdenia longiloba (Slender Marsdenia)	V, E1	10	0	3
Maundia triglochinoides	-/V	1	0.23 ha	3.15 ha
Phaius australis (Southern Swamp Orchid)	E1	9	0	68
Quassia sp. Moonee Creek (Moonee Quassia)	E1	E1	136 (stems)	899 (stems)

Two flora species not previously identified in the study area were identified in Section 1:

- Square-stemmed Spike-rush (*Eleocharis tetraquetra*) (listed as endangered under the TSC Act). This is a rare species found in swampy and moist habitats and its absence from the original surveys may be attributed to the drier seasonal conditions at the time of survey.
- Moonee Quassia (*Quassia* sp. Moonee Creek) (listed as endangered under the TSC Act and EPBC Act). The Moonee Quassia population was found in a rocky gully with steep banks on the western edge of the project boundary. The identification of this additional population may be attributed to recent disturbance at the site and the drier seasonal conditions at the time of the previous survey.

5.4. Pink Underwing Moth

5.4.1. Background

Some EIS field surveys for Pink Underwing Moth were constrained by restricted property access to some areas of potential habitat beyond the project boundary. Supplementary surveys were conducted to more accurately identify the distribution and extent of potential habitat beyond the project boundary to inform the impact assessment and detailed design.

5.4.2. Supplementary surveys

5.4.2.1. Methods

The field survey was undertaken along the Woodburn to Ballina section of the project, focusing on sections 10 and 11, including the following properties:

- Lot 1 DP595001.
- Lot 20 DP878558.
- Lot 2 DP724878.
- Lot 2 DP543525.
- Lot 2 DP870515.
- Lot 1 DP501685.
- Lot 23 DP847450.
- Lot 308 DP755745.

The following properties with habitat relevant to the survey continued to have restrictions on access:

- Lot 3 DP814504.
- Lot 110 DP755731.
- Lot 9 DP1126162.

Where possible, these properties were assessed from publicly available vantage points.

The supplementary field survey targeted areas not previously surveyed that allowed more extensive mapping of known and potential habitat for Pink Underwing Moth. The following data were collected within each additional site:

- Presence and abundance of Pink Underwing Moth and estimates of area coverage of its host plant *Carronia multisepalea*, where applicable.
- Vegetation condition and structure, rainforest indicator species richness and fleshy-fruited plant richness (based on Commonwealth listing advice for the Lowland Rainforest of Subtropical Australia threatened ecological community), Braun-Blanquet cover abundance (which is a measure of plant cover) and canopy cover.

This data allowed the identification of three habitat categories. These are mapped in Figure 5-19 and comprise:

- Known habitat for Pink Underwing Moth, where host plant and larval records occur and the moth has been recorded.
- Potential habitat for Pink Underwing Moth, where the host vine *Carronia multisepalea* has been detected but moth larvae have not been recorded.
- Potential habitat for Pink Underwing Moth, where the moth and host vine have not been recorded.

5.4.2.2. Results

The survey obtained 61 additional point records of *Carronia multisepalea*, the host vine for Pink Underwing Moth. These were also found over a wider area than in previous surveys. Additional records of the moth were restricted to a single property, where it was recorded previously, although the survey of this block was far more extensive than in previous surveys. As a consequence, the occurrence of the moth and vine was mapped over a wider area on this occasion. The records of Pink Underwing Moth comprised 45 larvae and nine eggs found in association with the host vine. The larvae comprised three first instar larvae, 38 second instar larvae and four fourth instar larvae.

The host vine also displayed evidence of old damage due to herbivory at all locations where it was found. Some of this damage was potentially due to past feeding of either Pink Underwing Moth or the distantly related and more common fruit-piercing moth *Eudocima fullonia* (encountered feeding on *C.multisepalea* in the previous survey; BAAM, 2012). Katydids and leaf beetles were also considered to be responsible for at least some of the leaf damage.

Figure 5-19 shows Pink Underwing Moth habitat that was recorded and mapped in both the EIS surveys and during the surveys carried out during the supplementary surveys.

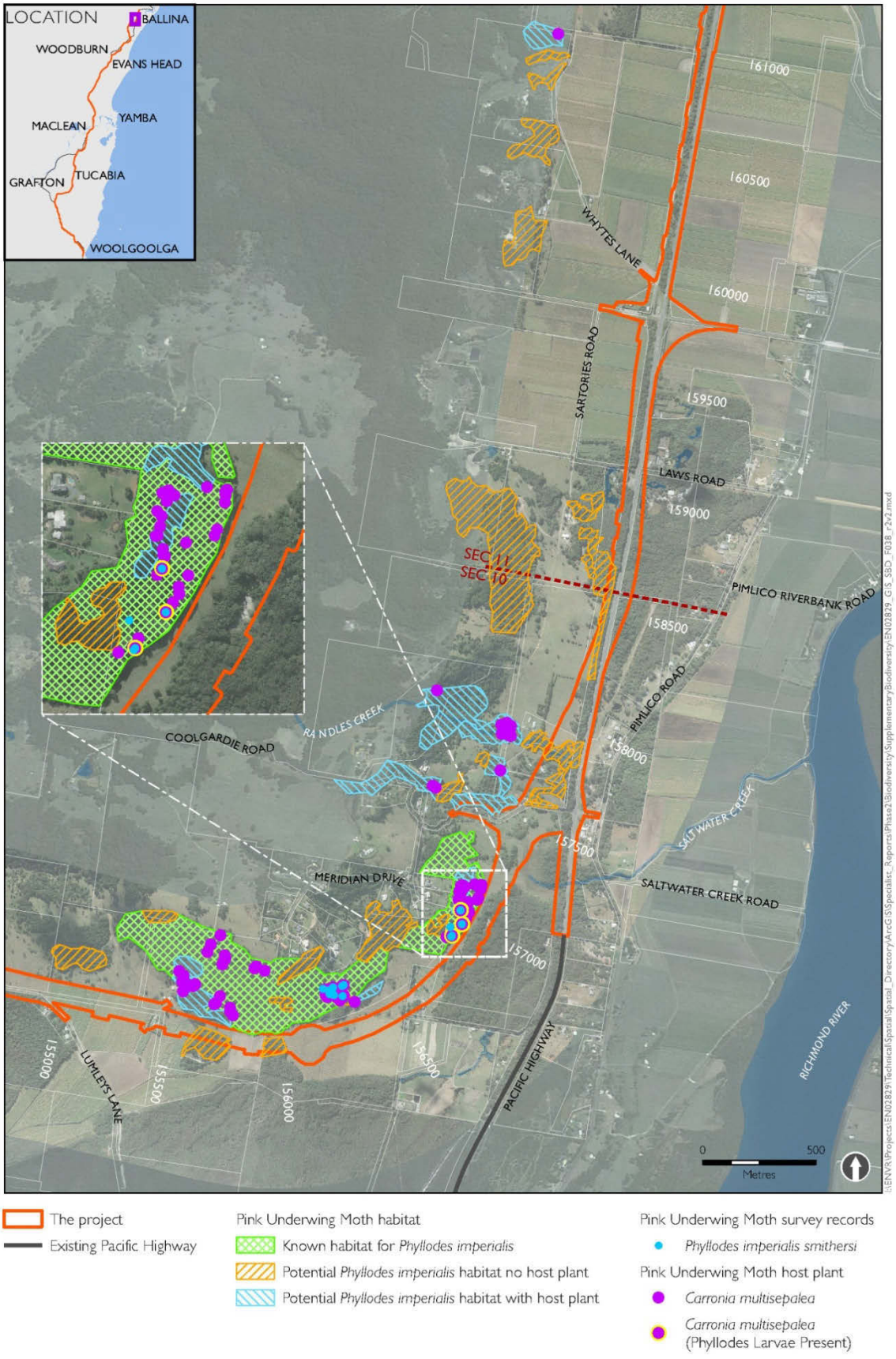

Figure 5-19 Pink Underwing Moth habitat mapped in the study area

5.5. Koala

Surveys undertaken for the EIS preceded the listing of the Koala on the EPBC Act and the release of the Interim Koala Referral Advice for Proponents in June 2012 (DSEWPaC, 2012). Additional surveys and mapping were undertaken to update the information in the EIS biodiversity assessment.

5.5.1. Background

Koala population surveys reported in the EIS involved area searches for Koala scats using set numbers of trees per plot to determine Koala presence and an index of Koala activity as per Phillips and Callaghan (2011). Other survey techniques included call playback and spotlight surveys to confirm the presence of koalas. Database reviews, vegetation mapping and habitat assessment plots (n=129) were also used to identify the distribution of important populations and of Koala habitat in relation to the project.

Koala scat plot locations were stratified by habitat type and selected to achieve spatial representation across all vegetation types. The data reported in the EIS provided an indication of the distribution of koalas and their preferred habitat in the study area. Survey results were used to assess the impacts of the project and devise mitigation measures.

The interim advice requests further detail to assess the presence of 'important populations' and 'habitat critical to the survival of the Koala'. This information is provided in the supplementary assessment and is based on:

- Field data and a review of background data on the historical and current distribution and status of koalas across the study area to identify the distribution of important Koala populations.
- Identification of habitat critical to the survival of koalas by assessing the presence and proportion of primary and secondary food tree species in each vegetation type as documented in the NSW Koala Plan of Management (DECC, 2008).

5.5.2. Supplementary surveys

5.5.2.1. Literature and database review

The following background literature and data were reviewed for this supplementary report:

- The Interim Koala referral advice for proponents (DSEWPaC, 2012).
- A report on the Impacts of Roads on koalas (AMBS, 2011).
- Richmond Valley Koala Atlas (Australian Koala Foundation, 2008).
- Koala rescue location data provided by the Friends of the Koala focused on road fatalities in the Northern Rivers region.
- Records of Koala sightings recorded in the Atlas of NSW wildlife database (OEH), the Protected Matters Search tool (EPBC Act), State Forests fauna database (DII) and Ballina Shire Council.
- The NSW Koala Recovery Plan (DECC, 2008) for identification of food tree species for the north coast region and categories of Koala habitat.

5.5.2.2. Supplementary scat searches

Additional Koala scat searches were conducted to supplement the presence/absence data reported in the EIS. Review of spatial data relied on data gathered for all previous surveys. Where there was no spatial data for Koala surveys, this was identified as a gap for the purposes of the supplementary surveys. The survey targeted spatial gaps from the previous fieldwork, identified using the project spatial data, including data on vegetation communities and BioMetric Vegetation Types.

A total of 59 Koala plots were reported for the preferred route studies (44 with spatial data). A further 100 sites were surveyed in the EIS and are described in the EIS biodiversity working paper.

The spatial analysis identified fewer surveys in specific vegetation types across the project. These vegetation types were targeted in the supplementary fieldwork and included:

- Blackbutt grassy open forest (sections 6–11).
- Swamp Mahogany open forest (sections 6–11).
- Red Mahogany moist open forest (sections 6–7).

An additional 72 scat search plots were surveyed in February 2013 for this supplementary investigation. These included:

- Sites where potential habitat was recorded previously but no evidence of koalas reported (n=41).
- The three vegetation types listed above, and locations near proposed connectivity structures in sections 7–11 that were not subject to previous Koala surveys(n=31).

Previous and supplementary survey sites are presented in Figure 5-20 to Figure 5-30. The total number of sites assessed and mapped across all project sections includes:

- 160 Koala habitat assessment plots.
- 132 scat search plots.

5.5.2.3. Habitat assessment

The EIS reported that the highway upgrade project would have impacts on about 557 hectares of 'habitat critical to the survival of koalas' (defined under the EPBC Act). This assessment was based on identifying the BioMetric Vegetation Types that are known to contain primary and secondary feed tree species identified in the Koala recovery plan for the north coast region (DEC, 2009). This was a broad assessment and did not take into account the proportion of these feed tree species as a percentage of the overall canopy, and is therefore likely to overestimate the area of critical habitat that would be impacted by the project.

According to DSEWPaC (2012), 'habitat critical to the survival of the Koala' is considered to be areas of forest or woodland where:

- "Primary Koala food tree species comprise at least 30 per cent of the overstorey trees.
- Primary Koala food tree species comprise less than 30 per cent of the overstorey trees, but together with secondary food tree species comprise at least 50 per cent of the overstorey trees.
- Primary food tree species are absent but secondary food tree species alone comprise at least 50 per cent of the overstorey trees.

- The above qualities may be absent in a forest or woodland but other essential habitat features are present and adjacent to areas exhibiting the above qualities.
- A relatively high density of koalas is supported, regardless of the presence of food tree species. Koala population densities vary across their range and regional data should be used to judge relative density."

The supplementary assessment aims to provide a more rigorous assessment of Koala habitat using the results from 160 habitat assessment plots conducted across all project sections. The plots (each 50 by 20 metres) were stratified by BioMetric Vegetation Types. At each plot, data were collected for the tree species in the canopy and proportion of the total canopy. The results are presented in Appendix B. The plots were used to classify the habitat into primary and secondary habitat according to DEC criteria (2008); these criteria were applied to the field data and vegetation mapping data to identify the proportion of habitat for koalas situated within the project boundary (refer Figure 5-20 to Figure 5-30).

The total area of habitat critical to the survival of koalas was determined by cross-referencing the habitat assessment plot data with the BioMetric Vegetation Type data. Vegetation polygons that met the DEC criteria were identified separately and then tallied to show the total area of habitat critical to the survival of the species as per DSEWPaC (2012). In some cases, as a precautionary approach, where a habitat assessment plot was absent, the polygon was assumed to meet these criteria if it was of the same vegetation type regardless of the proportion of habitat trees.

5.5.2.4. Results

Koala scats were confirmed and mapped at 18 sites within the project boundary (refer to Figure 5-20 toFigure 5-30). (The species was also confirmed from another six sites in sections 9 and 10 in the preferred route studies, but spatial coordinates are not available and these have not been mapped.) In Table 5-8, the data for confirmed sites are discussed in relation to the location of the Koala records and density of Koala records from the surrounding location.

Table 5-8 Locations were evidence of koalas was confirmed from the scat search surveys

Project section	Sites with scats	Location description	Distribution of Koala records	Regional Koala population information
1	1	Only one site near the Range Road intersection on the eastern side of the current Pacific Highway.	Very few atlas records between Corindi and Halfway Creek, no evidence of a local population centred near the study area.	Low density Koala populations reported in the Yuraygir National Park and state forests within the Clarence Valley LGA (CVC 2010).
3	3	Three sites, all between Sommervale Road and the Tyndale interchange on the eastern side of the Tucabia-Tyndale Road in proximity to Pine Brush State Forest.	Scattered low density of records between Red Rock and Tyndale, no evidence of an important population centred near the study area.	Very low density Koala populations reported in Yuraygir National Park and State forests within the Clarence Valley LGA (CVC 2010).
5	1	One site within Mororo Nature Reserve and adjoining property to the east. Koala observed in Mororo Nature Reserve likely associated with Woombah sub-population known from the east of this location.	Population known in Bundjalung National Park and several state forests to the west of the project boundary.	Regional population extends from the Clarence to the Richmond River. Important populations known to the east of the highway at Iluka and Woombah and west of the highway at Ashby.

Project section	Sites with scats	Location description	Distribution of Koala records	Regional Koala population information
7	1	One site adjacent to Tabbimoble Swamp Nature Reserve to the north.	Records are widespread throughout the Tabbimoble area from Bundjalung National Park to several state forests in the west. No concentrated areas showing high density Koala records - unlikely to be important population near the study area.	Regional population extends from the Clarence River to the Richmond River. Low density Koala populations reported through Bundalung National Park .
9	4	Broadwater National Park adjacent to the existing highway. Also south side of the Richmond River at Pine Tree Road Broadwater on the eastern side of the existing highway, within proximity to Broadwater National Park. Associated with Broadwater sub-population.	Population known from Rileys Hill and Broadwater National Park. Numerous records from this area in the atlas and Friends of the Koala have reported road strike in the Broadwater area. Important population present from Rileys Hill and Broadwater National Park.	Regional population extends from Clarence River to the Richmond River. Potentially medium to high density population in Broadwater to Rileys Hill area including parts of Broadwater National Park
10	8	One site along existing highway south of Coolgardie Road, and six sites between the Richmond River and Old Bagotville Road, including Thurgates Road and Old Bagotville Road. Associated with Wardell, Bagotville Coolgardie sub-population.	Population present from Coolgardie and Bagotville, particularly from the Richmond river to Wardell road. Numerous records in this location indicating high density population.	Regional population north of the Richmond River to Alstonville plateau. High density sub-populations in the Coolgardie and Bagotville area.

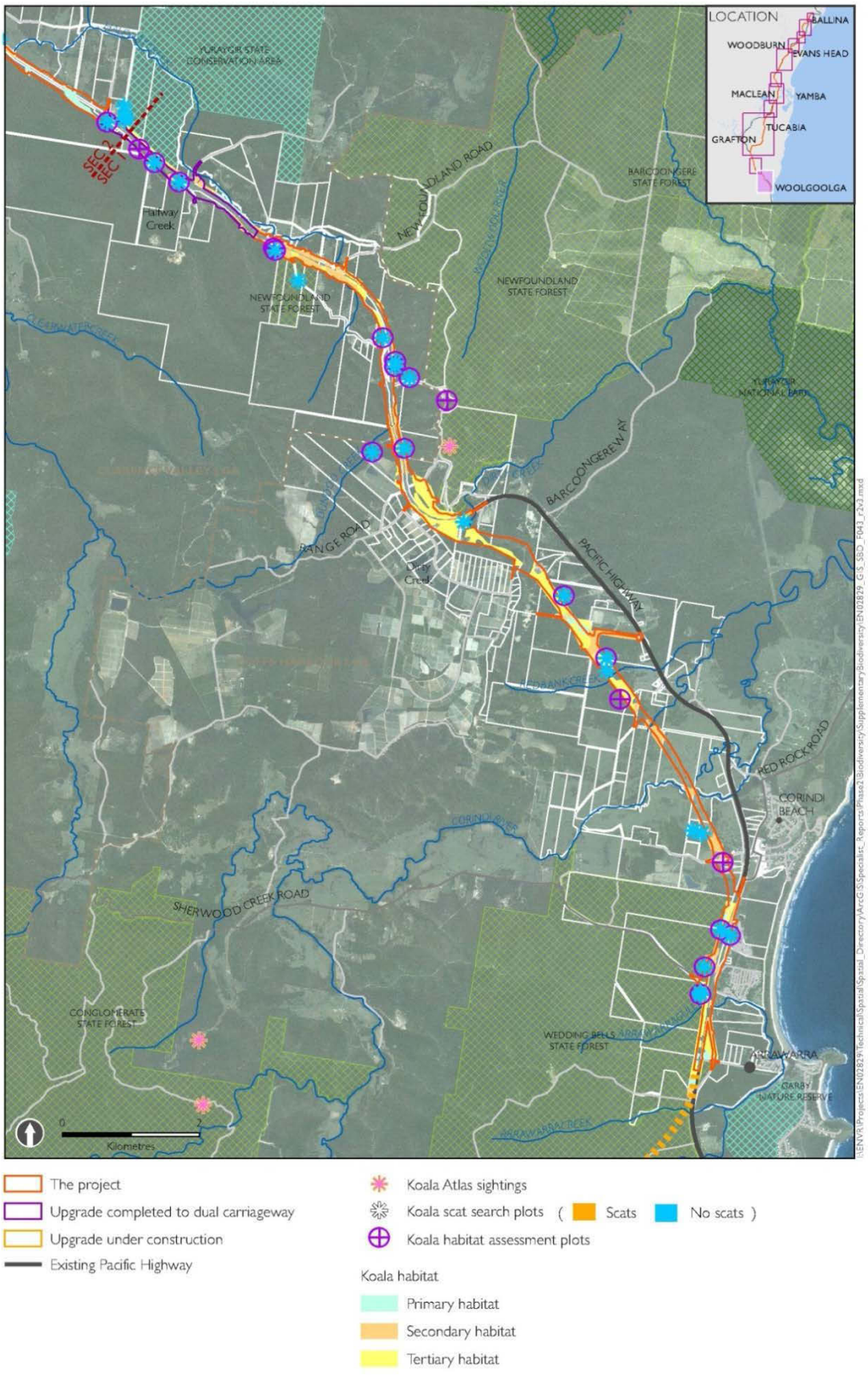

Figure 5-20 Koala survey locations and habitat categories (Section 1)

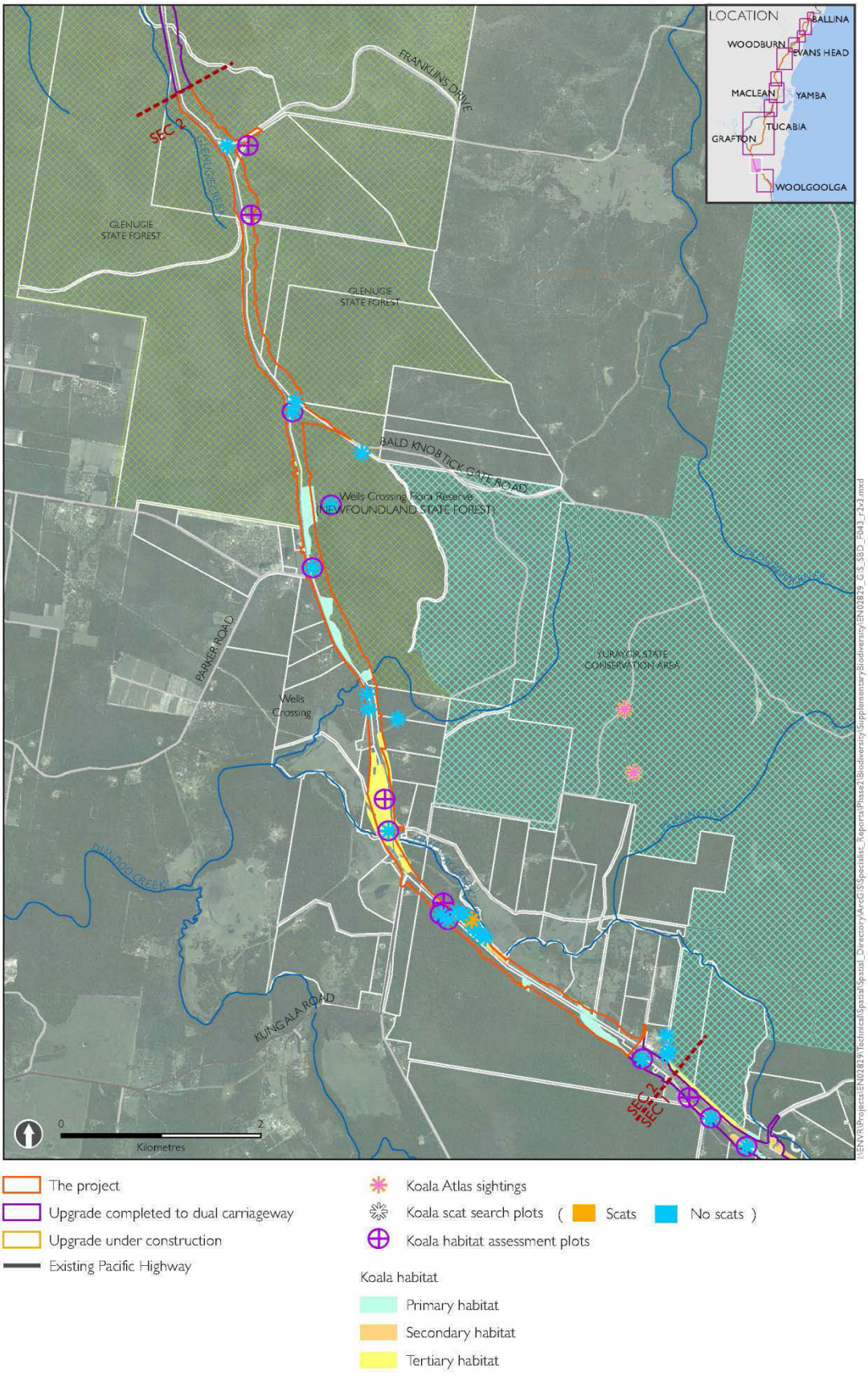

Figure 5-21 Koala survey locations and habitat categories (Section 2)

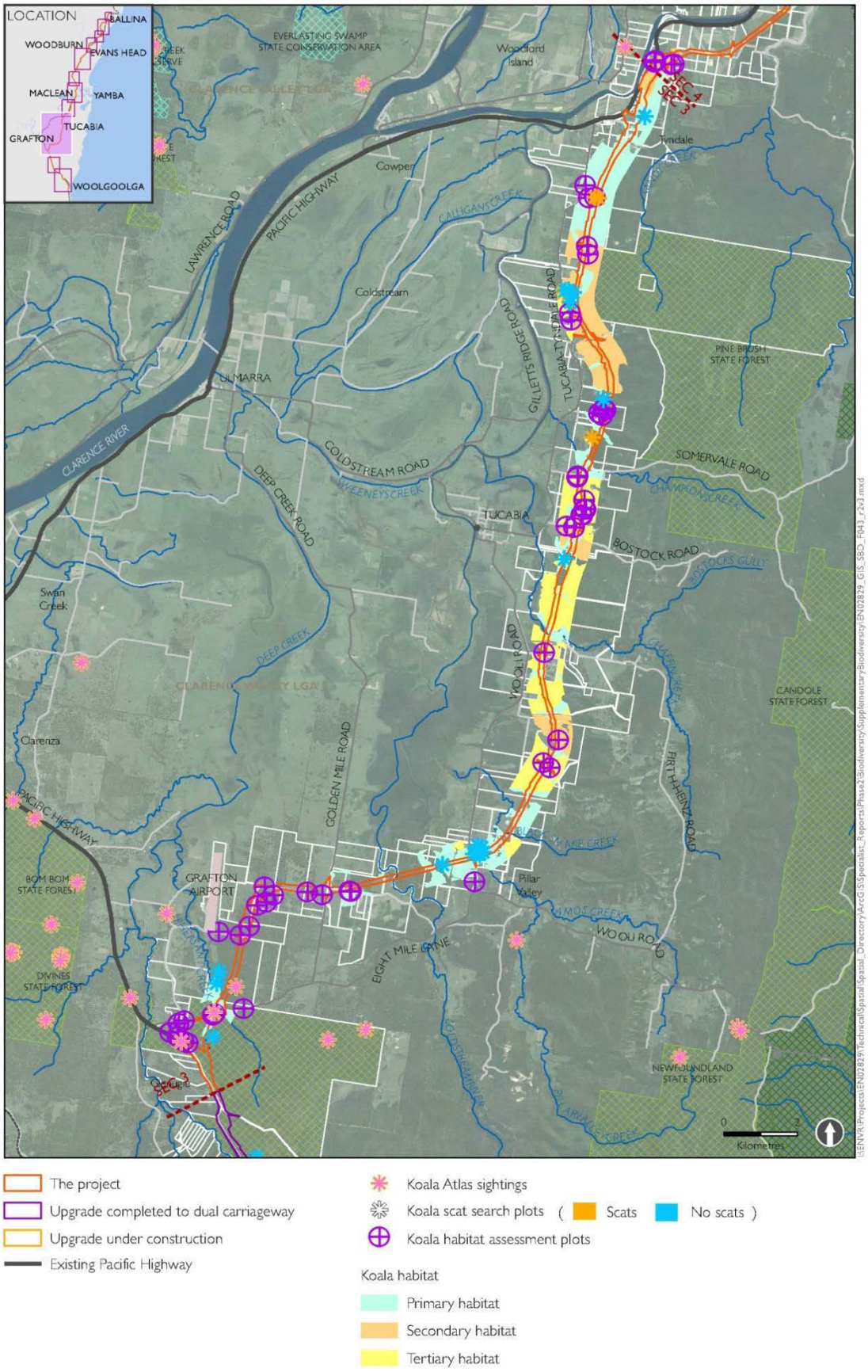

Figure 5-22 Koala survey locations and habitat categories (Section 3)

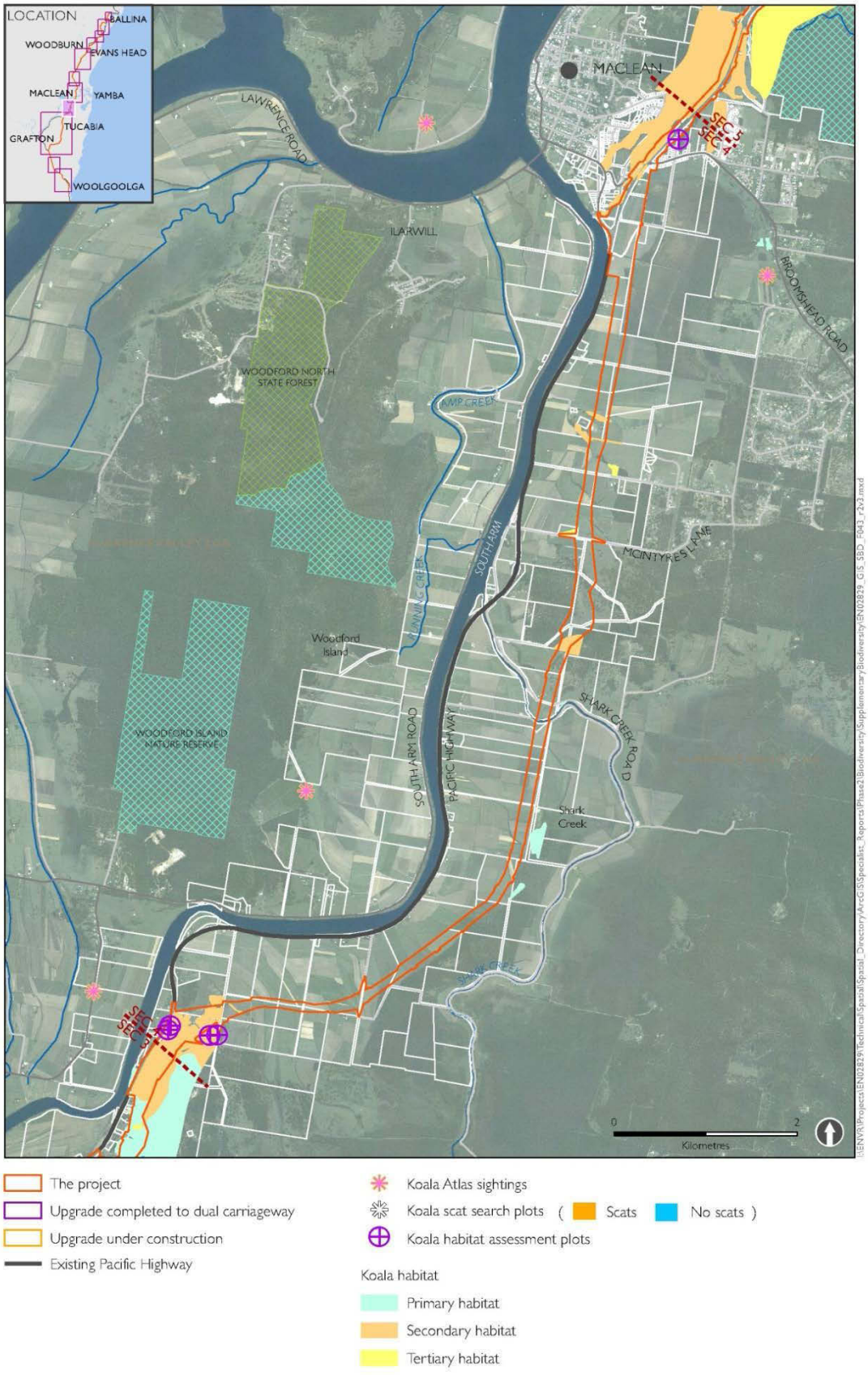

Figure 5-23 Koala survey locations and habitat categories (Section 4)

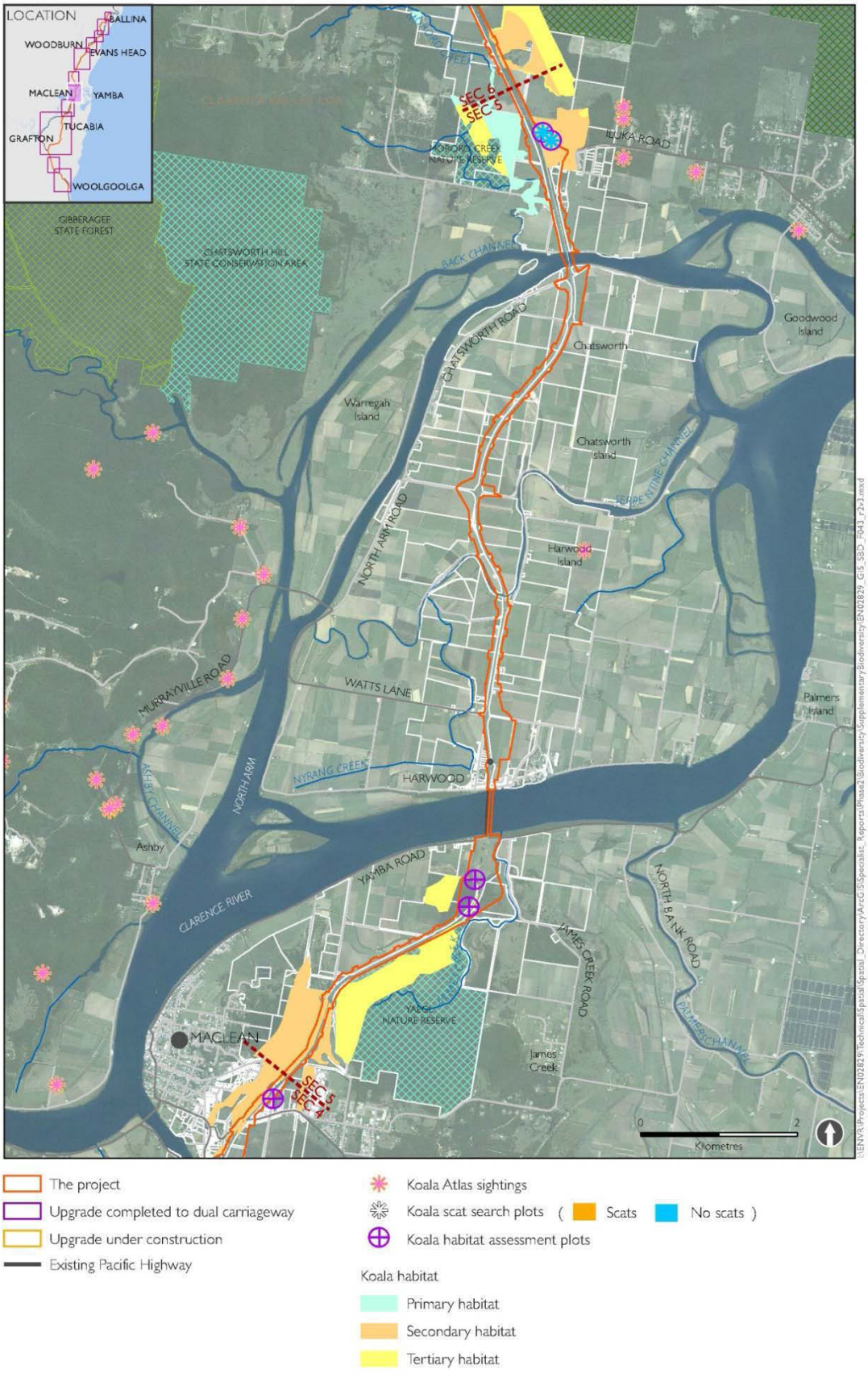

Figure 5-24 Koala survey locations and habitat categories (Section 5)

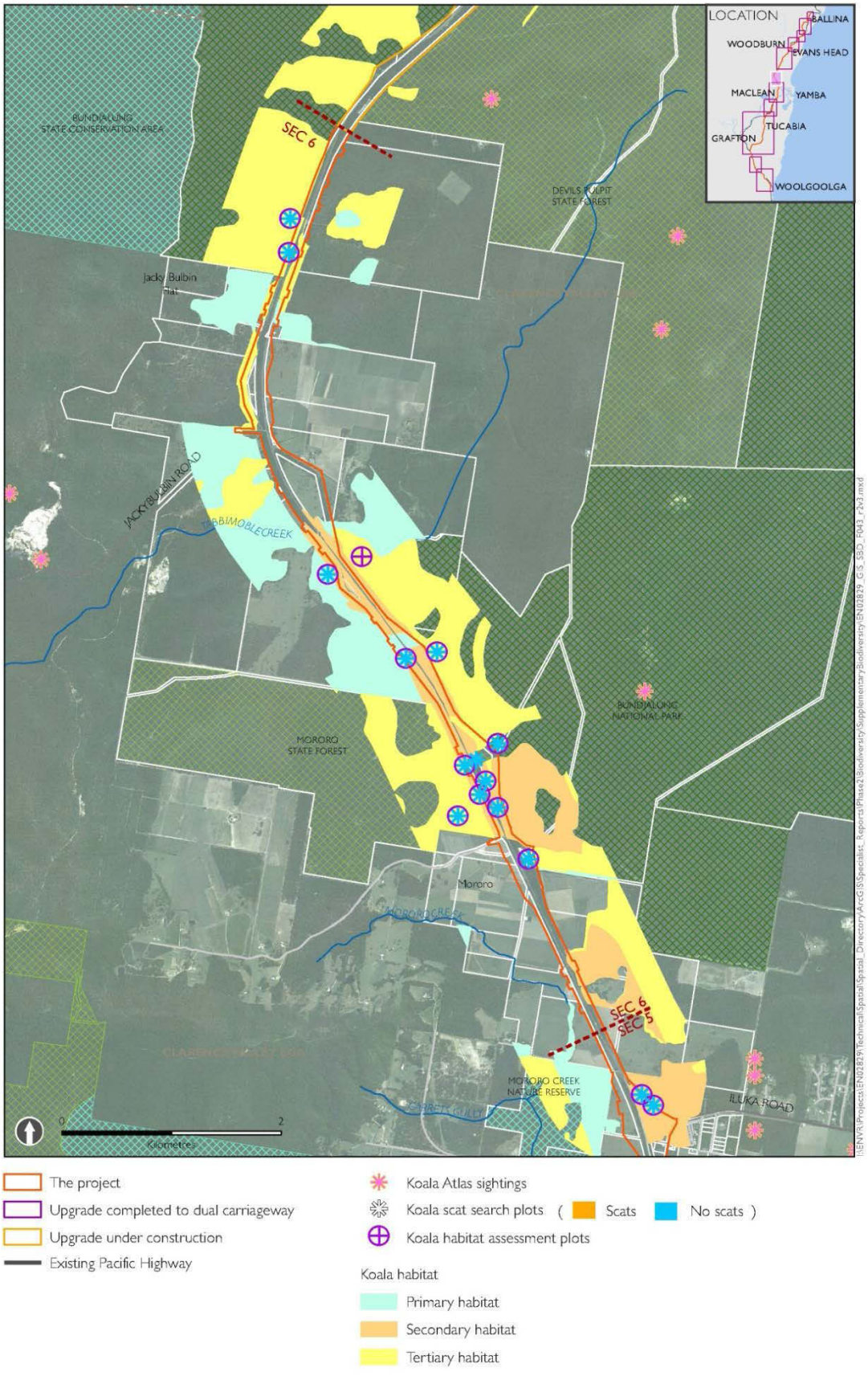

Figure 5-25 Koala survey locations and habitat categories (Section 6)

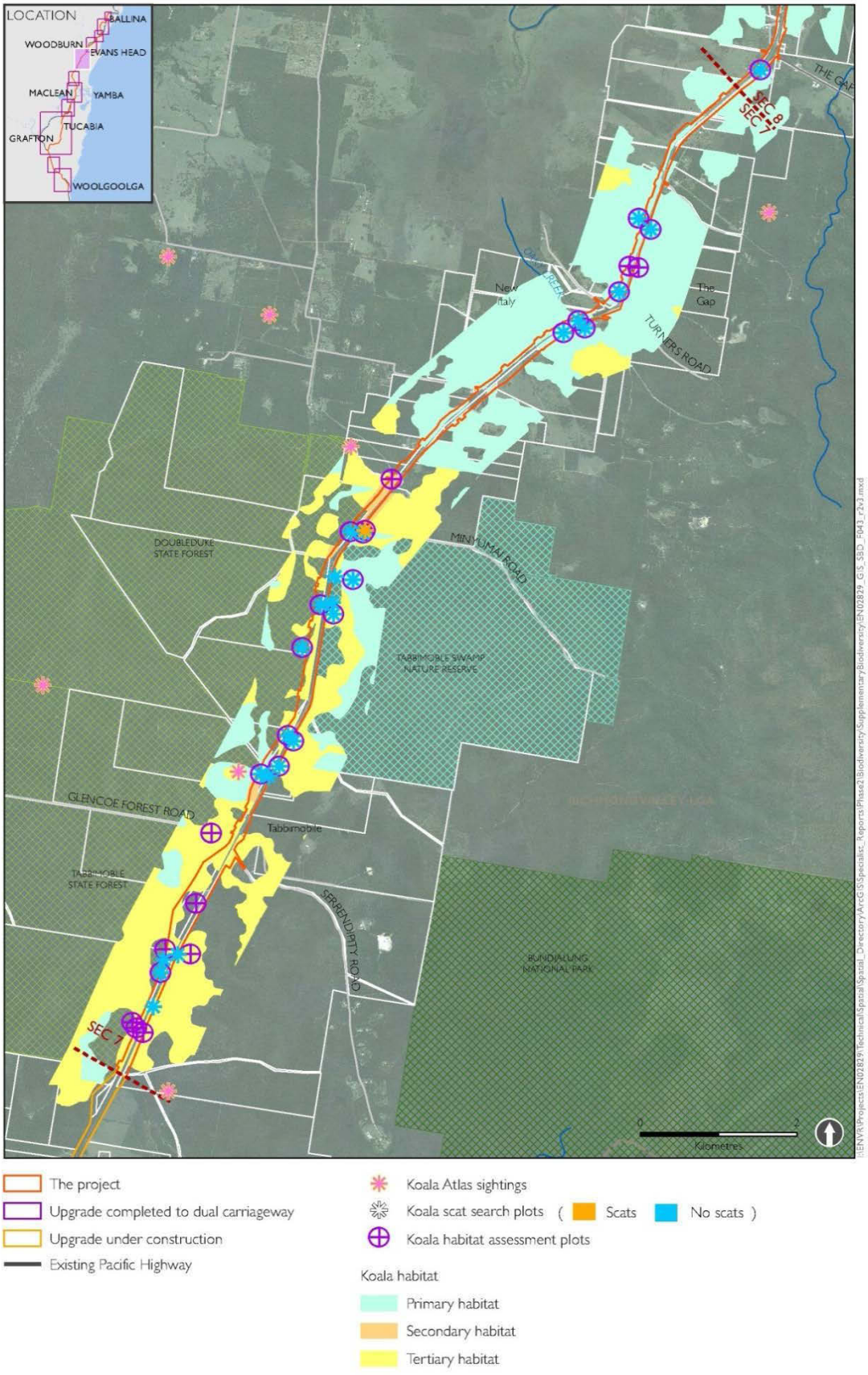

Figure 5-26 Koala survey locations and habitat categories (Section 7)

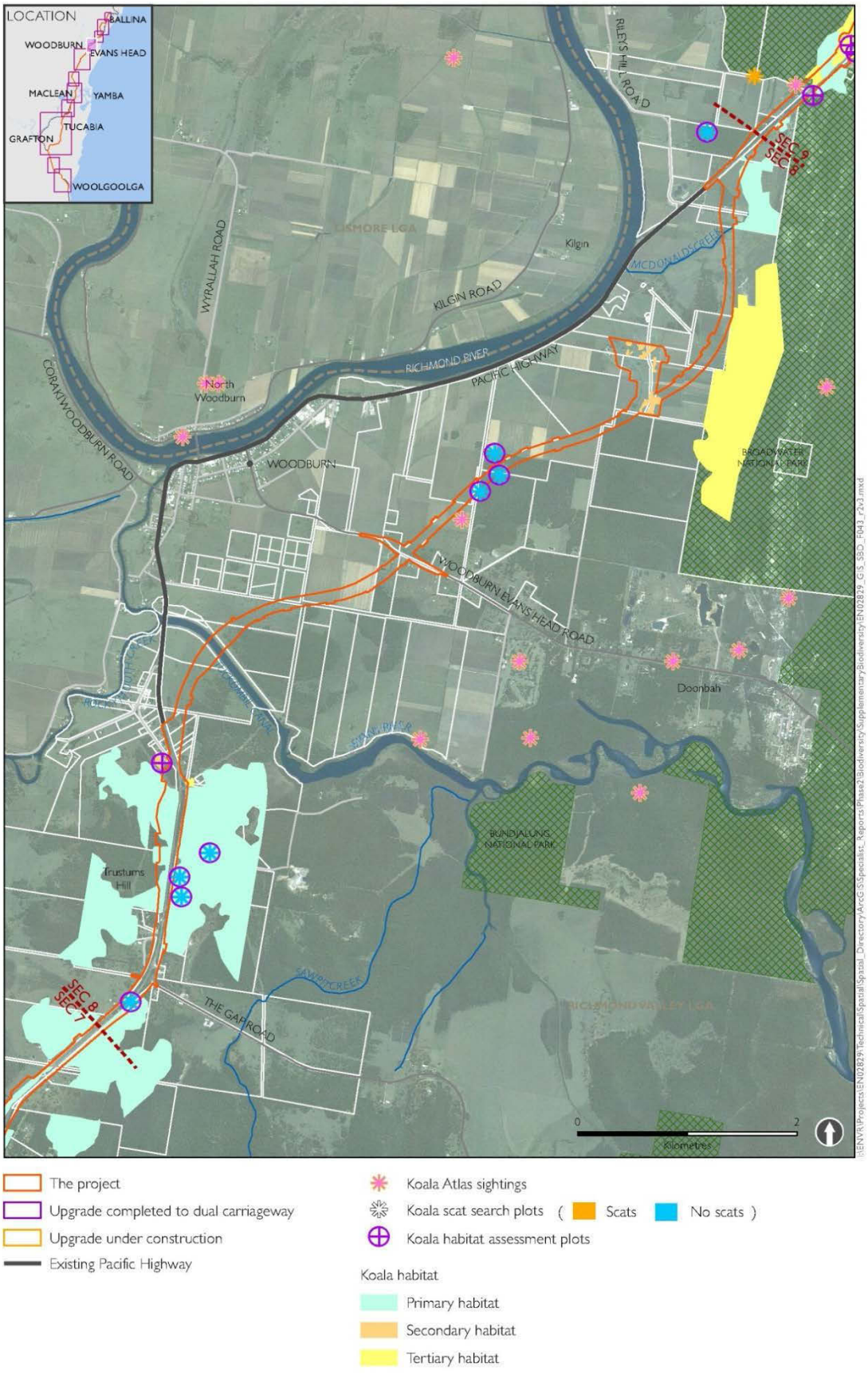

Figure 5-27 Koala survey locations and habitat categories (Section 8)

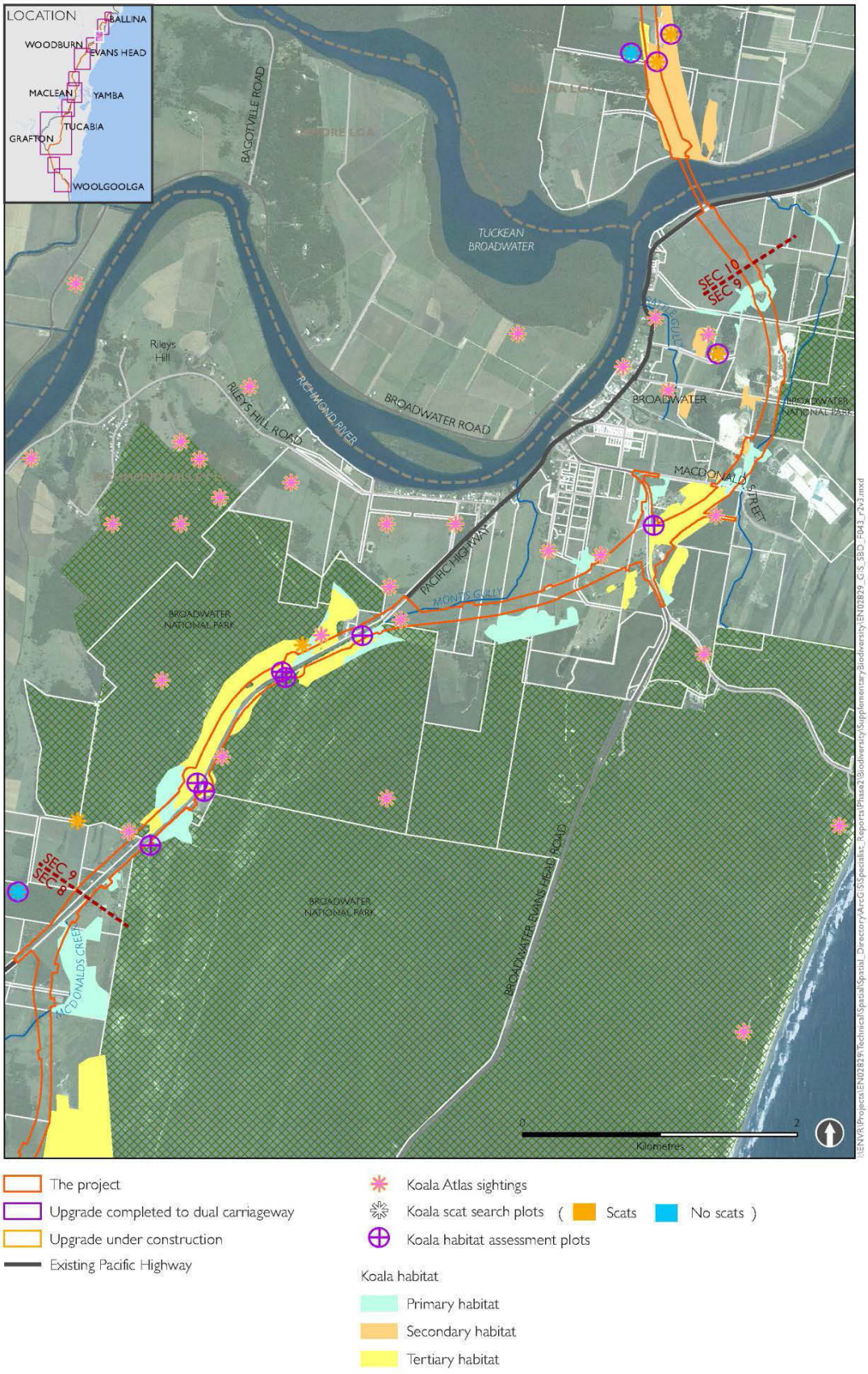

Figure 5-28 Koala survey locations and habitat categories (Section 9)

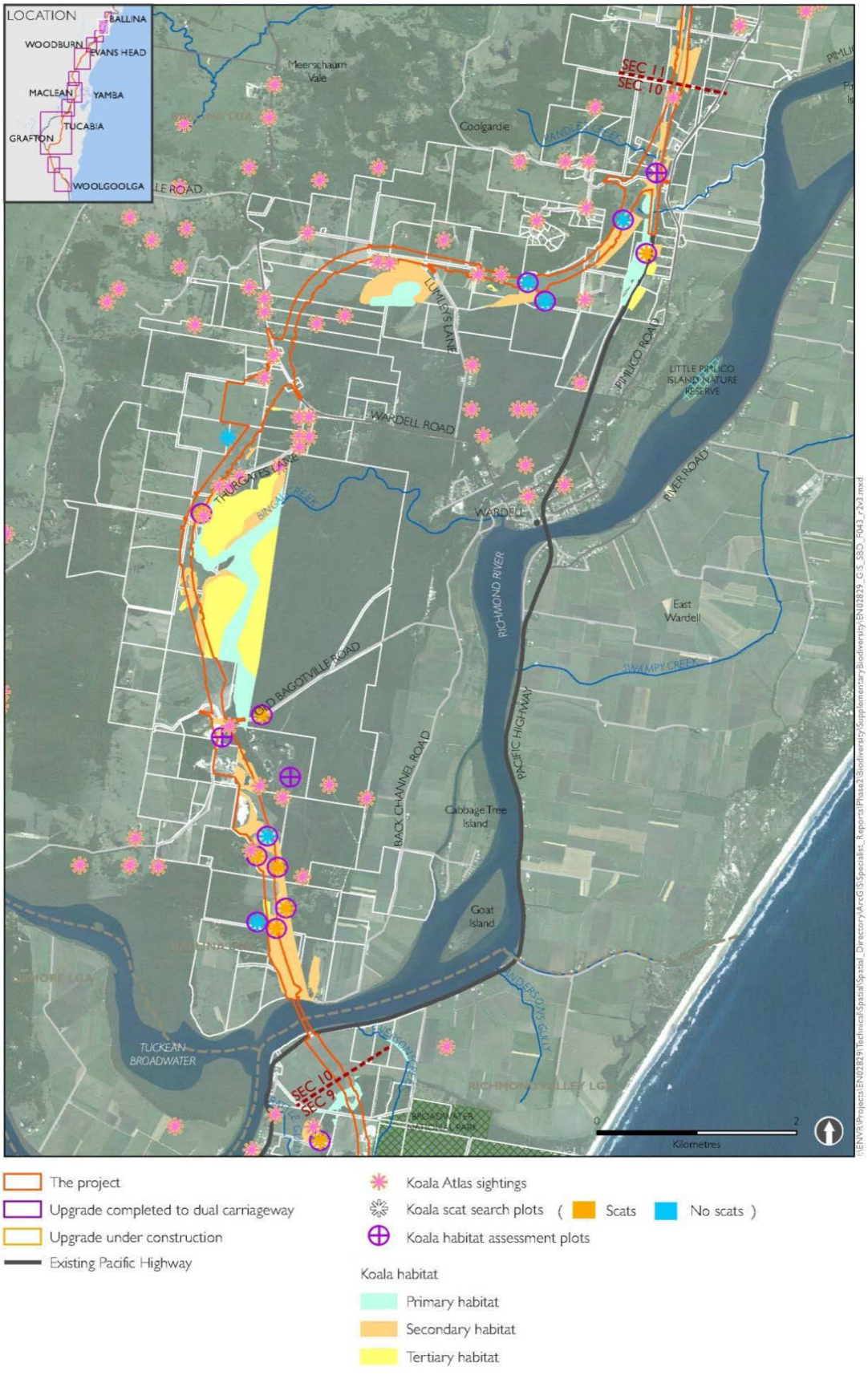

Figure 5-29 Koala survey locations and habitat categories (Section 10)

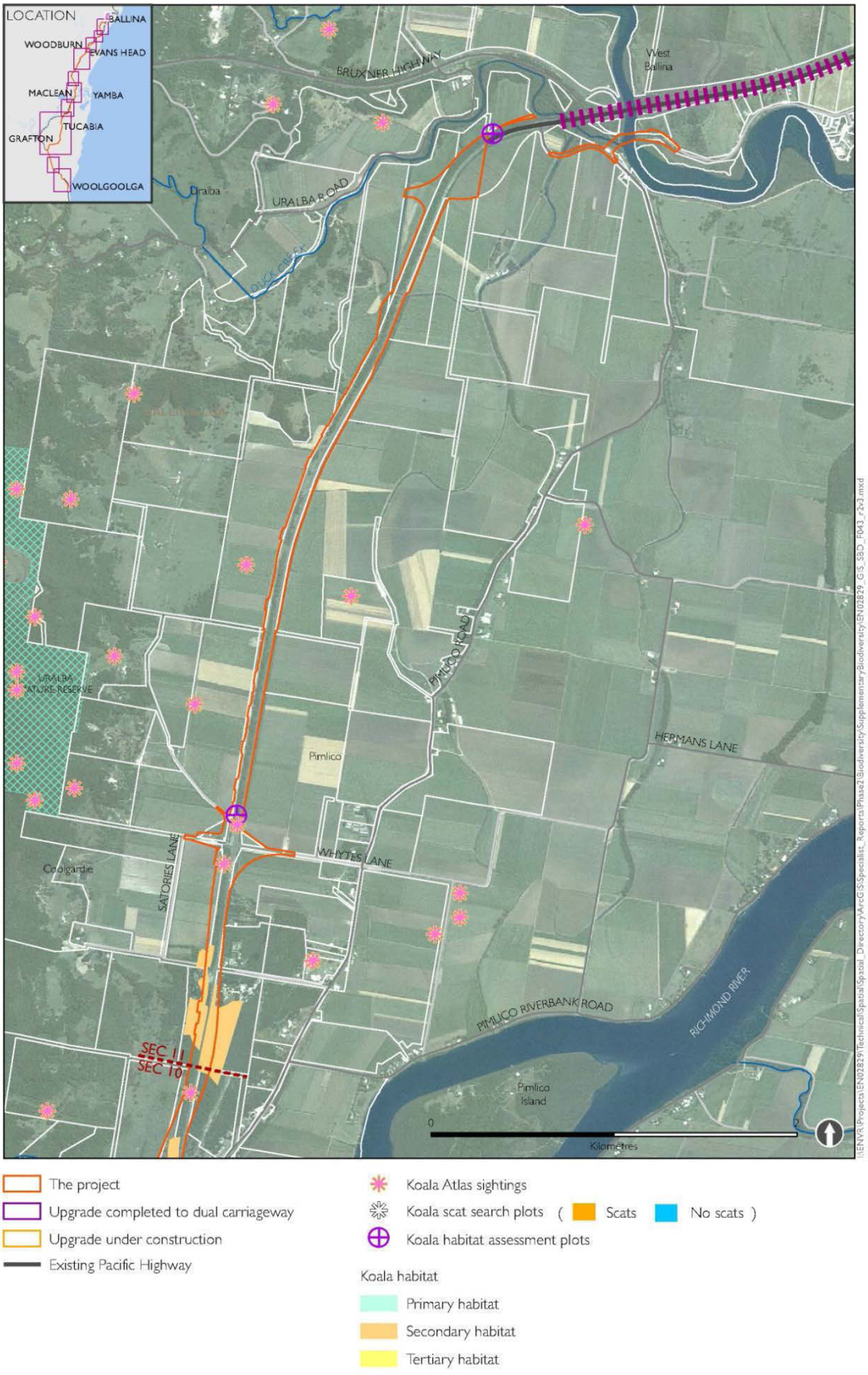

Figure 5-30 Koala survey locations and habitat categories (Section 11)

Important Koala populations within the study area

There are over 11,000 recorded Koala sightings in the NSW Atlas for the NSW North Coast Bioregion. The records are spread over all local government areas in a wide range of topographies and habitats, including reserves, State forests and private land. The data indicate that koalas could occur in all project sections in a range of habitats that would be impacted by the project.

There are high-density Koala populations occur in the Richmond Valley LGA between Woodburn and Wardell (project sections 9 and 10) particularly around Wardell to Coolgardie and Bagotville (Section 10) and south of the Richmond River from Rileys Hill to Broadwater National Park (Section 9). These populations are consistent with the definition of an 'important population' according to the Interim Koala Referral Advice for Proponents (DSEWPaC, 2012).The results of the scat searches across all project sections support the existing knowledge of high-density Koala populations close to the highway in sections 9 and 10 and low-density populations in sections 1, 3, 6 and 7.

A Koala sub-population is defined by the capacity of individuals to move from one habitat patch to another and exchange DNA. Sub-populations are separated by substantial barriers to movement (such as a river, mountain range, greater than 15 kilometres of cleared rural land or artificial barriers), and there is very little likelihood of exchange of individuals between the two groups. The Richmond River provides a major barrier to the Koala sub-population at Broadwater and restricts movements to the west and north. The Koala sub-populations noted in the EIS occurring north and south of the river (sections 9 and 10) are considered separate sub-populations. The northern sub-population is constrained by the river to the east, although there is contiguous habitat to the west towards Tuckean Nature Reserve and north to Alstonville where there are other known Koala sub-populations. It is recognised that the project would create a barrier for movements east and west near Coolgardie and this has been addressed in the connectivity strategy.

The Clarence Valley Koala Plan of Management (Clarence Valley Council, 2010) identifies three important Koala sub-populations in the northern parts of the LGA at Iluka, Woombah and Ashby. Until relatively recently, the Iluka Peninsula supported a renowned high-density Koala population; a drastic decline over the last 10 years or so has left this sub-population functionally extinct (Clarence Valley Council, 2010). This population occurs to the east of the Pacific Highway near the township of Iluka.

The Plan of Management reports on the results of Koala activity surveys conducted for the Ashby and Woombah sub-populations. The plan reports that:

- Koala activity within the Ashby area was neither widespread nor continuous, but was instead indicative of a small, fragmented population comprised of at least three disjunct breeding aggregations. (These aggregations all occur west and south of the highway upgrade, close to the river.)
- The distribution of Koala activity for the Woombah sub-population shows an area of habitat with low Koala usage around 500 metres east of the Pacific Highway between station 95.7 and station 97.1. The Koala records made during the EIS and supplementary biodiversity assessment on the western side of the highway in Mororo Creek Nature Reserve may be part of the Woombah sub-population, although the range of the population is reportedly east of the highway (as reported in in Clarence Valley Council, 2010).

Assessment of 'habitat critical to the survival of the Koala' in the project area

Several Koala food tree species listed for the NSW North Coast (DECC, 2008) were identified from the habitat assessment plots, including the primary species Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*E.tereticornis*), Tallowwood (*E.microcorys*), and Orange Gum (*E.bancrofti*). Secondary (Secondary-Class A) food tree species are represented by Red Mahogany (*E.resinfera*), Small fruited Grey-Gum (*E.propinqua),* and Narrow-leaved Red Gum (*E.seena*). Supplementary (Secondary-Class B) tree species include the stringybarks (*E.tindaliae* and *E.globodiaea*).

The revised total area of Koala habitat that would be directly cleared (by the project is shown in Table 5-9. It takes into account vegetation along all project sections where high- and low-density populations occur, and is not specific to important Koala populations.

As shown, 375.4 hectares of primary and secondary 'habitat critical to the survival of koalas' would be removed by the construction of the project. This is far less than the EIS estimate that the project would have impacts on about 557 hectares.

Table 5-9 Impacts on 'habitat critical to the survival of koalas'

Koala habitat category	Impact (Hectares)
Primary habitat	176.6
Secondary habitat (class A)	106.9
Secondary habitat (class B)	91.9
Total	**375.4 hectares**

5.6. Giant Barred Frog

5.6.1. Background

The EIS identifies risks to populations of the threatened Giant Barred Frog in project sections 1–2 and 6–8. This is due to the presence of known populations in these locations and suitable habitat, particularly between Woolgoolga and Halfway Creek, from Tabbimoble State Forest to the west of the highway, and near Tabbimoble Swamp Nature Reserve to the east of the highway.

In totality, the following surveys have been undertaken, either pre-EIS or post-EIS:

- A targeted survey for the Giant Barred Frog in project sections 6–8 (Iluka Road to Woodburn) during the preferred route studies (Lewis Ecological Surveys, 2006). The survey was carried out in optimum conditions associated with rainfall events in the week prior. (Refer to Appendix E.)
- Targeted frog surveys in Section 3 in the winter of 2007 (SKM, 2009), and follow-up summer surveys in December 2011 during more appropriate wetter conditions (EIS Working paper – Biodiversity).
- A targeted survey for the Giant Barred Frog within project sections 1 and 2 (Woolgoolga to Glenugie) under optimum conditions during December 2012 and January 2013 (Lewis Ecological Surveys, 2013) as part of the detailed design for the Woolgoolga to Glenugie upgrade. (Refer to Appendix E.)

The survey methods and results are presented below. Together, these surveys provide information on the distribution and condition of the habitat for the Giant Barred Frog inside the project boundary.

5.6.2. Targeted surveys

5.6.2.1. Methods

The survey approach was the same for all potential habitat areas and involved a diurnal reconnaissance survey to identify potential habitat for the target species followed by nocturnal visits to each site during optimal survey conditions.

The methods described are for project sections 1, 2, 3, 6, 7 and 8. Seventy sites were surveyed across the six project sections to cover suitable habitat for a range of targeted threatened frog species. Of these 70 frog survey sites, suitable stream habitats for the Giant Barred Frog were only present at 15 sites. The stream sites providing suitable habitat for the Giant Barred Frog are listed in Table 5-10 together with survey times and the corresponding report reference.

Table 5-10 Waterways targeted for Giant Barred Frog surveys (2006-2013)

Project section	Waterway (survey site)	Station	Survey dates and reference
1	Tributary of Arrawarra Creek	0.3	December 2012; February 2013 (LES 2013a/b)
	Corindi Creek	3.6	December 2012; February 2013 (LES 2013a/b)
	Dirty Creek	8.5	December 2012; February 2013 (LES 2013a/b)
	Boneys Creek	13.3	December 2012; February 2013 (LES 2013a/b)
2	Halfway Creek	20.7	December 2012; February 2013 (LES 2013a/b)
3	Coldstream River	43.3	August 2007 (SKM 2009)
	Unnamed creek	48.6	August 2007 (SKM 2009); December 2011 (EIS)
	Chaffin Creek	52.5	August 2007 (SKM 2009); December 2011 (EIS)
	Champions Creek	57.0	December 2011 (EIS – Biodiversity working paper)
6	Mororo Creek	96.7	February 2006 LES (2006)
	Tabbimoble Creek	101.6	February 2006 (LES 2007)
7	Tabbimoble overflow	121.8	February 2006 (LES 2006)
	Sawpit Creek	125.4	February 2006 (LES 2006)
8	North of New Italy area	127.3	February 2006 (LES 2006)
	Tabbimoble Canal	130.0	February 2006 (LES 2006)

The surveys were either area-based or time-based, using a 500-metre transect or a 60-minute search time. The location of survey sites in relation to stream habitats is shown in Figure 5-31 to Figure 5-35. During the survey period, active search techniques were employed by two people using 50-watt hand-held spotlights, call imitation at regular intervals, and illumination of the water column to identify and capture tadpoles. The objective of this approach was to obtain a higher degree of accuracy arising from a single visit.

5.6.2.2. Results

The results of the targeted survey for Giant Barred Frog (Lewis Ecological Surveys, 2013a) confirmed the previous account of this species in the Corindi River, as identified by Ecotone (2007) during the preferred route studies. The results also confirmed the importance of this site for the species. Seven individuals were reported in 2007 and 10 individuals at the same site in 2013.

The EIS also identified and assessed potential habitat for this species in Dirty Creek (Section 1) and Halfway Creek (Section 2), even though no targeted surveys had at that time been done on these waterways. Subsequently, the species has now been confirmed at both sites from the targeted surveys carried out in 2013 (Lewis Ecological Surveys, 2013a and 2013b). The 2013 surveys also report a moderate likelihood of the species occurring at Boney Creek (station 13.3) and a tributary of Arrawarra Creek (station 0.3), both in Section 1. The remaining areas of sections 1 and 2 were confirmed as having a low potential for this species (as identified in the EIS) as they lack specific habitat attributes such as pool-riffle sequences, steep-sided banks and adequate riparian vegetation, such as the moist sclerophyll or lowland riparian rainforest species preferred by this species (Lewis and Rohweder, 2005).

The species was not identified from the targeted surveys in Section 3 (SKM, 2009), although the habitat was considered moderately suitable habitat at Chaffin Creek (station 52.5). There are previous records of this species on the Coldstream River around three kilometres upstream of Sandy Crossing. Potential habitat for this species is likely in the upper reaches of the Coldstream River upstream from the project on the basis of the dense wet sclerophyll riparian habitats and presence of pools along the stream. The habitat from Sandy Crossing to the lower reaches of the river exhibits swamp sclerophyll forest elements dominated by low-growing paperbark swamps and Swamp Oak, sparse Eucalypt forest or cleared grazed land and is considered unsuitable for the species.

The species was not identified in sections 6–8 (Lewis Ecological Surveys, 2006 and 2007). The habitat in these sections were considered to have a low likelihood occurrence due to the absence of important habitat characteristics. Tabbimoble Creek (station 101.6) and Sawpit Creek (station 125.5) provide some of these habitat attributes, but are highly disturbed as a result of cattle grazing, clearing and logging, which suggests the Giant Barred Frog probably does not occur in this area. The nearest recorded location for this species is around three kilometres west of New Italy in Doubleduke State Forest, with more occurrences further to the west in the Bungawalbin Catchment (Lewis and Rohweder, 2005; Atlas data). Sawpit Creek is to the east of the project and does not cross under the highway.

A summary of the presence of Giant Barred Frog in the study area and the suitability of unconfirmed habitats is detailed in Table 5-11 and illustrated in Figure 5-31 to Figure 5-36.

Table 5-11 Waterways targeted for Giant Barred Frog surveys

Project section	Waterway	Station	Suitability of habitat for Giant Barred Frog
1	Tributary of Arrawarra Creek	0.3	Moderate
	Corindi Creek	3.6	Known population
	Dirty Creek	8.5	Known population
	Boneys Creek	13.3	Moderate
2	Halfway Creek	20.7	Known population
3	Coldstream River	43.3	Low
	Unnamed creek	48.6	Unlikely
	Chaffin Creek	52.5	Moderate
	Champions Creek	57.0	Moderate
6	Mororo Creek	96.7	Low
	Tabbimoble Creek	101.6	Moderate
7	Tabbimoble overflow	121.8	Low
	Sawpit Creek	125.4	Moderate
8	North of New Italy area	127.3	Low
	Tabbimoble Canal	130.0	Low

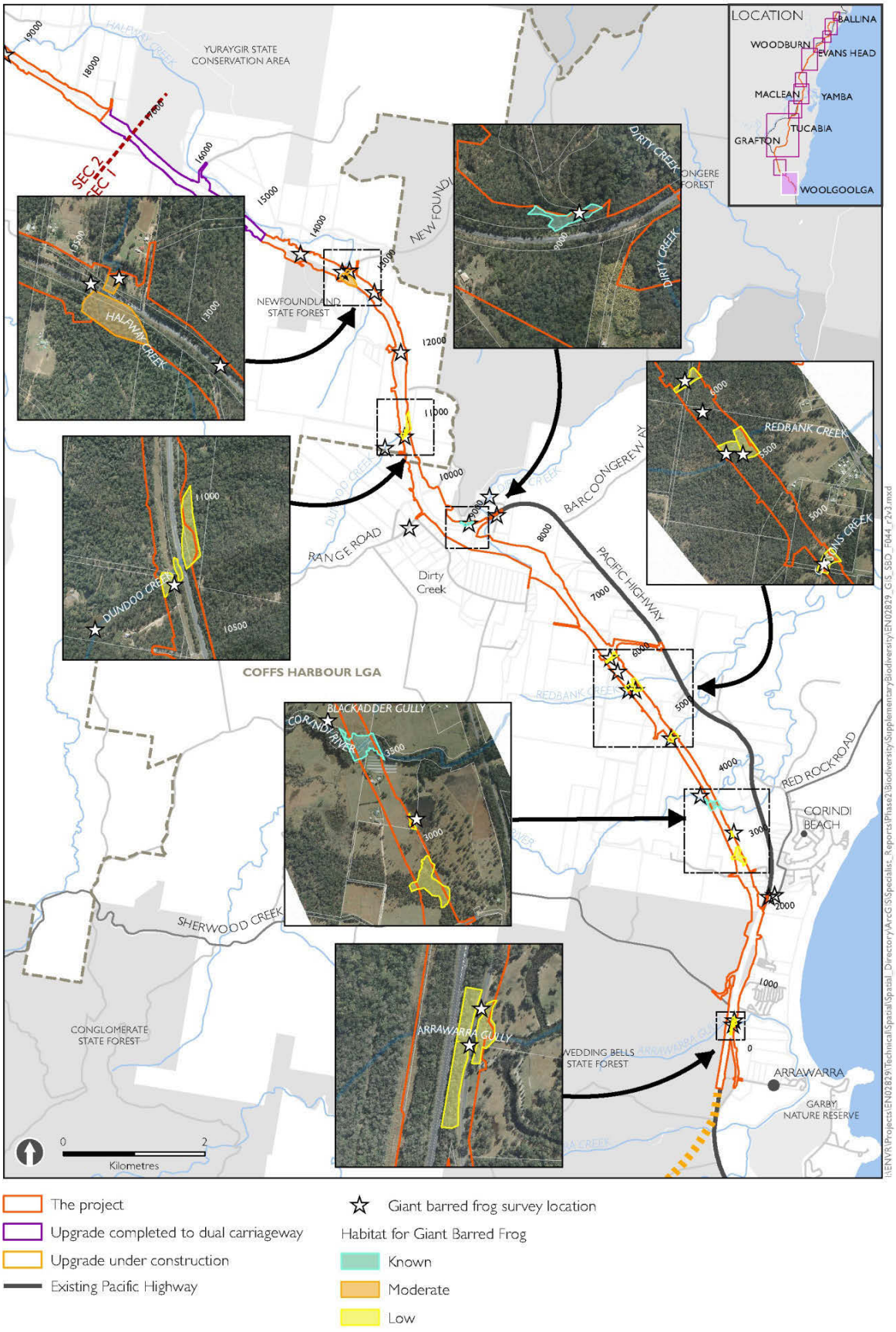

Figure 5-31 Distribution and suitability of habitat for Giant Barred Frog (Section 1)

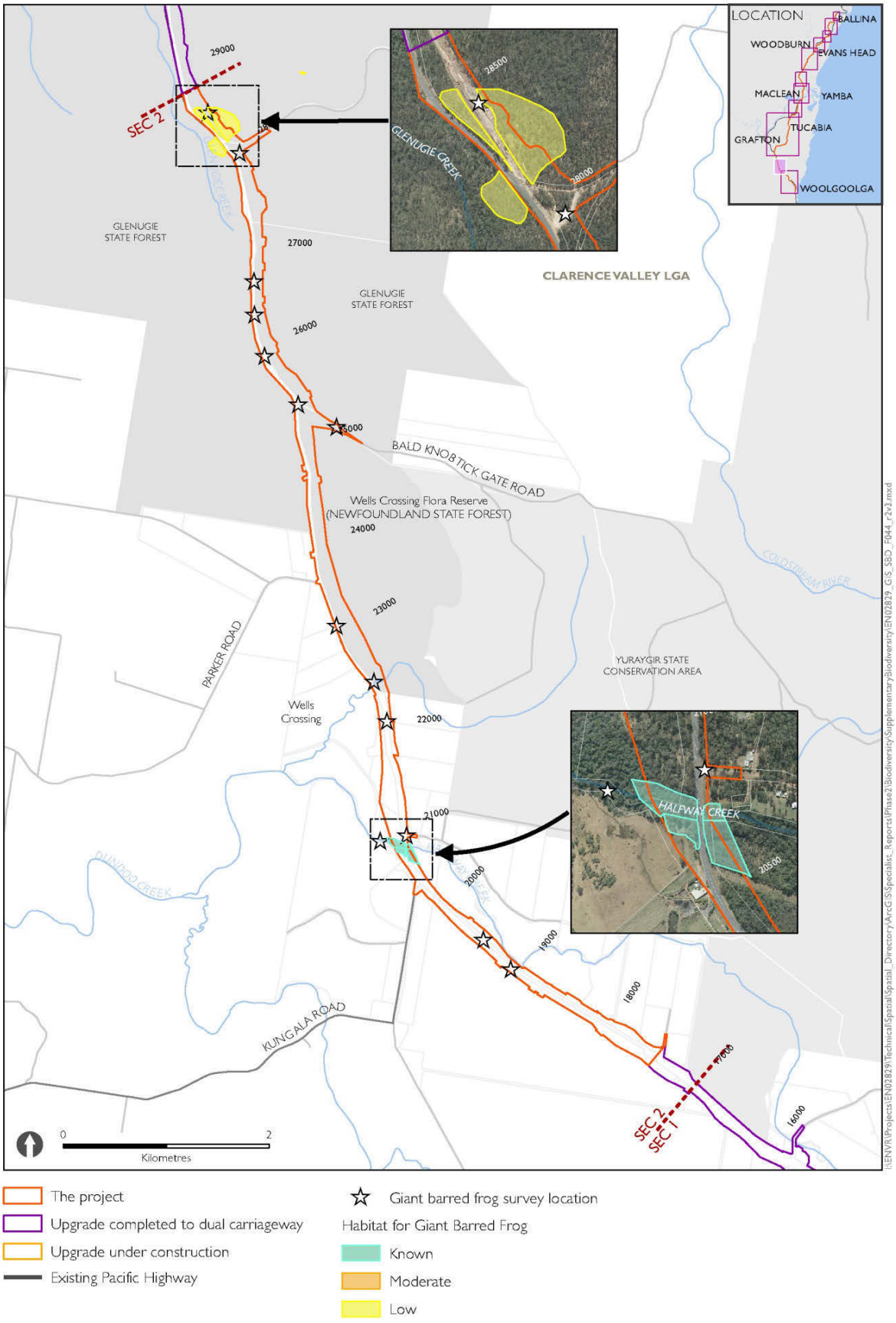

Figure 5-32 Distribution and suitability of habitat for Giant Barred Frog (Section 2)

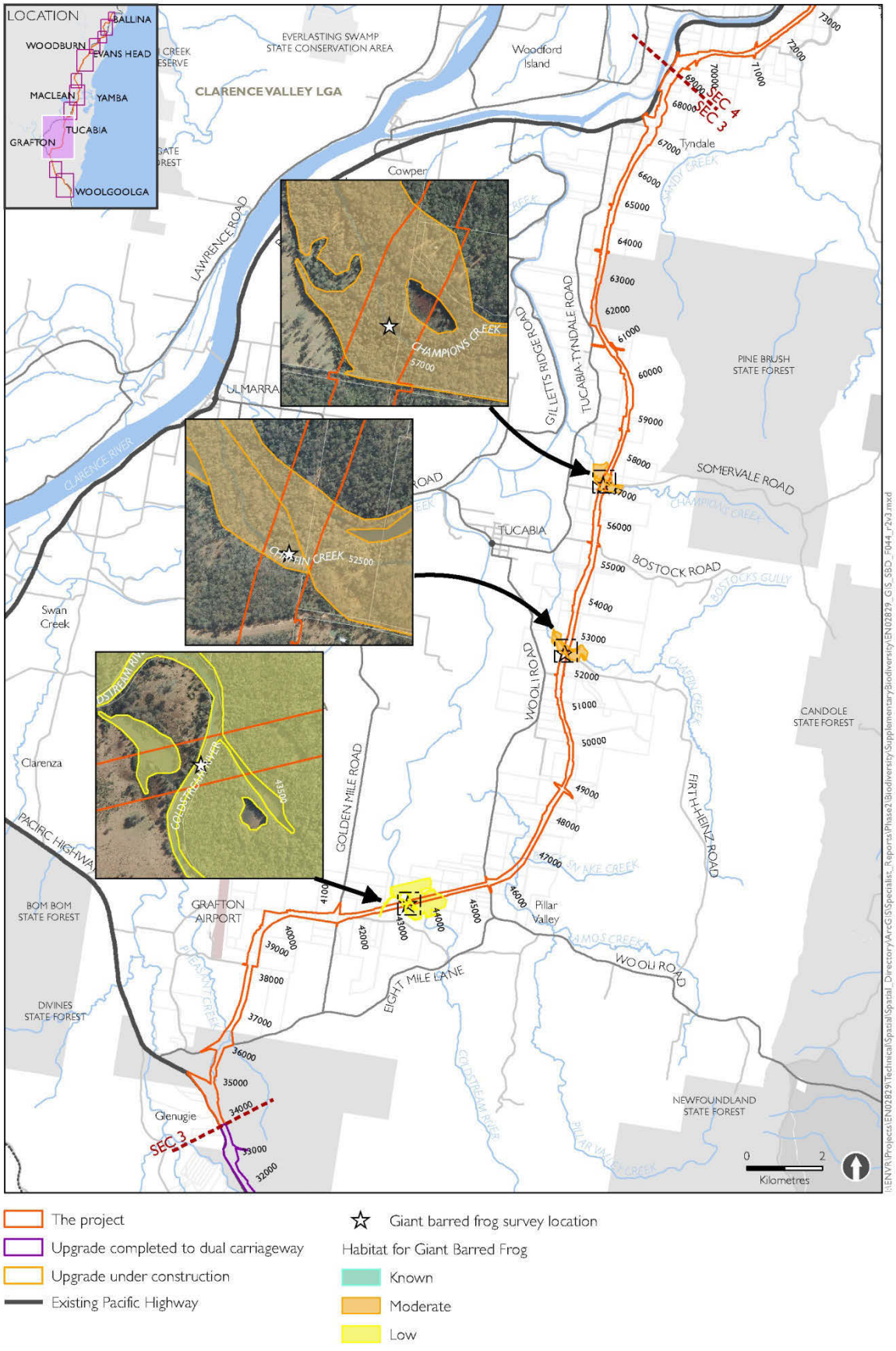

Figure 5-33 Distribution and suitability of habitat for Giant Barred Frog (Section 3)

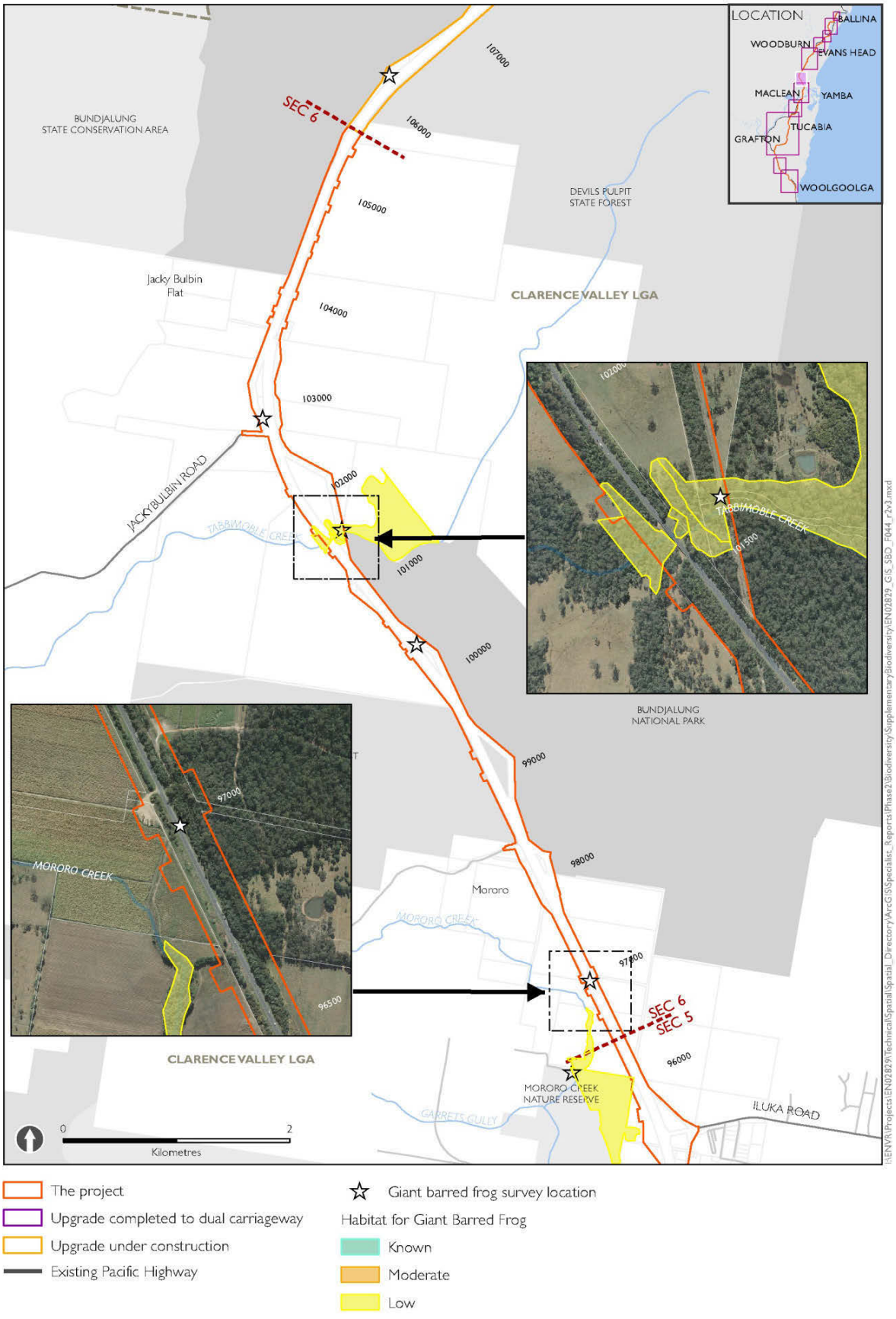

Figure 5-34 Distribution and suitability of habitat for the Giant Barred Frog (Section 6)

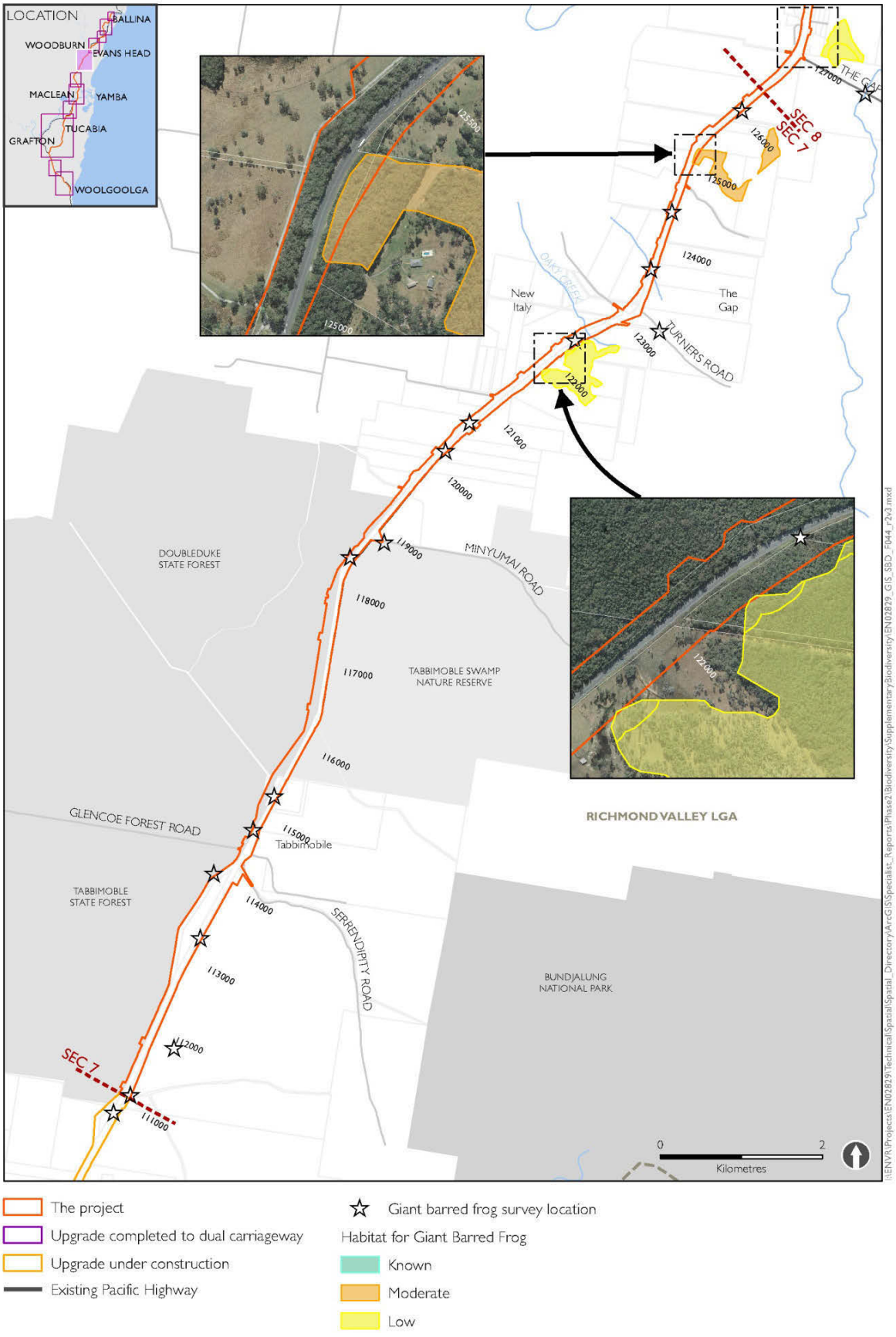

Figure 5-35 Distribution and suitability of habitat for the Giant Barred Frog (Section 7)

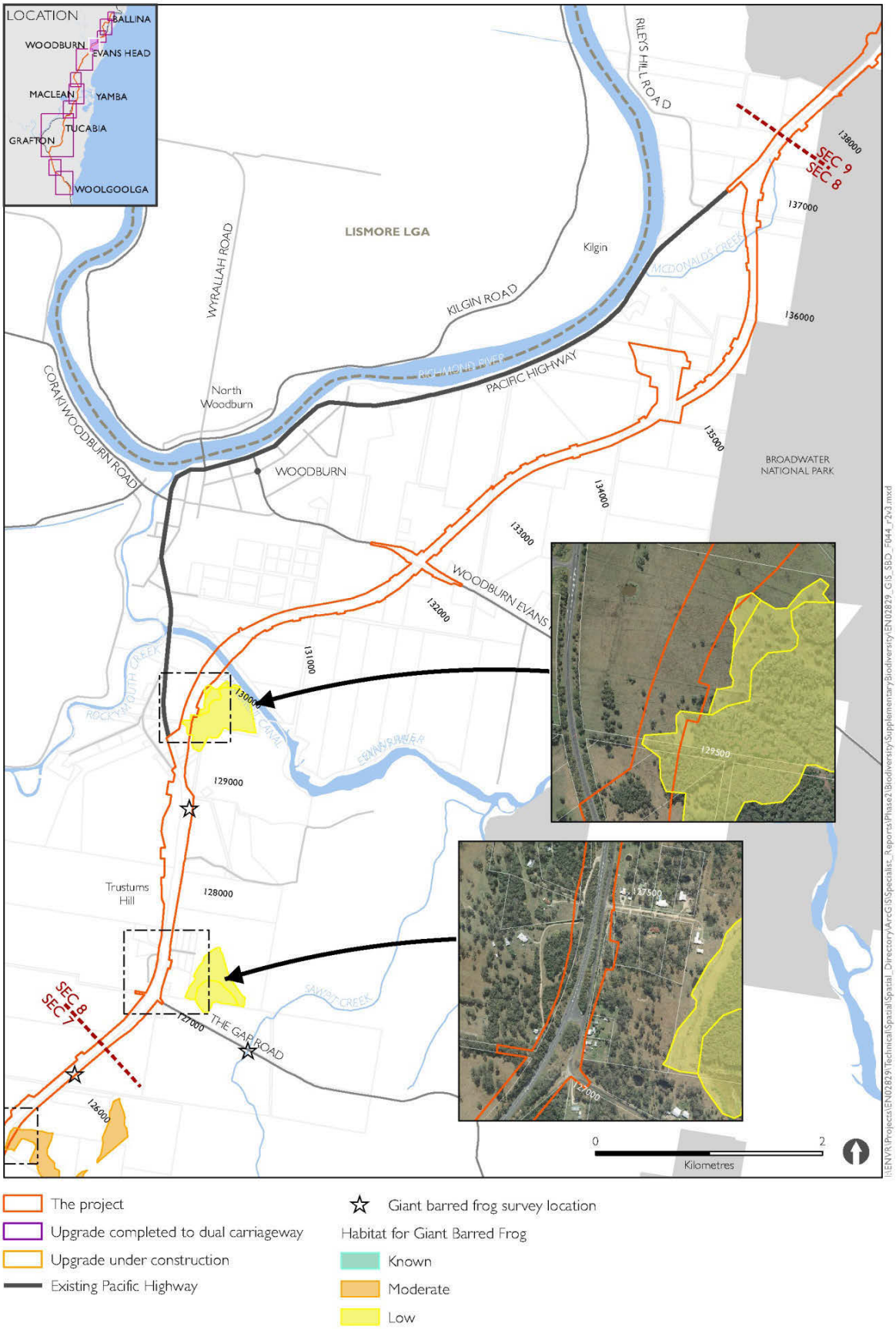

Figure 5-36 Distribution and suitability of habitat for Giant Barred Frog (Section 8)

5.7. Oxleyan Pygmy Perch

5.7.1. Background

The EIS identifies risks to populations of the threatened Oxleyan Pygmy Perch in project sections 1–2 and 6–9, where there are known populations and potential habitat. A targeted survey for the Oxleyan Pygmy Perch was conducted in sections 6 to 8 (Iluka Road to Woodburn) for the EIS under optimum conditions and the species was reported at a number of sites.

The critical review noted the need for additional surveys in sections 1–2 due to the poor (non-optimal) conditions experienced in the previous surveys conducted.

5.7.2. Supplementary surveys

Methods

Two temporally different surveys were conducted over the same 16 waterways to sample variation in species presence over time and provide a baseline for future monitoring. The methods and results of these surveys are reported in GeoLink (2012) and Aquatic Science and Management (2013). (Refer to Appendix F.) The surveys were targeted at Oxleyan Pygmy Perch and Purple-spotted Gudgeon and the locations of the waterways sampled are described in these reports.

Results

The two targeted surveys did not find any Oxleyan Pygmy Perch or Purple-spotted Gudgeon in the 16 significant waterways crossed by the highway upgrade alignment between Woolgoolga and Glenugie. Habitat quality and availability varied across the sites sampled, as did water quality. At some sites the combination of available habitat and water quality were indicative of sites that are potentially suitable for Oxleyan Pygmy Perch and Purple-spotted Gudgeon.

In addition, an intensive fishing effort was undertaken to search for Oxleyan Pygmy Perch and Purple-spotted Gudgeon in and outside of the Woolgoolga to Glenugie upgrade corridor (sections 1 and 2). This involved 29 sites, 433 hours of fish trapping and 27,373 seconds of electrofishing. However, this effort failed to find any Oxleyan Pygmy Perch or Purple-spotted.

Although there are some sites that are suitable for these target species in terms of water quality and habitat availability, it is considered unlikely that there are any populations of these species along the upgrade corridor in sections 1 and 2 (Aquatic Science and Management, 2013). The sites that are most suitable for recruitment of Oxleyan Pygmy Perch are within Section 1, between Arrawarra Gully and Dirty Creek, because this species is thought to be restricted to coastal lowlands (Knight and Arthrington, 2008). Although the study area is outside the current known range of Oxleyan Pygmy Perch, they were collected from Cassons Creek in 1972 (Knight & Arthrington, 2008).

The sites that would be most likely to harbour a population of Purple-spotted Gudgeon are mostly in Section 2, between Halfway Creek and Glenugie Creek, with the addition of Boneys Creek and Dundoo Creek from Section 1 (Aquatic Science and Management, 2013).