



WARRELL CREEK TO URUNGA: NEST BOX PLAN OF MANAGEMENT

DECEMBER 2016



PREPARED FOR THE ROADS AND MARITIME SERVICES BY:

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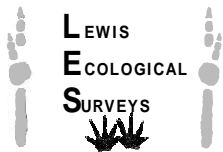
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Top Left– Hollow bearing tree number 285 from Burkes Lane area (section K).

Bottom Left to Right – Squirrel Gliders (*Petaurus norfolcensis*) inhabiting a nest box shortly after its installation in the Hunter Valley.
Gould's Wattleed Bat (*Chalinolobus gouldi*) a common inhabitant of the project study area, juvenile Sugar Glider (*Petaurus brevipes*).

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1.0 INTRODUCTION

1.1 Background

This Nest Box Plan of Management (NBPoM) forms part of the overall management of fauna for the Upgrading of the Pacific Highway to a four lane divided carriageway from the existing Allgomera deviation, south of Warrell Creek to the Waterfall Way, Raleigh by constructing the Warrell Creek to Urunga Upgrade (the Project). The primary objective of this plan is to implement nest boxes as a compensatory mechanism for the loss of den, roost and nest resources and thereby satisfying Minister Condition of Approval B6 "*prior to the commencement of any construction work that would result in the disturbance of any native vegetation (or as otherwise agreed to by the Director General), the Proponent shall in consultation with OEH prepare and submit for the approval of the Director General a Nest Box Plan to provide replacement hollows for displaced fauna consistent with the requirements of SoC F7. The plan shall detail the number and type of nest boxes to be installed which must be justified based on the number and type of hollows removed (based on detailed pre-construction surveys), the density of hollows in the area to be cleared and adjacent forest, and the availability of adjacent food resources. The plan shall also provide details of maintenance protocols for the nest boxes installed including responsibilities, timing and duration*".

Among those hollow dependant fauna previously recorded in the Warrell Creek to Urunga area are a number of threatened species including the Yellow-bellied Glider (*Petaurus australis*), Glossy Black Cockatoo (*Calyptorhynchus lathamii*), Powerful Owl (*Ninox strenua*) and microchiropteran bats such as the Greater Broad-nosed Bat (*Scoteanax rueppellii*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*). The project application report prepared by SKM (2010) highlighted a number of ecological impacts including but not limited to the loss of suitable and/or potential foraging habitat and hollow bearing trees (HBT's) which represent potential den, roost or nest sites for the species above.

1.2 Why Provide Nest Boxes

The removal of HBT's has the potential to impact upon the population processes of a species requiring tree hollows. For example, the removal of hollows can expose individuals to greater levels of predation, reduced reproductive success of that species and can increase inter-specific and intra-specific competition for resources (Carbery 2004). For these reasons, the removal of HBT's is currently listed as a key threatening process (KTP) pursuant to the *Threatened Species Conservation Act* (NSW Scientific Committee 2006). The provision of nest boxes can ameliorate these processes, and is the focus of increased research efforts (*see review in* Goldingay and Stevens 2009).

1.3 Structure of this Plan

This NBPoM identifies the fauna which are likely to utilise tree hollows along the construction/clearing footprint and provides an indication as to the number, type, location, installation heights, aspect and density of nest boxes required to compensate for this whilst addressing the implications of land tenure and maintenance considerations. As part of preparing this plan, a monitoring and maintenance program has also been developed to ensure that nest boxes are functioning appropriately and to assess their effectiveness over the life of this plan (2013-2017). For the purposes of this plan, the term effectiveness refers to whether or not the identified fauna groups outlined in this plan utilise the provided nest boxes.

2.0 FAUNA SPECIES USING TREE HOLLOW IN THE LOCALITY

Fifty-seven (57) species of animal that use natural tree hollows for nesting/roosting or as den sites were recorded as part of pre-approval surveys for the Pacific Highway upgrade, notwithstanding a number of other fauna that potentially inhabit the area (SKM 2010). Among those previously recorded fauna were 25 mammals, 23 hollow-dependent birds, three reptiles and six species of hylid frog with 12 of these currently listed as threatened fauna pursuant to the NSW *Threatened Species Conservation Act 1995* (Appendix A). Perusal of the Bionet Wildlife Atlas data for the area suggest there are a few other hollow dependant species that may utilise tree hollows in this area, namely other hylid frogs (i.e. *Litoria chloris*), Stephens Banded Snake (*Hoplocephalus stephensi*), some bats (i.e. East Coast Free-tail Bat *Mormopetrus norfolkensis*) and birds including Masked Owl (*Tyto novaehollandiae*). Habitat descriptions including natural tree hollow characteristics for each of these species or species groups is provided in Appendix B.

3.0 DISTRIBUTION, CHARACTERISTICS AND SUITABILITY OF EXISTING TREE HOLLOWES

The use of tree hollows by fauna may depend on a number of factors including hollow characteristics (diameter, height, depth), the number of hollows in a tree, tree health, size, location, density and the resulting thermoregulatory capabilities of the hollows themselves (Gibbons and Lindenmayer 2003). A more detailed discussion of these factors is provided in Section's 4-6 with relevance to the species considered in this plan. This section describes the characteristics of tree hollow resources present within the RMS road corridor during a ground based observation survey between the 6th December 2011 and 12th October 2012. The actual delineation of clearing limits for construction is not yet known (Kristy Harvey pers. comm. 4.4.2012). Some additional information has been obtained on the extent of tree hollows in the adjacent landscape, as this information will determine the locations where nest boxes will be installed.

3.1 Areas Not Accessed

The following areas were not accessed as part of the field surveys:

- Ch. 43365-44365 which includes retained mature Coastal Blackbutt vegetation associated with MR J. F. McInnes property;
- A few properties scattered across the Nambucca Floodplain Investigation area including Ch. 50165-50665 (Hunt property), some smaller land parcels on the southern part of Old Coast Road (i.e. Farrawell and Browne properties) and Ch. 55765-56565 (Sheather and Clarke properties);
- Ch. 62665-62865 (Boggy Creek) where access could not be obtained at the time of the survey; and
- Ch. 69315-69765 but only the eastern side of existing carriageway which is more than 100 m from any likely construction works and contains a prominent incised drainage line.

Cumulatively, the above areas amount to approximately 3 km of the 40.8 km upgrade with most of this area occurring on the Nambucca River floodplain. To address this shortfall, the contractor should perform tree hollow surveys for the remaining areas as part of their pre-clearing inspection works prior to clearing and then calculate the required numbers of nest boxes in accordance with this plan (refer to Section 4.0).

3.2 Within the Clearing Footprint

3.2.1 Distribution

Five hundred and nineteen (519) HBT's providing an estimated 2942 tree hollows have been identified between Warrell Creek (south) and the Waterfall Way/Pacific Highway interchange at Repton (Figure 3-1; Appendix C). Each of these trees have been assigned a designated number for reference (i.e. H01-H551²) and marked with white paint and pink or orange flagging tape.

The survey identified a number of areas as containing a high density (>6 hbt/ha) of tree hollow resources. They included:

- 15 HBT's along Albert Drive, Donnellyville (ch.46165);
- 25 HBT's growing within Old Coast Road reserve and adjacent crown land between ch. 53680-54050;
- 14 HBT's growing partly on Hartman property and Old Coast Road reserve between ch. 55300-55700;
- 13 HBT's where the carriageway first traverses Nambucca State Forest (Old Coast Road and Jacks Ridge Road, ch. 56965);
- 10 HBT's to the south of Old Coast Road in the central part of Nambucca State Forest (ch. 60065);
- 13 HBT's to the south of Cow Creek, Valla (ch. 63415);
- 24 HBT's to the south of Deep Creek, Valla (ch. 64335-64735);
- 38 HBT's at Blackbutt Drive, Valla Beach (ch. 66365);
- 50 HBT's in the vicinity of Burkes Lane, Oyster Creek (ch. 68565);
- 12 HBT's in the Mines Road, Pickett Hill (ch. 70765);
- 14 HBT's to the south of Ainsworth Road Cut, Newry (ch. 74065); and
- 13 HBT's at Raleigh South (ch. 80665).

² Nine of the mapped trees now occur adjacent to the clearing footprint.

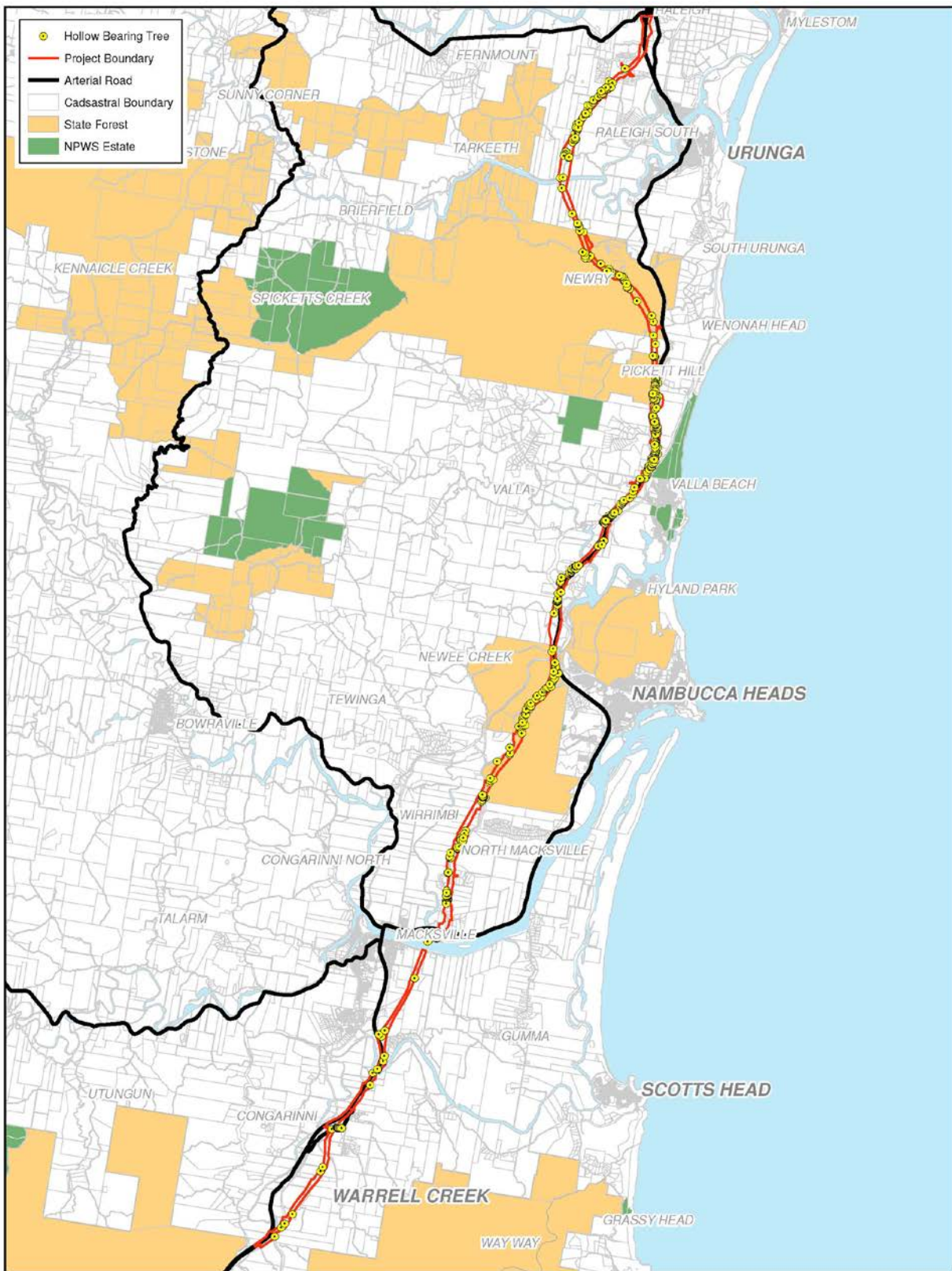


Figure 1 : LOCATION OF HOLLOW BEARING TREES

<p>Source: Cadastral: Roads and Traffic Authority 2007 HBT Survey: Lewis Ecological Surveys April 2012 Roads: Geoscience Australia 2008</p>	<p>Highway Design (footprint): RTA 2011 Project Boundary: RTA 2011 Crainings: Geoscience Australia 2009 State Forests: NSW DPI 2008</p>	<p>0 1,500 3,000 4,500 6,000 7,500 Metres A4 Scale 1:140,887</p>	<p>LEWIS ECOLOGICAL SURVEYS Pty Ltd</p>	<p>File Name: 1_RTA_Strafe_HBT_Survey Date: 14-04-2012 www.geocview.com.au GEOVIEW 3710 Caparanda Drive Byron Bay, NSW 2481 T: 01 0 409 461147 E: info@geocview.com.au W: www.geocview.com.au</p>
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Figure 3-1. Overview of hollow bearing tree resources for the Warrell Creek to Urunga Upgrade.

3.2.2 Tree Hollow Characteristics

Of the 2942 identified tree hollows, 321 (11%) were trunk hollows, 2611 (89%) were limb hollows, and 10 (<1%) were basal trunk hollows (i.e. butt of the tree trunk). The size of each hollow was assigned into three size classes based on their estimated size of their entrance. This approach identified:

- 1542 small hollows (<50 mm);
- 960 medium hollows (50 – 150 mm);
- 394 large hollows (>150 mm);
- 36 trees had prominent fissures (narrows splits predominantly in tree trunk); and
- 10 basal/butt hollows.

Most of the identified 519 HBT's contained more than one hollow with an average of 5.7 functional hollows per tree (S.D =4.1). Around 12% of the identified HBT's contained ≥ 10 tree hollows with up to 32 hollows recorded in a large Coastal Blackbutt adjacent to Burkes Lane, Oyster Creek (ch. 26900).

3.2.3 Suitability of the Tree Hollow Resources to Fauna

The suitability of each tree hollow to specific fauna groups was assigned primarily on the basis of the entrance size, tree species, status (live, dead), height above the ground and the size of the tree based on an estimated diameter at breast height (DBH). The spatial arrangement of hollows and their location within the landscape was also considered. For example, an isolated paddock tree containing hollows was considered unsuitable for gliders due to the canopy gap being beyond their normal volplane (i.e. gliding) capability. Similarly, a medium to large open hollow in dense vegetation away from water was not considered suitable for hollow nesting ducks (i.e. Maned Duck, *Chenonetta jubata*). The status of hollow using fauna is documented in Appendix A making reference as to whether the species has been previously recorded from or near (i.e. < 1km) the RMS road corridor. For example, the environmental assessment prepared by SKM (2010) identifies that higher levels of arboreal fauna diversity were recorded within the state forests. Caution should be exercised in this instance following the discovery of numerous tree hollow resources within the road corridor at locations where little or no survey effort had been employed for the EA. For example, Blackbutt Drive (ch. 24500) contains numerous senescent Coastal Blackbutt and to a lesser extent White Mahogany and Pink Bloodwood. This area provides habitat for species such as the threatened Yellow-bellied Glider and < 1km top the north some consideration should be given toward the presence of the threatened Squirrel Glider. Other common arboreal fauna including possums and smaller marsupial gliders probably also occur in this area. Other examples include the Oyster Creek area, the south end of Little Newry State Forest abutting private land and the existing Pacific Highway, and the southern part of Nambucca State Forest.

Perusal of Figure 3-2 illustrates:

- Most of the identified habitat trees provide hollows suitable for:
 - Arboreal herpetofauna including *Eulamprus* and *Egernia* skinks, arboreal snakes (i.e. Green Tree Snake) along with most of the hylid tree frogs known from the area.
 - Scansorial mammals such as the Brown Antechinus;
 - Microchiropteran bats;
 - Small gliding marsupials including the Feather-tail Glider (*Acrobates pygmaeus*) and Sugar Glider;
 - Larger Gliders including Greater Glider, Yellow-bellied Glider and Squirrel Glider (*Petaurus norfolcensis*); and
 - Parrots, particularly Scaly-breasted Lorikeet, Rainbow Lorikeet and Eastern Rosella.
- Two hundred and thirty-one (231) HBT's provide den resources for possums;
- One hundred and fifty-five (155) HBT's provide suitable retreat and overwintering sites for Lace Monitor;
- Fifty-six (57) HBT's provide suitable nest resources for black cockatoos and Australian King Parrot (*Alisterus scapularis*);
- Eighty-six (86) HBT's provide potential nest resources for smaller owls such as the Southern Boobook (*Ninox novaehollandiae*) and Barn Owl (*Tyto alba*); and
- Seven of the recorded HBT's were considered suitable for large forest owls including Masked Owl (*Tyto novaehollandiae*), Powerful Owl (*Ninox strenua*) and to a limited extent Sooty Owl (*Tyto tenebricosa*).

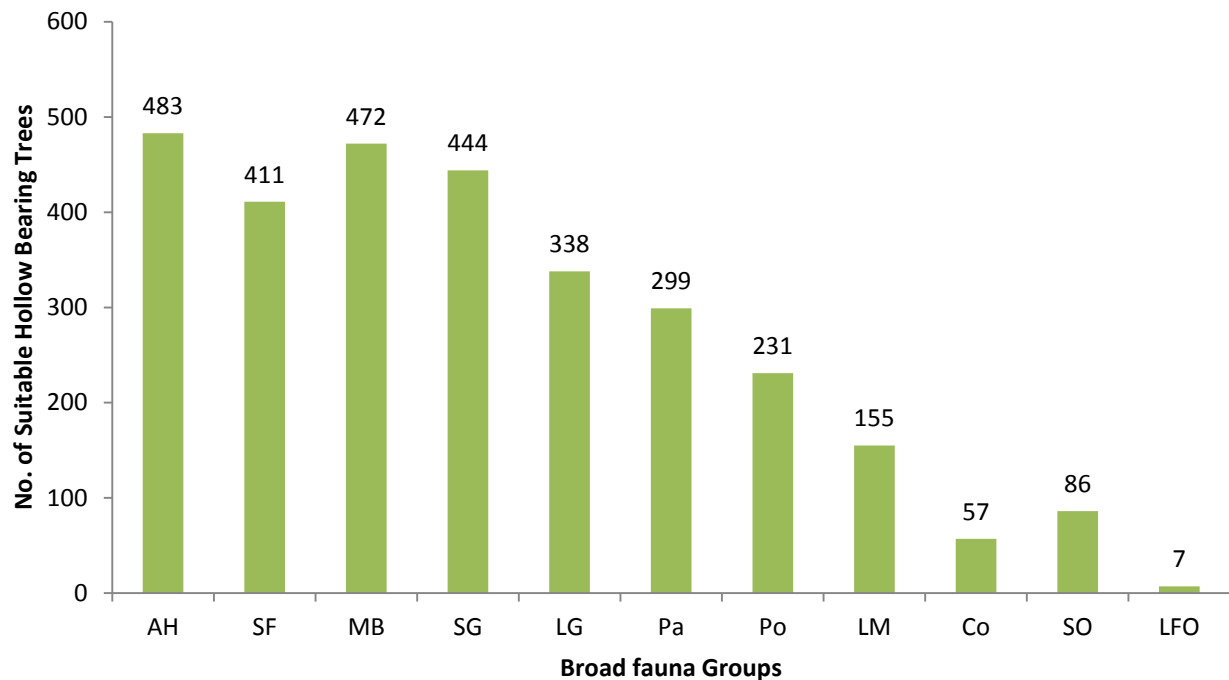


Figure 3-2. Suitability of the identified tree hollows to broad fauna groups from the 519 HBT's identified within the road corridor.

SF = Scansorial mammals (e.g. Antechinus), MB = Microchiropteran bats, SG = Small gliders (Feather-tail Glider, Sugar Glider), LG = Larger Gliders (Squirrel, Yellow-bellied, Greater), Po = Possums (Common Ring-tail Possum, Common Brushtail Possum and Short-eared Brush-tail Possum), PA = Parrots (i.e. Eastern Rosella, Lorikeets), LP = Large Parrot (i.e. King Parrot), Co = Cockatoos (Sulphur-crested Cockatoo, Yellow-tailed Black Cockatoo, Glossy Black Cockatoo), SO = Smaller Owls (Southern Boobook, Barn Owl), LFO = Large Forest Owl (Powerful Owl, Masked Owl, Sooty Owl), LM = Lace Monitor, AH = Arboreal herpetofauna (*Egernia*, *Eulamprus*, Tree Frogs)

3.3 A Look at Tree Hollow Resources Adjacent to the Clearing Footprint

Field surveys employing 1 hectare quadrats were established at 35 locations immediately adjacent to the road corridor to collect data on the density of HBT's and to estimate the number of functional tree hollows accordingly to the aforementioned size classes (Table 3-1). A range of broad fauna habitats were surveyed including:

- Riparian habitats of Upper Warrell Creek, Rosewood Creek, Warrell Creek and the Kalang River;
- Moist Sclerophyll Forests bordering riparian habitats (i.e. Warrell Creek) or within sheltered gullies in Nambucca and Newry State Forests;
- Swamp Forests on the southern side of the Nambucca River Floodplain, Hyland Park, Deep Creek area and further north at Raleigh (i.e. north of Short Cut Road); and
- Dry Sclerophyll Forests broadly distributed across the project.

In addition to broad fauna habitats some surveys were undertaken in:

- Forest types that had been recently logged (<6 months) by Forests NSW; and
- Plantation forest types in Newry State Forest to provide a snapshot look at habitat tree retention.

This survey identified most of the forested lands adjacent to the road corridor contain <4 HBT's per hectare. The exceptions were lands adjacent to chainages:

- North east of ch. 55800 (within Old Coast Road Reserve and boundary of Hartman Private Property);
- South of ch. 60365 (Allan's Trail in Nambucca State Forest);
- West of ch. 63965 (opposite Auld Close, Hyland Park);
- North west of Blackbutt Drive ch. 66565 (Valla); and
- East of ch. 79265 (Raleigh South).

Cursory surveys at Oyster Creek (Burkes Lane) indicate the high density of HBT's (~6 HBT/ha) continues beyond the RMS Road Corridor boundary and over an area of ~ 8 ha.

The majority of the HBT's occur within close proximity to roads, property boundaries or drainage lines. In a number of instances there is a disproportional density of HBT's within the road corridor when compared to the surrounding environs as these areas have historically been treated as "buffer" zones.

After reviewing the HBT data it was considered necessary to critique other specific tree hollow characteristics in assessing the need for nest boxes within a given area. At those localities where HBT's exceeding 4/ha they were assessed to see whether they contained a:

- High proportional of stags as opposed to senescent trees (i.e. >70%) indicating a reduced life expectancy of hollow resources;
- An adequate amount of tree hollows to accommodate displaced fauna during clearing operations;
- Were in close proximity to specific mitigation devices such as fauna underpasses and vegetated medians adopted for the project; or
- Form part of previously mapped key habitats and corridors linking important coastal lowlands with upland areas (Scotts *et al.* 2000).

With respect to this latter point, the EPA Key Habitats and Corridors Project identifies the Oyster Creek/Valla as forming a critical part of a regional habitat corridor known as the Oyster Creek Urunga Corridor. This corridor links large areas of coastal vegetation from Deep Creek in the south to the Bellinger River in the north, providing potential key linkages for threatened forest fauna.

Using the secondary consideration described above it was deemed necessary to provide nest boxes in the vicinity of:

- North east of ch. 55800 (within Old Coast Road Reserve and boundary of Hartman Private Property) given the number of tree hollows within a particular few trees (>12 per tree);
- South of ch. 60365 (Allan's Trail in Nambucca State Forest);
- Burkes Lane, Oyster Creek (ch. 68765); and
- Moyles Road area (ch. 73765).

The proposed recipient areas for nest boxes have been presented in Section 6.0 of this plan.

Table 3-1. Comparison between the numbers of HBT's identified for removal and the extent and characteristics of HBT's in adjacent forested land.

Note – omitted chainages reflect cleared lands or areas where field surveys could not be undertaken (i.e. Nambucca River Floodplain investigation area).

SoC = Side of Carriageway; No. = Number, M = Metres, ha = hectare, S = Small (<50mm), M = Medium (51-150 mm), L = Large (>150 mm), nd = no data, SC = Secondary Consideration as per text on page 7.

Plot No	Chainage	No HBT Removed from 400 m section of carriageway	SoC	Fauna Habitat	Tree Hollows in Adjacent Forest							Nest Boxes Required	Nest Box Zone (Figure 3-1)
					No. Stags	No. Senescent Trees	Density ha	Estimated No. Functional Hollows					
								S	M	L	Total		
1	42765	2	West	Riparian with Flooded Gum, Tallowwood, White Mahogany, Weeping Lilly Pilly and Water Gum.	0	2	2	5	0	0	5	Yes	A
2	43265	1	East	Mixed Dry and Moist Sclerophyll Forest with Coastal Blackbutt, Pink Bloodwood, tallowwood and White Mahogany	0	0	0	0	0	0	0	No	-
3	44665	2	East	Riparian (weedy) with emergent Flooded Gum and weedy Camphor Laurel and Privet	0	1	1	2	0	0	0	Yes	B
4	48365	6	West	Mixed Riparian and Moist Sclerophyll Forest with Swamp Oak, Flooded Gum, Tallowwood, Grey Ironbark)	0	2	2	4	2	0	0	Yes	C
5	56965	13	East	Dry Sclerophyll Forest with Coastal Blackbutt, Red Mahogany and White Mahogany	1	2	3	10	5	6	21	Yes	D
6	58165	0	West	Dry Sclerophyll Forest with Coastal Blackbutt, Red Mahogany and White Mahogany	0	2	2	5	0	0	5	No	-
7	58765	3	East	Dry Sclerophyll Forest (Coastal Blackbutt, Pink Bloodwood) on ridges running down to Moist Sclerophyll Forest (Flooded Gum, Turpentine, Tallowwood) in gullies.	0	0	0	0	0	0	0	Yes	E
8	59665	7	West	Moist Sclerophyll Forest (Coastal Blackbutt, Flooded Gum, Red Mahogany, Turpentine)	0	3	3	8	4	0	12	Yes	F
9	60365	12	South	Dry Sclerophyll Forest (Coastal Blackbutt, Pink Bloodwood, Grey Gum, White Mahogany)	1	3	4	14	6	3	23	Yes	G (SC)
10	61165	6	East	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Scribbly Gum, Red Mahogany)	0	0	0	0	0	0	0	No	-
11	61315	7	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Tallowwood, Pink Bloodwood, Red Mahogany)	1	2	3	6	1	0	7	Yes	H
12	61965	2	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Tallowwood, Red Mahogany)	0	0	0	0	0	0	0	No	-
13	63865	5	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Red	1	4	5	11	6	2	19	No	-

Plot No	Chainage	No HBT Removed from 400 m section of carriageway	SoC	Fauna Habitat	Tree Hollows in Adjacent Forest							Nest Boxes Required	Nest Box Zone (Figure 3-1)
					No. Stags	No. Senescent Trees	Density ha	Estimated No. Functional Hollows					
								S	M	L	Total		
				Mahogany, Tallowwood)									
14	64565	20	West	Swamp Forest (Red Mahogany, Swamp Mahogany, Coastal Blackbutt, Turpentine with Callicoma and occasionally Banksia	0	3	3	6	3	1	10	Yes	I
15	66615	24	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood with dense Callicoma understorey in parts)	0	~4	~4	nd	nd	nd	nd	Yes	J (SC)
16	68315	41	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Tallowwood, Pink Bloodwood, Flooded Gum)	1	1	2	6	3	1	10	Yes	K (SC)
17	70215	15	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Tallowwood, Pink Bloodwood, Grey Ironbark)	1	1	2	4	1	0	5	Yes	L
18	70865	16	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Grey Ironbark)	0	0	0	0	0	0	0	Yes	M
19	71945	1	West	Riparian Moist Sclerophyll Forest (Sydney Blue Gum, Grey Ironbark, Flooded Gum, Tallowwood with Water Gum)	1	0	1	2	0	0	0	No	-
20	72415	2	West	Dry Sclerophyll Forest (Coastal Blackbutt, Tallowwood, White Mahogany, Pink Bloodwood, Stringybark)	0	1	1	3	1	0	4	No	-
21	72965	1	East	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Grey Ironbark, Turpentine)	0	0	0	0	0	0	0	No	-
22	73565	2	west	Dry Sclerophyll Forest (Coastal Blackbutt, Pink Bloodwood, Grey Ironbark, White Mahogany, Tallowwood)	1	1	2	7	2	0	9	Yes	N
23	74565	7	West	Moist Sclerophyll Forest in gullies (Red Mahogany, Small-fruited Grey Gum, Tallowwood) with Dry Sclerophyll Ridges (Coastal Blackbutt, Pink Bloodwood, Grey Ironbark, White Mahogany, Small-fruited Grey Gum, Tallowwood)	0	0	0	0	0	0	0	Yes	O
24	75365	2	West	Moist Sclerophyll Forest in gullies (Red Mahogany, Small-fruited Grey Gum, Tallowwood, Coastal Blackbutt) with Dry Sclerophyll Ridges (Coastal Blackbutt, Pink Bloodwood, Grey Ironbark, White Mahogany, Small-fruited Grey Gum, Tallowwood)	2	0	2	4	3	2	9	No	-

Plot No	Chainage	No HBT Removed from 400 m section of carriageway	SoC	Fauna Habitat	Tree Hollows in Adjacent Forest							Nest Boxes Required	Nest Box Zone (Figure 3-1)
					No. Stags	No. Senescent Trees	Density ha	Estimated No. Functional Hollows					
								S	M	L	Total		
25	75765	0	East	Forest NSW Plantation (Coastal Blackbutt) with neighbouring gullies native regeneration of Red Mahogany, Turpentine, Tallowwood, Coastal Blackbutt)	0	0	0	0	0	0	0	No	-
26	76765	1	West	Dry Sclerophyll Forest (Coastal Blackbutt, White Mahogany, Pink Bloodwood, Red Mahogany, Tallowwood, Turpentine)	1	0	1	3	1	0	4	Yes	P
27	77765	2	West	Riparian Sclerophyll Forest with mix of dry and moist elements (Grey Ironbark, Flooded Gum) with estuarine components (Swamp Oak, Grey Mangrove)	1	0	1	2	1	0	3	No	-
28	79265	9	East	Dry Sclerophyll Forest upslope (Tallowwood, Small-fruited Grey Gum, Pink Bloodwood, Coastal Blackbutt, White Mahogany) with Swamp Forest on lower slopes (Broad-leaved paperbark, Swamp Mahogany)	1	5	6	26	11	5	32	Yes	Q (SC)
29	80165	5	West	Moist Sclerophyll Forest (Tallowwood, Flooded Gum, White Mahogany, Pink Bloodwood, Grey Ironbark)	1	1	2	7	1	0	8	Yes	R
30	81665	1	West	Swamp Forest (Swamp Mahogany, Swamp Oak, Cheese Tree) rising into Moist Sclerophyll Forest (Coastal Blackbutt, Tallowwood)	0	0	0	0	0	0	0	No	-
31	49815	0	West	Broad-leaved Paperbark and Swamp Oak Swamp Forest with surrounding cleared land	0	0	0	0	0	0	0	No	-
32	50965	3	East	Broad-leaved Paperbark and Swamp Oak Swamp Forest	0	3	3	4	2	0	6	No	-
33	53915	25	West	Under scrubbed moist sclerophyll forest (Tallowwood, Pink Bloodwood, White Mahogany, Coastal Blackbutt) perched above Swamp Forest	1	2	3	8	3	0	11	Yes	S
34	55065	7	East	Dry sclerophyll forest (Coastal Blackbutt, Pink Bloodwood, Tallowwood, Turpentine)	1	2	3	7	2	1	10	Yes	T
35	55800	10	East	Dry sclerophyll forest (Coastal Blackbutt, Pink Bloodwood, Tallowwood)	1	4	2	7	2	0	9	Yes	U

4.0 NUMBER OF NEST BOXES REQUIRED

This section presents the proposed number of nest boxes required and the types of fauna the nest boxes should accommodate during stage one (ground based tree hollow survey) of a two stage assessment (i.e. recalculation once clearing of detailed design is completed). The final (i.e. second stage) will be an appraisal once the clearing works have been completed and a final tally of the actual numbers of hollow bearing trees and tree hollows has been tallied based on the detailed design (numerical data substituted back into the formulas provided below). At this point in the time the nest box plan will be updated to reflect the final number of nest boxes required and re submitted to the EPA for approval.

4.1 The Proposed Number of Nest Boxes Required

A condition for this project's approval was to compensate for the loss of HBT's by using nest boxes, however, it did not provide any scope as to the ratio or what defines when compensation is necessary. In this absence, those areas adjacent to the RMS road corridor that support fewer than 4 HBT's per hectare require nest boxes. Secondary considerations have also resulted in two initially exempt areas (i.e. ch. 60365, ch. 68765 and ch. 73765) being re classified as areas requiring nest boxes. This approach is consistent with the nest box plan prepared for the Kempsey Bypass project (Lewis 2010).

In this context 467 nest boxes of various sizes are required for the Warrell Creek to Urunga project with:

- 152 nest boxes required for the Warrell Creek to Nambucca Heads (ch. 61265); and
- 315 nest boxes required for the Nambucca Heads (ch. 61265) to Urunga Upgrade.

A two stage formula has been used to derive the number of nest boxes required for each area identified in Table 3-1.

Stage 1:

$A \times B \times 1.3 = \text{Proposed Number of Nest Boxes Required}$

Where:

$A = \frac{\text{Number of identified HBT's within the clearing footprint of a specified zone}}{\text{Area (ha) of vegetated land identified for removal}} = \text{Density HBT/ha}$

$B = \frac{\text{Total number of tree hollows identified}}{\text{Total number of HBT's within the zone}} = \text{Mean number of functional hollows per HBT}$

1.3 = 30% error factor built in to accommodate for the difficulties associated with identifying tree hollows in habitat with one or more of the following factors:

- Dense lower or mid stratum (i.e. Callicoma);
- Particular tree species (i.e. Broad-leaved Paperbark) that are difficult to accurately critique for tree hollows;
- Adverse weather conditions when surveys had to be completed. For example, more difficult to identify tree hollows on cloudy days as the opportunities to utilise shadowing is not available.

As an example, using this formula at Zone I (ch. 64265-64865) can be summarised as follows:

- 4.5 ha has been identified for removal;
- 23 HBT's have been identified within the RMS road corridor; which contain
- 165 functional tree hollows.

Applying the base formula of:

$5.11 (A) \times 7.17 (B) = 36.7$ nest boxes followed by the introduction of the 30% error/compensatory factor: $1.3 \times 36.7 = 47.7$. This number is then rounded up to the nearest whole number to show 48 nest boxes are required

for Zone I. This number is then reviewed in stage 2 and for every cockatoo/owl nest box required within a given zone an additional possum nest box is required to reduce competitive interactions for nesting/denning resources. Four additional possum boxes are required bring this total to 52. Stage 2 below is used to determine the types of nest boxes required.

4.1.1 The Final Number of Nest Boxes Required – Warrell Creek to Nambucca Heads section

Finalisation of mainline clearing including clearing for the North Facing Ramps was completed in October 2016. As per the requirement of Section 4.0 Number of Nest Boxes Required, this plan calls for final calculations of clearing areas and hollow loss to be calculated and the updated number of nest boxes required to be included within the report. Due to reduced land size and limited suitable vegetation to support nest boxes within prescribed zones in compliance with the requirements of the management plan, a proposal to use additional nest box replacement zones and extend existing zones was submitted to the Project. The proposal was approved by the Project Environmental Representative in August 2016. GeoLINK produced a report (reference 2378-1318) which details the final calculations and numbers of nest boxes required post-clearing and includes the new nest box replacement zones and extensions and approval documentation. The report has been added to this management plan as an addendum, refer to **Appendix D**.

In accordance with Section 4.0 and 7.1 of this report, 92 nest boxes were installed prior to or during clearing. The final calculations have determined a lesser number of nest boxes required (143) than the 152 proposed. **Appendix D** provides more details of the calculations used, which were in accordance with Section 4.1.

Stage 2:

Within each zone, the number and specific designs of nest boxes have been tailored to best accommodate for the loss of hollow resources. This has been done on a proportional basis, so if for example 20% of the tree hollows being removed are considered suitable for small gliders, then 20% of the nest boxes should be specifically designed for gliders such as Sugar Glider and Feathertail Glider. Using the Zone I example again:

- 52 nest boxes are required and these will comprise:
 - 6 microchiropteran bats;
 - 8 scansorial fauna (*Antechinus*/*Phascogale*) boxes;
 - 9 small gliders;
 - 6 larger gliders;
 - 9 possums;
 - 6 parrots/lorikeets;
 - 4 cockatoos, larger parrots or small owls with an additional 4 possum boxes to reduce competition.

Some specific fauna groups have been omitted from the nest box schedule given they have generalist habits (i.e. arboreal herpetofauna) which suggest they will utilise most of the current nest box designs or their nesting habits are synonymous with other widely scattered resources found adjacent to the footprint (i.e. termitaria for kingfishers). Moreover, the number of bat nest boxes has been reduced in a number of instances given their highly mobile habits compared to other fauna considered in this plan and the relatively low uptake rates recorded during monitoring for the Kempsey Bypass project (Lewis 2012 in prep).

4.2 Type of Nest Boxes to be Supplied

Most of the HBT's identified for removal contain small and medium sized limb and to a lesser extent trunk hollows which are considered suitable for smaller fauna including scansorial marsupials such as *Antechinus*, small gliders including the Feather-tail Glider and Sugar Glider, some larger species of glider (i.e. Yellow-bellied Glider), microchiropteran bats, possums, and smaller hollow dependant birds up to the size of lorikeets and rosella's. It therefore seems appropriate that the nest boxes themselves be designed with these fauna groups in mind. Ultimately, this equates to fewer large nest boxes capable of providing roosting and nesting habitat for cockatoos and owls.

Nest boxes considered suitable for the following fauna groups have been proposed:

- Scansorial fauna (*Antechinus*)
- Small gliders (Feather-tail Glider and Sugar Glider);
- Larger gliders (Squirrel Glider, Yellow-bellied Glider, Greater Glider)
- Possums (Common Brushtail Possum, Short-eared Possum and to a lesser extent Common Ringtail Possum);
- Microchiropteran bats (fluttering and direct flying species that utilise tree hollows);
- Medium sized parrots/lorikeets;
- Cockatoo (Black Cockatoos);
- Small Owls (Southern Boobook and Barn Owl); and
- Large Forest Owls (Masked Owl, Sooty Owl, Powerful Owl).

No specific nest box designs have been proposed for arboreal herpetofauna given they are considered to have generalist habits and likely to use a number of the designs proposed in this plan. For example, a juvenile python would be capable of using the bat and scansorial fauna nest boxes whilst a larger adult may be more inclined to seek refuge within a possum, cockatoo or small owl nest box.

Microchiropteran bats have been considered here as a single group and include only those species which utilise tree hollows (i.e. cave roosting species such as *Miniopterus spp* not considered). The target species range in size from the small (4 g) Little Forest Bat (*Vespadelus vulturnus*) through to the medium sized bats including the Chocolate Wattled Bat (*Chalinolobus morio*) and Gould's Wattled Bat (*Chalinolobus gouldi*) up to the relatively large Greater Broad-nosed Bat (*Scoteanax rueppellii*) and White-striped Mastiff Bat (*Tadarida australis*) which attain weights of 25-38 g. Whilst these and other species were recorded during the pre approval field surveys there is no evidence to suggest they actually utilise tree hollows within the clearing footprint which probably forms only a fraction of their home range (see Van Dyke and Strahan 2008). Moreover, roost site selection can be highly variable with entrances often larger than what may normally be required. For example, Gould's Wattled Bat is known to use roost sites with entrances of 100 mm whilst Lessor Long-eared Bat (*Nyctophilus geoffroyi*) may also use similarly large roosts as times, even where smaller tree hollows are spatially abundant (Dixon and Lumsden 2008; B. Lewis unpub. data). Given these unknowns and the fact that most of the bats being considered are relatively small (i.e. <20 g; see Churchill 2008) they have been considered here as a single group.

When providing nest boxes for microchiropteran bats, an important consideration is the thermoregulatory³ properties of the nest box as this is thought to be a significant factor in bat roost site selection (Gibbons and Lindenmayer 2002; Lourenco and Palmeirim 2004). Even when the requirements are met for a single species or size guild there may also be seasonal requirements in relation to migratory habits or breeding biology. For example, Bechstein's bats (*Myotis bechsteinii*) in Germany tend to prefer sun-exposed boxes during lactation whereas shaded boxes were preferred pre-lactation (Kerth *et al.* 2001).

Attempting to successfully compensate for the larger more mobile species may also result in a reduction of nest box use or effectiveness of this plan. For example, there is limited evidence to suggest black cockatoos will readily use artificial nest boxes. Given that both the Yellow-tailed Black Cockatoo and Glossy Black Cockatoo have been recorded in the area on a number of occasions, it is appropriate that an equitable number of nest boxes be constructed for these species. This is partly due to the relatively low number of suitable tree hollows located throughout the adjacent forests, particularly Nambucca, Little Newry and Newry State Forests (pers. obs). Whilst herpetofauna have not been specifically accounted for it is expected that at least some of the nest boxes will provide amicable refuge habitat.

In relation to the Large Powerful Owl evidence indicates they can typically inhabit tracts of forests in the vicinity of 500-1000 ha so there are a lot of potential nest sites in this area. It should be noted that this report is based on a preliminary ground based assessment and will be updated following clearing works. Hence this would allow for the possibility of an increase in the number of nest boxes for the Large Powerful Owl, should the post clearing survey justify it.

³ Thermoregulation relates to the ability of an animal to keep its body temperature within certain boundaries, even when the surrounding temperature is very different. This process is one aspect of homeostasis, a dynamic state of stability between an animal's internal environment and its external environment.

Table 4-1. Proposed number of nest boxes for each of the identified nest box zones.

Note - Flexibility should be permitted to change the placement of nest boxes as currently proposed if landholder agreement is not reached. Contractor's Project Ecologist to perform.

Ha = Hectare, No. = Number, HBT = Hollow Bearing Tree. SoC = Side of Carriageway, RMS = Roads and Maritime Services, SF NSW = State Forests NSW.

Specific Designs: MB = Microchiropteran bats, SF = Scansorial mammals (e.g. Antechinus, Phascogale), SG = Small gliders (Feather-tail Glider, Sugar Glider), Po = Possums (Common Ring-tail Possum, Common Brushtail Possum and Short-eared Brush-tail Possum), P/L = Parrots (i.e. Eastern Rosella, Lorikeets), Co = Cockatoos/Large Parrot (Sulphur-crested Cockatoo, Yellow-tailed Black Cockatoo, Glossy Black Cockatoo, King Parrot), SO = Smaller Owls (Southern Boobook, Barn Owl). C = Cockatoo, S = Small Owls

Add. Poss refers to the number of possum boxes required in the vicinity of Cockatoo/King parrot/Small Owl/Large Forest Owl nest boxes to discourage their uptake of these nest boxes.

Zone	Chainages	Area removed ha	No. HBT Removed	No. Functional Hollows	No. Nest Boxes required	Specific Designs									Position		
						MB	SF	SG	LG	Po	P/L	Co/SO	LFO	Add. Poss	SoC	Tenure	Comment
WC2NH																	
A	42565-43015	5.2	2	22	6	0	2	0	2	2	0	0	0	0	East	Private	Install on eastern side of ch. 42865. Note - glider incisions tentatively identified in this area and connects with contiguous vegetation to the east.
B	44765-44965	0.75	2	7	14	3	2	0	0	3	4	1	0	1	Either	Private	Install either side of the drainage line. Property owner specifically requested nest boxes. RMS will continue to consult and negotiate with property owners.
C	48265-48765	6.1	6	23	5	2	1	0	0	2	0	0	0	0	East	RMS	Install within RMS road corridor on eastern side bordering Warrell Creek. Contributes into dry fauna corridor crossing structure for northern side of Warrell Creek.
D	56865-57465	5.8	13	62	15	2	2	3	2	2	2	1	0	1	East	RMS/SFNSW	Install on the RMS/Nambucca SF boundary with final location to be determined by project ecologist. Note – this area may need to be reviewed as part of redesign with the Nambucca Floodplain investigation area.
E	58565-59065	7.0	3	11	3	0	1	1	0	1	0	0	0	0	East	RMS/SFNSW	Retain HBT64 and install nest boxes on RMS/Nambucca SF boundary ch. 58515. Ties into combined culvert/fauna underpass.
F	59465-60015	7.2	12	50	10	0	3	2	2	2	1	0	0	0	West	RMS/SFNSW	Install on the RMS Nambucca SF boundary. Must consider Yellow-bellied Gliders and any potential crossing points. Adjacent to proposed vegetated median.
G	60115-60915	9.2	19	110	17	1	3	3	4	3	1	1	0	1	South	RMS/SFNSW	Install on the RMS Nambucca SF boundary. Must consider Yellow-bellied Gliders and any potential crossing points around Allan's Fire Trail.
S	53680-54100	2.7	25	101	49	10	6	13	6	6	6	2	0	0	West	RMS/Crown/Private	Ideally there should be sufficient tree retention to provide amenity improvements on western side thus retaining a number of hollow bearing trees. Nest boxes should also be placed in this area. At the interface with RMS/private/crown tenures.
T	55000-55400	8	9	53	9	0	2	3	2	1	1	0	0	0	East	RMS/Private	Position boxes on the eastern side of the Old Coast Road service road within RMS retained vegetation.
U	5550055750-	4	9	73	24	3	2	5	5	5	3	1	0	0		RMS/Private/Old Coast Road reserve	Construction contractor should make efforts to retain HBT in this area in particular HBT551. Nest boxes should be positioned on eastern side north of ch. 55700 at the discretion of the Project Ecologist.
				WC2NH Total	152	21	24	30	23	27	18	6	0	3			
NH2U																	
H	61265-61865	15.3	10	33	3	0	1		1		1	0	0	0	West	RMS/SFNSW	Ch. 61365 install on boundary within retained vegetation or alternatively within riparian zone of Cedar Creek.
I	64265-64865	4.5	23	165	52	6	8	9	6	9	6	4	0	4	Both	Private and RMS	Seek landholder support for installation. Ensure at least half of nest boxes occur within swamp forest habitat. May need to considered adjacent vegetation to the south bordering Valla Road.
J	66165-66765	10.2	40	259	36	4	5	6	5	5	5	3	0	3	West	Private	Give due consideration to retaining as much remnant vegetation as possible. Specialist surveys for Yellow-bellied Glider warranted here. RMS will continue to consult and negotiate with property owners.
K	68165-68815	5.7	60	427	109	12	15	15	15	15	15	9	2	11	West	Private	Negotiate with private landowners to west of ch. 68765. Forest through here contains old growth elements and specialist surveys should be undertaken to quantify the presence of threatened hollow dependant fauna including large gliders and large forest owls. Ties in with combined culvert fauna underpass. RMS will continue to consult and negotiate with property owners.
L	70065-70565	10.4	19	106	14	2	3	3	2	2	2	0	0	0	East	RMS	Install within RMS corridor on eastern side of ch. 65565-70065 to increase security over tenure and maintenance. Ties in with combined culvert fauna underpass.
M	70565-71065	5.1	21	145	41	4	7	5	7	4	6	4	0	4	Both	RMS, SFNSW, Private	Install a cross section of boxes in each tenure. Consult with SF NSW, to seek support for the installation of nest boxes within drainage lines (Forest Management Zones).

Zone	Chainages	Area removed ha	No. HBT Removed	No. Functional Hollows	No. Nest Boxes required	Specific Designs									Position		
						MB	SF	SG	LG	Po	P/L	Co/SO	LFO	Add. Poss	SoC	Tenure	Comment
N	73465-74065	10.8	9	40	5	0	2		2	1	0	0	0	0	Both	RMS	Install boxes in areas to tie in with areas adjacent to the vegetated medians being used to maintain glider connectivity.
O	74365-74865	7.1	8	31	6	0	2	2	2	0	0	0	0	0	Either	RMS	Project ecologist to advise once clearing limits defined on refined design. Installation should occur within the RMS/SF interface. Ties in with dedicated fauna underpass.
P	76165-76765	6.6	5	24	10	2	2	3	2	0	1	0	0	0	West	RMS	Increased the error factor to 100% after considering the structure of the existing Swamp Mahogany forest (i.e. likely to contain more hollows than documented) and its local importance for seasonal foraging resources. All nest boxes to be installed within or close to this community (ch. 76290-76565).
Q	79065-79765	8.75	13	63	11	0	2	1	2	2	2	1	0	1	Either	RMS	Install nest boxes within retained vegetation within the RMS road corridor. Occurs within an area identified for retained vegetated median.
R	80065-80765	9.1	17	96	16	2	3	2	3	2	2	1	0	1	Either	RMS	Install on both sides but ensure the swamp forest vegetation on eastern side is given due consideration. For example, retain vegetation to the east of ch. 80565 or move boxes south into the vegetated median zone.
				NH2U Total	303	32	50	46	47	40	40	22	2	24			

5.0 DESIGN AND CONSTRUCTION OF NEST BOXES

5.1 Some Design Considerations

The recommended dimensions of nest boxes for fauna known or considered likely to occur in the vicinity of the carriageway has been summarised in Table 5-1. Whilst recognising that different fauna require different nest box dimensions the constructed box should take the following design considerations into account:

- Consideration for the target species or fauna group so that:
 - The entrance hole is no larger than for the intended recipient;
 - The entrance hole is positioned toward the top of the nest box so the area remains dark;
 - Rear entrances may be used for some species, namely gliders and bats to avoid competition from non target species (see below); and
 - Rough sawn timber to allow animals to grip the exterior of the nest box.
- Should consider the need for anti competition devices such as:
 - Rear openings for scansorial fauna, bats and gliders to avoid uptake by Common Myna (*Acridotheres tristis*) or common generalist birds such as Rainbow Lorikeets (*Trichoglossus haematodus*);
 - Anti pest devices should be considered. For example, Buffalo Fly ear tags are considered a suitable deterrent for the European Bee (*Apis mellifera*) when positioned close to the nest box entrance.
- Specific furniture needs of the intended recipient fauna such as:
 - Lining the floor with ≥ 20 mm of non-toxic wood shavings, or in the event they conceal the opening of the nest box, an alternative material such as decayed wood or shredded bark should be selected; and
 - Provision of toe holds to enable young to climb from the nest box.
- A number of weather associated variables including:
 - The use of ≥ 30 mm thick timber to insulate against heat and cold;
 - All joints and gaps should be sealed with a non toxic glue;
 - The lid of the nest box should overhang by ≥ 25 mm like an awning to reduce moisture damage;
 - Small drain holes should be placed in the bottom front section of the nest box; and
 - The exterior should be preferably painted with a dark coloured outdoor water-based acrylic paint or oil, and the internal surfaces left unpainted.
- Whilst considering the above, the thermoregulatory capabilities of the nest box need to be considered, particularly for bats as this is thought to significantly influence roost use (see Gibbons and Lindenmayer 2002; Lourenco and Palmeirim 2004). This may be achieved using one or more variables including but not limited to the thickness of the nest box walls, external colour of the box (white versus black or an intermediate colour such as grey) or aspect in its positioning. Whilst this has been the focus of little research effort in Australia several overseas studies support this (see review in Goldingay and Stevens 2009). For example, Soprano Pipistrelles (*Pipistrellus pygmaeus*) in Portugal preferred the high temperatures ($\sim 40^{\circ}\text{C}$) associated with black roost boxes over white or grey coloured boxes (Lourenco and Palmeirim 2004). Seasonally, Bechstein's bats (*Myotis bechsteini*) in Germany seem to prefer sun-exposed boxes during lactation whereas shaded boxes were preferred pre-lactation (Kerth *et al.* 2001).
- Given that monitoring is often proposed there should be allowances for routine maintenance included in the overall nest box design. For example, a hinged lid to allow visual inspection and maintenance access.
- Where monitoring is proposed, the labelling of the nest boxes should be in such a way so as to easily identify them from other nest boxes. For example, a box number and code for each fauna group be stamped or riveted onto the bottom or side of each nest box to enable easier identification, preferably from the ground.
- There should be no sharp edges such as protruding nails or staples.
- Where nest boxes are being designed specifically for gliders they should have a good landing surface close to the nest box such as a large branch.
- The design of the positioning and fastening mechanism should be sturdy and stable and preferentially with a slight forward lean to assist with drainage whilst allowing for growth in the host tree. It is recommended that bracketing use the Habisure™ system (Hollow Log Homes Pty Ltd) where possible as this has the added advantage of allowing at least one metre growth in the diameter of the host tree before adjustment is required, is non-invasive to the tree and provides the required security (Figure 5-1).

Table 5-1. Summary of specifications for nest boxes targeting specific species or fauna groups (Grant 1997; Franks and Franks 2006; McNabb and Greenwood 2011).

Dimen = Dimension.

1 = Nest boxes are to be installed as close to the canopy as possible, thus in the first instance the upper limit of the height range is to be adopted. The lower limit should only be referred to where a series of constraints are present and be approved by the RMS Project Ecologist or Environment Manager. Note – designs 6 and 7 culminate into the required 25 boxes for cockatoos/owls/larger parrots.

Nest Box Type	Total No Required	Fauna Group	Nest Box Dimensions (Grant 1997; Franks and Franks 2006)				Comments
			Inner Dimen. (mm)	Depth (mm)	Entrance Width (mm)	Height Above Ground ¹ (m)	
1	64	Scansorial mammals (i.e. Antechinus, Brush-tailed Phascogale)	180 x 180	300	35 – 40	5-8	Timber should be at 30 mm thick for insulation. Choose a tree with no side branches for predator avoidance. Flap of carpet over the entrance to prevent a draft. Drill 5 mm drainage holes at the base of the box.
2	40	Microchiropteran bats (fluttering and direct flying species)	200 x 200	400	10 – 30	5-8	Wedge shaped design reduces build up of guano. PVC design can also be used. Entrance should be a slit at the bottom of the box and heavily grooved to promote grip.
3	55	Small Gliders (i.e. Sugar Glider)	200 x 200	300	40-45	5-8	Recent research would suggest 5 m is sufficient positioning height (R. Goldingay pers. comm.).
4	57	Larger Gliders (i.e. Yellow-bellied Glider)	250 x 300	400	70-90	8-10	Use rear entry design to reduce uptake by possum and other non specific fauna.
5	55	Possums (Brush-tails)	250 x 300	400	85-100	5-8	A ladder of wire mesh or cut steps on the inside will allow the young to climb out.
6	12	Small Owls (Boobook Owl, Barn Owl)	250 x 300	500	100	8-10	Make spout entrance short and horizontal.
7	13	Black Cockatoos/Large Parrots (King Parrot)	300 x 400	1200	200	8-10	A large piece of timber should be attached to the lid for chewing. Layer of sawdust will attract cockatoos and 5mm drainage holes should be placed in base of box. Angled spout entrance.
8	48	Medium-sized Parrots (Lorikeets/Rosellas)	200 x 200	400	65	5-8	Layer of sawdust will attract parrots such as Rosellas. Place 5 mm drainage holes in the base of the box.
9	2	Large forest owls	550 x 550	800	200	12-20	May have to be custom build and installed using an elevated work platform (EWP) or specialist tree climbers.

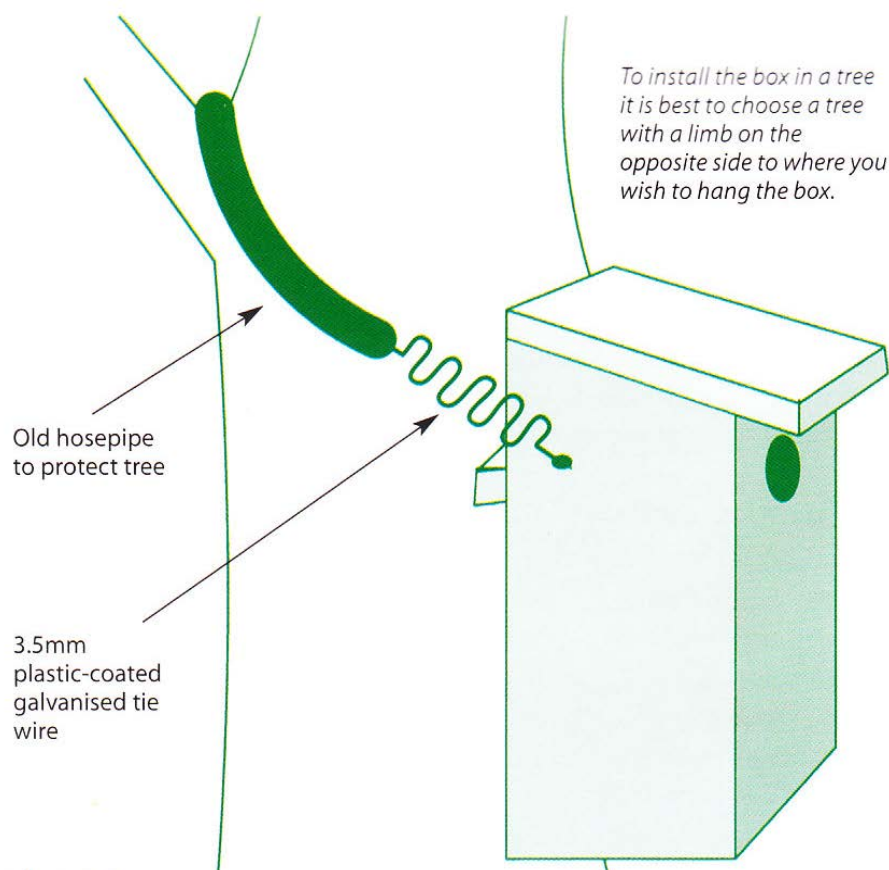


Figure 5-1. Diagrammatic sketch of the Habisure system. Courtesy of Alan and Stacey Franks (Hollow Log Homes ©)

5.2 Dealing with Non Target or Pest Species

A number of pest species both native and exotic are relevant to this plan and are known to utilise both natural hollows and nest boxes. The most relevant ones to this plan are:

- European Bee;
- Exotic birds including Common Myna and Common Starling (*Sturnus vulgaris*); and
- Termites and ants.

These species may construct hives or nests in boxes that exclude the target groups of hollow dependant fauna. Six European Bee hives have been recorded within the RMS road corridor including a:

- Stag (HBT 3) at ch. 42885;
- Dead stag (HBT 14) at ch. 46165;
- Coastal Blackbutt (H226) at ch. 67415;
- Coastal Blackbutt (H263) at ch. 68365;
- Tallowwood (H244) at ch. 68565;
- Tallowwood (HBT 395) at ch. 74215; and
- Turpentine (HBT 526) at ch. 53985.

This is undoubtedly an underestimate as conditions were often unsuitable for conducting hive surveys (i.e. often raining).

Termites can similarly invade nest boxes and eventually consume them, whilst ants although not known to prevent nest box use, can cause maintenance problems. Natural hollows frequently used by exotic birds can out compete native species for nesting resources. The introduction of nest boxes may further facilitate habitat availability for exotic birds resulting in an increase of the local population and in some instances may contribute to key threatening processes pursuant to the *TSC* Act. For example, inadvertently providing habitat for European

Bees. Therefore, a number of recommendations have been suggested to eliminate pest species from nest boxes including the use of:

- Rear openings for glider and bat boxes to reduce uptake by non target species;
- Replacement of a perch with a router-grooved ladder. Nest boxes without a visible entrance hole are less likely to be used by birds (Birds Australia 2001);
- Pest strips or Buffalo Fly ear tags attached and passed into the nest box on a long pole when a colony of ants, termites or honeybees are inactive so as to destroy established colonies; and
- Talcum powder, Coupex ® and other domestic agents can be applied to the entrance of a nest box to deter ants.

It is recommended these later strategies form part of the monitoring and maintenance schedule.

6.0 DISTRIBUTION AND POSITION OF NEST BOXES

This section extends on from the discussion in Section 3.0 which set out to determine broad areas where nest boxes were required. The selected location and positioning of nest boxes is a fundamental component of this plan given that it will ultimately determine the effectiveness of this as a mitigation tool. The use of nest boxes may also be affected by the availability of tree hollows in the surrounding area which varies in this context from nil to 6 HBT's per hectare in the measured 1 ha quadrats and estimates of 8 HBT's per hectare in an area to the west of Burkes Lane (see Table 3-1).

As a general rule nest boxes should be installed on large (>400 mm dbh), mature trees close to or on the main trunk. Taking this into account the proposed locations shown in Table 4-1 have also considered:

- The number of tree hollows identified for removal in that part of the construction corridor;
- The residual number of tree hollows on those lands adjacent to the clearing footprint;
- The suitability of those tree hollows to fauna adjacent to the clearing footprint;
- Availability and suitability of other key life cycle components such as foraging resources for displaced fauna including but not limited to autumn-winter flowering Swamp Mahogany (*Eucalyptus robusta*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*), late winter-spring flowering Forest Red Gum (*Eucalyptus tereticornis*) or the presence of *Allocasuarina spp* in the case of the Glossy Black Cockatoo;
- Habitat connectivity in the context to those area's identified for removal and the intended recipient fauna; and
- Other fauna mitigation devices and their locations along the carriageway. For example, fauna underpasses and vegetated medians.

Preference has also been given to:

- Areas that contained mixed aged stands of trees, some of which have started to produce tree hollows albeit in low densities or are likely to in the short-medium term (20-40 yrs); and
- Where preferably within RMS's managed road reserve or have been endorsed by landholders during initial consultations.

In addition to those points raised above, the behavioural ecology of the target species must also be considered along with site specifics including aspect, positioning height above the ground, installation techniques and the spatial arrangement or density of nest boxes. This latter point is required to meet the territorial needs of some species that will vigorously defend a territory, attacking individuals of the same species, and occasionally destroying rival nests. Others species are more gregarious, tolerating overlapping home ranges. Therefore an understanding on the individual territorial requirements of a species' can be used as a guide to the density of nest boxes within any given area. Lindenmayer *et al.* (2003) suggested there is a spatial trend in the occupancy pattern of nest box use where nest boxes used for arboreal marsupials placed in a clump of four had greater occupancy rates over time. This would suggest the occupancy of nest boxes by fauna would depend on the density of other roosting/nesting habitat resources within the localised area. Tables 4-1 and 6-1 have been used as a guide in selecting the location and density of nest boxes within the nominated areas.

The position of the nest box on the host tree has also been considered in the context of predominant weather patterns, along with light and noise disturbances arising from the carriageway. It is proposed that nest boxes be installed with their entrances facing away from the lights of traffic and from a north west to south east position on the tree trunk to provide additional shelter from rain and wind (i.e. dominant rainfall from the south west). If this is not always possible, an alternative, particularly for glider nest boxes is to have the entrance facing into the tree. This would necessitate a maintained gap between the nest box entrance and the tree of around 100 mm.

Another important consideration is the height at which nest boxes are placed in the host tree. It has often been recommended that nest boxes be placed as high as possible to protect the occupants from predation and low enough to allow monitoring and maintenance. After considering the preferred height of nest box placement for each of the fauna groups it is recommended that nest boxes be positioned at heights of 5-8 m and possibly a little higher for specific fauna such as black cockatoos (8-10 m) and higher again for the two large forest owl nest boxes. The recommended height has taken into account the surrounding structure of the vegetation where the overstorey ranges from 11-16 m in the Swamp Forest communities to more than 25 m in the taller moist

sclerophyll forest found around throughout the state forests. After considering the heights proposed for the installation of the nest boxes a suitable extension ladder with the necessary safety equipment and training would be sufficient to install and subsequently monitor them or alternatively a portable Elevated Work Platform (EWP). In the cases of the large forest owl nest boxes it may be necessary to have them installed by specialist tree climbers.

Table 6-1. Breeding territory and distance required between nest boxes for native fauna that utilise tree hollows and were either recorded, or considered likely to occur along the carriageway.

Bold type denotes vulnerable fauna pursuant to the NSW TSC Act. NS = No nest boxes supplied for these species.

Common Name	Scientific Name	Territorial at any stage of life-cycle? (y/n)	Breeding territory (ha) or distance between nests (m)	Distance between nest boxes (m)	Nest Box Type (see Table 5-1)
Birds					
Australian Wood Duck	<i>Chenonetta jubata</i>	Y ¹	unknown ¹	-	NS
Grey Teal	<i>Anas gracilis</i>	Y ¹	1 pair per 0.25 ha ¹	-	NS
Chestnut Teal	<i>Anas castanea</i>	Y ¹	unknown ¹	-	NS
Glossy Black Cockatoo	<i>Calyptorhynchus lathami</i>	N²	-	-	7
Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>	N ²	-	-	7
Galah	<i>Cacatua roseicapilla</i>	N ²	-	-	6
Long-billed Corella	<i>Cacatua tenuirostris</i>	N ²	5 nests per tree ²	2-3 m	NS
Sulphur-crested Cockatoo	<i>Cacatua galerita</i>	N ²	-	-	7
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	N ²	Several pairs in same tree ²	2-3 m	8
Scaly-breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>	N ²	Several pairs in same tree ²	2-3 m	8
Musk Lorikeet	<i>Glossopsitta concinna</i>	N ²	Several pairs in same tree ²	2-3 m	8
Little Lorikeet	<i>Glossopsitta pusilla</i>	N²	Several multiple species in same tree²	2-3 m	NS
Australian King Parrot	<i>Alisterus scapularis</i>	Y ²	100 m ²	100 m	7
Eastern Rosella	<i>Platycercus eximius</i>	Y ²	90 m ²	90 m	8
Powerful Owl	<i>Ninox strenua</i>	Y²	300-1500 ha²	3.8 km	9
Sooty Owl	<i>Tyto tenebricosa</i>	Y²	200-800 ha²	2.5 km	9
Masked Owl	<i>Tyto novaehollandiae</i>	Y²	200-800 ha²	2.5 km	9
Southern Boobook	<i>Ninox novaeseelandiae</i>	Y ²	37 ha ²	600 m	6
Barn Owl	<i>Tyto alba</i>	Y ²	300 m ²	300 m	6
Australian Owlet-Nightjar	<i>Aegothesles cristatus</i>	Y ²	<80 ha ²	750-900 m	8
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	Y ²	25 ha ²	500 m	NS
Sacred kingfisher	<i>Todiramphus sanctus</i>	Y ²	4 ha ³	200 m	NS
Dollarbird	<i>Eurystomus orientalis</i>	Y ²	14 ha ³	300 m	NS
White-throated Treecreeper	<i>Cormobates leucophaeus</i>	Y ³	3-7 ha ³	170-250 m	NS
Striated Pardalote	<i>Pardalotus striatus</i>	Y ³ immediate area	Pairs up to 100's pairs	2 m	NS
Starling ¹	<i>Sturnus vulgaris</i> ¹	Y ⁴	2.3 territories/ha	100 m	NS
Common Myna ¹	<i>Acridotheres tristis</i> ¹	Y ⁴	0.8-2.0 ha	125 m	NS
Reptiles					
Southern Leaf-tailed Gecko	<i>Phyllurus platurus</i>	N ⁵	-	-	NS
Tree Skink	<i>Egernia mcphreei</i>				NS
Lace Monitor	<i>Varanus varius</i>	Unknown ⁵	-	-	NS
Diamond Python	<i>Morelia spilota spilota</i>	Unknown ⁵	-	-	NS
Carpet Python	<i>Morelia spilota</i>	Unknown ⁵	-	-	NS
Frogs					
Bleating Tree Frog	<i>Litoria dentata</i>	N ⁶	-	-	NS
Perons Tree Frog	<i>Litoria peronii</i>	N ⁶	-	-	NS
Tyler's Tree Frog	<i>Litoria tyleri</i>	N ⁶	-	-	NS

Common Name	Scientific Name	Territorial at any stage of life-cycle? (y/n)	Breeding territory (ha) or distance between nests (m)	Distance between nest boxes (m)	Nest Box Type (see Table 5-1)
Mammals					
Brown Antechinus	<i>Antechinus stuartii</i>	N ⁷	1-2 ha ⁸	-	1
Brush-tailed Phascogale	<i>Phascogale tapofata</i>	Y⁸	5-60 ha⁸	-	1
Mountain Brushtail Possum	<i>Trichosurus caninus</i>	Y ⁸	0.2-4 ha ⁸	100 m	5
Common Brushtail Possum	<i>Trichosurus vulpecular</i>	Y ⁸	0.2-4 ha ⁸	100 m	5
Feather-tail Glider	<i>Acrobates pygmaeus</i>	N ⁹	0.15-2.1 ha ¹⁰	~2-4 ⁹	1/2
Sugar Glider	<i>Petaurus breviceps</i>	Unknown ¹¹	0.89-1.54 ha ¹¹	100-125 m	3
Squirrel Glider					3/4
Yellow-bellied Glider	<i>Petaurus australis</i>	Y¹⁴	30-60 ha	125 m	4
Greater Glider					4
Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>	Unknown ⁸	-	-	5
White-striped Mastiff Bat	<i>Tadarida australis</i>	N ¹⁵	-	-	2
Eastern Free-tail Bat	<i>Mormopterus norfolkensis</i>	N¹⁵	-	-	2
Gould's Wattle Bat	<i>Chalinolobus gouldi</i>	N ¹⁵	-	-	2
Chocolate Wattle Bat	<i>Chalinolobus morio</i>	N ¹⁵	-	-	2
Eastern Forest Bat	<i>Vespadelus pumilus</i>	N ¹⁵	-	-	2
Little Forest Bat	<i>Vespadelus vulturnus</i>	N ¹⁵	-	-	2
Southern Forest Bat	<i>Vespadelus regulus</i>	N ¹⁵	-	-	2
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	Y¹⁶	Regional if maternity site	-	2
Eastern Broad-nosed Bat	<i>Scotorepens orion</i>	N ¹⁵	-	-	2
Lesser Long-eared Bat	<i>Nyctophilus geoffroyi</i>	N ¹⁵	-	-	2
Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>	N ¹⁵	-	-	2

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7.0 NEST BOX MANAGEMENT

The management of nest boxes forms part of the overall management of fauna for the Upgrading of the Pacific Highway from just south of Warrell Creek (Allgomeria deviation) north the Waterfall Way, Raleigh.

7.1 When will the Nest Boxes be Installed?

The contractor will install 60% of the nominated nest boxes will be installed prior to or during the clearing works with the objective of providing temporal refuge habitat for those hollow dependent fauna displaced during clearing operations. The remaining 40% of nest boxes will be installed by the contractor once a final tally of functional tree hollows has been compiled and reviewed as a result of the data collected during the clearing supervision. Occupancy rates of tree hollows during the clearing supervision will also facilitate the final number and types of nest boxes being installed. Ultimately, the Project Ecologist will be responsible for determining these values as they will be performing the clearing supervision.

7.2 Monitoring and Maintenance

Roads and Maritime Services have committed to developing a suitable monitoring and maintenance strategy to evaluate the effectiveness of the nest boxes with this summarised in Table 7-1. As such, it will be important to assign each nest box a number and ensure its location is recorded using a GPS. It is proposed that summer and winter monitoring would take place shortly after the installation period (i.e. Year 3 and 4 of this plan) and this would continue in Year 6 and Year 8. An annual maintenance program will align with this monitoring program after which a pre handover maintenance inspection will be undertaken at Year 8 (Table 7-1).

During each monitoring event, the following information should be collected for each nest box using a field proforma:

- Inspection dates, weather conditions (i.e. rain, wind, cloud cover, ambient temperature) and time each box was inspected;
- Nest box number;
- Is the nest box currently occupied by native fauna;
- If yes, what species;
- If no, are there signs of use and can the species be identified or assigned to a group (i.e. bats, birds);
- Has the nest box been used by a pest species (i.e. European Bees, Common Myna, Termites);
- Is there any deterioration of the nest box;
- Is there any maintenance required; and
- Has the surrounding landscape changed (i.e. clearing, partial clearing).

Factors to be considered as part of the maintenance schedule include:

- The need to remove exotic pests species such as Common Mynas, Common Starling and European Bees;
- Replacement of fallen, damaged or degraded nest boxes;
- Repositioning or relocation of dysfunctional⁴ nest boxes;
- Checking each box is not holding water or leaking; and
- Removing excess nesting material⁵ as this may impede access over time.

⁴ Dysfunctional for the purposes of the nest box monitoring program shall mean nest boxes that are showing no signs of use during the latter stages of the monitoring program (i.e. after 3 monitoring episodes).

⁵ Build-up of nest material that threatens to block nest box entrance or create management problems as determined by the qualified zoologist undertaking the monitoring program.

Table 7-1. Timing of key actions for this nest box plan of management, responsibilities and documentation requirements.

Management Action/Year Number	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Responsibility	Documentation Requirements
Pre Construction										
Prepare Nest Box Plan	√								RMS	Construction Environmental Management Plan
Construction										
Commission Construction of Nest Boxes	√	√							Contractor	-
Install Nest Boxes		√	√						Contractor	Construction Environmental Management Plan
Monitoring										
Summer			√	√		√		√	Contractor	Yearly reporting
Winter			√	√		√		√	Contractor	Yearly reporting
Maintenance										
Maintenance of boxes			√		√		√		Contractor	
Pre Handover Maintenance Inspection								√	Contractor	Nest Box Reporting

7.3 Performance Measures

The performance of the nest box program would be assessed against the following parameters:

- Use of nest boxes by a wide range of native fauna;
- Use of nest boxes designed for specific species by those species (i.e. Brush-tailed Phascogale nest box being used by this species);
- Low rates of exotic fauna using nest boxes; and
- Reduced maintenance requirements.

7.4 Contingency Measures

A number of contingency measures have been proposed to overcome potential problems associated with using nest boxes as a mitigation device. These have been summarised in Table 7-2.

Table 7-2. Potential problems encountered when using nest boxes as a mitigation tool to offset tree hollow losses.

Problem	Contingency/Correction Action
Nest box being used by non target species.	Review the selection and number of nest box designs.
Nest boxes become occupied by exotic or invasive fauna (i.e. European Bees, Termites).	Review/modify nest box design to exclude undesirable species, treat if applicable (i.e. Buffalo Fly ear tags for bees) or relocate those nest boxes to another location.
Poor uptake/usage rate by native fauna.	Review the types and numbers of nest box designs.
Nest boxes deteriorating rapidly and requiring maintenance.	Identify causes of nest box failure, modify design and construct accordingly.

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APPENDIX A

Hollow Dependant Fauna Recorded along the RMS Road Corridor

Table A. Summary of hollow dependant fauna recorded on or near to the Warrell Creek to Urunga.

Bold type denotes species currently listed as vulnerable pursuant to the NSW *Threatened Species Conservation Act* (1995).

* denotes introduced species.

Family Name	Common Name	Scientific Name
FROGS		
HYLIDAE	Common Green Tree Frog	<i>Litoria caerulea</i>
HYLIDAE	Bleating tree Frog	<i>Litoria dentata</i>
HYLIDAE	Eastern Dwarf Frog	<i>Litoria fallax</i>
HYLIDAE	Graceful Tree Frog	<i>Litoria gracilentata</i>
HYLIDAE	Peron's Tree Frog	<i>Litoria peronii</i>
HYLIDAE	Red-eyed Tree Frog	<i>Litoria chloris</i>
HYLIDAE	Tyler's Tree Frog	<i>Litoria tyleri</i>
REPTILES		
GECKONIDAE	Southern Leaf-tailed Gecko	<i>Saltuarius swaini</i>
VARANIDAE	Lace Monitor	<i>Varanus varius</i>
SCINCIDAE	Tree Skink	<i>Egernia mcpheei</i>
SCINCIDAE	Bar-sided Skink	<i>Eulamprus martini</i>
PYTHONIDAE	Carpet Python	<i>Morelia spilota</i>
COLUBRIDAE	Green Tree Snake	<i>Dendrelaphis punctulata</i>
MAMMALS		
DASYURIDAE	Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>
DASYURIDAE	Brown Antechinus	<i>Antechinus stuartii</i>
PETAUROIDEA	Yellow-bellied Glider	<i>Petaurus australis</i>
PETAUROIDEA	Squirrel Glider	<i>Petaurus norfolcensis</i>
PETAUROIDEA	Sugar Glider	<i>Petaurus breviceps</i>
PETAUROIDEA	Greater Glider	<i>Petauroides volans</i>
PSEUDOCHERIDAE	Common Ringtail Possum	<i>Pseudocheirus peregrinus</i>
ACROBATIDAE	Feather-tail Glider	<i>Acrobates pygmaeus</i>
PHALANGERIDAE	Common Brushtail possum	<i>Trichosurus vulpecula</i>
PHALANGERIDAE	Short-eared Brushtail possum	<i>Trichosurus caninus</i>
VESPERTILIONIDAE	Chocolate Wattle Bat	<i>Chalinolobus morio</i>
VESPERTILIONIDAE	Gould's Wattled Bat	<i>Chalinolobus gouldi</i>
VESPERTILIONIDAE	Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>
VESPERTILIONIDAE	Eastern Broad-nosed Bat	<i>Scotorepens orion</i>
VESPERTILIONIDAE	Undescribed Broad-nosed Bat	<i>Scotorepens sp</i>
VESPERTILIONIDAE	Eastern Forest Bat	<i>Vespadelus pumulus</i>
VESPERTILIONIDAE	Southern Forest Bat	<i>Vespadelus regulus</i>
VESPERTILIONIDAE	Southern Forest Bat	<i>Vespadelus vulturnus</i>
VESPERTILIONIDAE	Little Bent-wing Bat	<i>Miniopterus australis</i>
VESPERTILIONIDAE	Southern Myotis	<i>Myotis macropus</i>
VESPERTILIONIDAE	Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>
VESPERTILIONIDAE	Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>
VESPERTILIONIDAE	Lesser long-eared Bat	<i>Nyctophilus geoffroyi</i>

Family Name	Common Name	Scientific Name
VESPERTILIONIDAE	Gould's Long-eared Bat	<i>Nyctophilus gouldi</i>
MOLOSSIDAE	Little Free-tail Bat	<i>Mormopterus sp. 2</i>
MOLOSSIDAE	White-striped Mastiff Bat	<i>Tadarida australis</i>
BIRDS		
ANATIDAE	Hardhead	<i>Aythya australis</i>
ANATIDAE	Pacific Black Duck	<i>Anas superciliosa</i>
ANATIDAE	Wood Duck	<i>Chenonetta jubata</i>
ANATIDAE	Grey Teal	<i>Anas gracilis</i>
ANATIDAE	Chestnut Teal	<i>Anas castanea</i>
CACATUIDAE	Glossy Black Cockatoo	<i>Calyptorhynchus lathami</i>
CACATUIDAE	Yellow-tailed Black Cockatoo	<i>Calyptorhynchus funereus</i>
CACATUIDAE	Galah	<i>Cacatua rosicapilla</i>
PSITTACIDAE	Rainbow Lorikeet	<i>Trichoglossus haematodus</i>
PSITTACIDAE	Scaly Breasted Lorikeet	<i>Trichoglossus chlorolepidotus</i>
PSITTACIDAE	Little Lorikeet	<i>Glossopsitta pusilla</i>
PSITTACIDAE	Musk Lorikeet	<i>Glossopsitta concinna</i>
PSITTACIDAE	Australian King Parrot	<i>Alisterus scapularis</i>
PSITTACIDAE	Eastern Rosella	<i>Platycercus eximius</i>
STRIGIDAE	Southern Boobook	<i>Ninox novaeseelandiae</i>
STRIGIDAE	Powerful Owl	<i>Ninox strenua</i>
TYTONIDAE	Masked Owl	<i>Tyto novaehollandiae</i>
TYTONIDAE	Sooty Owl	<i>Tyto tenebricosa</i>
TYTONIDAE	Barn Owl	<i>Tyto alba</i>
AEGOTHELIDAE	Australian Owlet Nightjar	<i>Aegotheles cristatus</i>
CAPRIMULGIDAE	White-throated Nightjar	<i>Eurostopodus mystacalis</i>
ALCEDINIDAE	Laughing Kookaburra	<i>Dacelo novaeguineae</i>
ALCEDINIDAE	Sacred Kingfisher	<i>Todiramphus sanctus</i>
ALCEDINIDAE	Forest Kingfisher	<i>Todiramphus macleayii</i>
CORACIIDAE	Dollarbird	<i>Eurystomus orientalis</i>
CLIMACTERIDAE	White-throated treecreeper	<i>Cormobates leucophaeus</i>
PARDALOTIDAE	Striated Pardalote	<i>Pardalotus striatus</i>
PARDALOTIDAE	Spotted Pardalote	<i>Pardalotus punctatus</i>
STURNIDAE	Common Starling *	<i>Sturnus vulgaris</i> *
STURNIDAE	Common Myna *	<i>Acridotheres tristis</i> *

APPENDIX B

Ecology of Relevant Hollow Dependant Fauna

Table B. Summary of hollow dependant fauna species known from the lower foothills and coastal plans of the Nambucca and Kalang Valley.

M = Metres, MM = Millimetre, DBH = Diameter at breast height.

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Mammals							
Scansorial mammals							
Brush-tailed Phascogale (<i>Phascogale tapoatafa</i>)	Largely an arboreal inhabitant of dry sclerophyll forests and woodlands with little/sparse ground cover. It uses multiple den sites usually a tree hollow but also known to use rotted stumps and bird nests. Forages on arthropods and small vertebrates over variable home range of 5-100 ha depending on habitat quality (Soderquist and Rhind 2008).	Rough barked trees of ≥ 250 mm DBH					Large tree cavities with small secure entrances are preferred (Soderquist and Rhind 2008).
Brown Antechinus (<i>Antechinus stuartii</i>)	Widespread in a variety of forested and heathland habitats reaching its highest density in habitats with dense groundcover and abundant logs. Nests are constructed in hollow log or tree hollow when young reach 5 weeks old (Crowther and Braithwaite 2008)						Likely to use a range of nest box types.
Small Gliders							
Feather-tail Glider (<i>Acrobates pygmaeus</i>)	Widely distributed throughout tall forests and woodlands of eastern Australia with home range of up to 2.1 ha (Ward and Woodside 2008). Normally den in groups of 3-5 individuals with observations of up to 25 individuals.	400-2000 mm DBH	25	120	920		Known for utilising any available enclosed space including tree hollows, telephone interchange boxes, bird boxes, old bird nests or abandoned possum drays Ward and Woodside 2008).

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Sugar Glider (<i>Petaurus breviceps</i>)	Found in variety of habitats including rainforest, sclerophyll forests and woodland habitats of eastern and northern Australia (Suckling 2008). Highest densities tend to occur in open forest habitats where animals have access to dense patches of <i>Acacia</i> (Suckling 2008).	>300 mm DBH	8 -31	35-50	60-700	<5	It seems to tolerant some level of habitat fragmentation being often road in linear strips of vegetation and has been successfully introduced in rehabilitated habitats augmented with nest boxes.
Large Gliders							
Squirrel Glider (<i>Petaurus norfolcensis</i>)	Inhabitant of dry sclerophyll forest and woodland but usually absent from dense coastal ranges of NSW. Such habitats tend to have <i>Eucalyptus</i> , <i>Corymbia</i> , <i>Angophora</i> species with a shrubby understorey of <i>Acacia</i> or <i>Banksia</i> with at least one winter flowering species providing an important nectar source (van der Ree and Suckling 2008)	Rough barked trees including Ironbarks and Swamp Mahogany 900mm DBH					Usually select multiple tree hollows with a tight fitting entrance.
Yellow-bellied Glider (<i>Petaurus australis</i>)	Generally restricted to tall, mature eucalypt forest and coastal woodlands in high rainfall areas of temperate to sub-tropical eastern Australia (NPWS 2003; Menkhorst and Knight 2003). A family group of two to six individuals usually occupy a home range of 30-60 ha (Goldingay 2008). Tree hollows are used for denning and these are changed periodically throughout the year.	800-2000 mm DBH	44	110 - 140	1300	6 - 13	These gliders require large hollows because family groups share den sites (Gibbons and Lindenmayer 2003).
Greater Glider (<i>Petauroides volans</i>)	An inhabitant of Eucalypt, <i>Corymbia</i> and <i>Angophora</i> dominated habitats from low open forests on the coast to tall closed forest of the coastal ranges and along riparian corridor and woodlands west of the dividing range (McKay 2008).	>1m DBH	11	180		2 - 14	
Possums							
Common Ringtail Possum (<i>Pseudocheirus peregrinus</i>)	Occupant of usually dense vegetation types including rainforest where shrubs form dense tangled foliage although inhabitant riparian woodland vegetation west of the dividing range. Spherical nests lined with shredded bark or grass are made in a hollow limb or dense undergrowth (McKay and Ong 2008).	100 - 1430 DBH	4	66-80	> 200	8	Ringtail possums inhabiting areas with dense understorey vegetation are more likely to build drays from sticks and vegetative matters as a shelter in preference to tree hollows (McKay and Ong 2008).

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Common Brushtail Possum (<i>Trichosurus vulpecula</i>)	Widely distributed throughout Australia, however, sclerophyll forests tend to be the preferred habitat (Kearle and How 2008). Although tree hollows are the usually den location in either tree limb or trunk individuals have been recorded using termite mounds, hollow logs and rabbit warrens (Kearle and How 2008).	550-1150 mm DBH	6	> 100	90-120	4 - 8	The generalist denning habits of this species suggest alternative nesting resources should be an effective substitute for the loss of tree hollow habitat.
Short-eared Brushtail Possum (<i>Trichosurus caninus</i>)	An inhabitant of moist forests north from about Newcastle (How 2008). It reaches its peak density of 1 individual per 10 ha in forest gullies with abundant tree hollows in north eastern NSW (Martin 2008). Den site selection is normally in a live or dead tree although it has been known to utilise epiphytes.	550-1150 mm DBH	6	> 100	90-120	4 - 8	
Flying Mammals							
Microchiropteran bats (i.e. East Coast Free-tail Bat, Greater Broad-nosed Bat, Large-footed Myotis)	No preferred hollow characteristics are apparent among bats and both natural and man-made structures are used. However some species of microchiroptera are partly heterothermic suggesting that their selection of roost sites is strongly influenced by microclimatic conditions (Gibbons and Lindenmayer 2003). Bat species have been known to show fidelity to a roost area, rather than a single roost (Gibbons and Lindenmayer 2003) which may indicate the substitution of natural hollows with nest boxes will not greatly influence local populations of this fauna group.	Mature, senescent or dead trees > 800 mm DBH.					Been recorded using roost trees as small as 25 mm.
Birds							
Ducks							
Australian Wood Duck (<i>Chenonetta jubata</i>)	An inhabitant of grasslands, open woodlands, wetlands, flooded pastures and coastal inlets and bays. Also common on farmland with dams, as well as around rice fields, sewage ponds and in urban parks. Often be found around deeper lakes that may be unsuitable for other waterbirds, as it prefers to forage on land (Pizzey and Knight 2008).	Live or dead trees above or near water	3		400		Often re-using the same site.

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Grey Teal (<i>Anas gracilis</i>)	Common inhabitant of all sheltered watered areas ranging from freshwater to saltwater. It preferred habitat tends to be timbered pools and river systems of the inland areas, where large aggregations numbers thousands are not uncommon (Marchant and Higgins 1993).	Usually tall tree along watercourse	3.5		1300		Rarely on ground, under shrubs or bushes.
Chestnut Teal (<i>Anas castanea</i>)	Inhabitant of wetlands and estuaries in coastal regions, and is one of the few ducks able to tolerate hyper saline waters, although it still needs fresh water for drinking. It will also use open freshwater lakes, reservoirs and sewage ponds during dry seasons. It mainly breeds in coastal areas, needing hollow trees in water or short grasslands near water for nesting, and it will readily take to suitably constructed nest boxes (Marchant and Higgins 1993; Pizzey and Knight 2008).	Close to water	1-10.5				Nest sites tend to be lower in mangrove communities
Cockatoos							
Glossy Black Cockatoo (<i>Calyptorhynchus lathamii</i>)	In coastal parts of NSW the preferred habitat for Glossy Black Cockatoo is dry open forest or woodland with a plentiful supply of <i>Allocasuarina</i> species for foraging, and large hollows for nesting (Pepper <i>et al.</i> 2000). Glossy Black Cockatoos are selective in their choice of foraging sites and chose stands that produce the highest seed to cone ratio (Pepper <i>et al.</i> 2000). Typically nest sites occur close (<2 km) to areas with a plentiful supply of <i>Allocasuarina</i> .	Live or dead Eucalypt >700mm DBH usually <1km from feeding area.	5-28	210	400-1200		Known to use nest boxes constructed from hollow logs.
Yellow-tailed Black Cockatoo (<i>Calyptorhynchus funereus</i>)	The Yellow-tailed Black Cockatoo inhabits temperate rainforest, sclerophyll forests, woodlands and coastal heaths throughout eastern Australia (Pizzey and Knight 2008). It has a varied diet of grubs, seeds from <i>Pinus</i> , <i>Hakea</i> , <i>Banksia</i> and other plants, fruits and plant shoots. Breeding usually takes place in a large senescent eucalypt of considerable age (Nelson and Morris 1994).	Hollow in mature senescent tree	5-56	460	600-2400		Mean estimated age of nest trees used by Yellow-tailed Black Cockatoo 221 years (Nelson and Morris 1994)
Sulphur Crested Cockatoo (<i>Cacatua galerita</i>)	Inhabitant of most forested and wooded areas including urban areas (Pizzey and Knight 2008). Tend to display sedentary habits.	Hollow in limb or trunk of dead or living tree often near water	1-35	220	200-1800		

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Galah (<i>Cacatua roseicapilla</i>)	Inhabitant of most forested and wooded areas including urban areas often close to water (Pizzey and Knight 2008). Seeds of grasses and cultivated crops are eaten, making these birds agricultural pests in some areas where they are often described as abundant. Birds may travel large distances in search of favorable feeding grounds.	Hollow in limb or trunk of dead or living tree often near water	1-19	250	700-2000		
Forest Owls							
Powerful Owl (<i>Ninox Strenua</i>)	An inhabitant of sclerophyll forests and occasionally woodlands of eastern and south-eastern Australia (Pizzey and Knight 2008). Studies suggest it is highly mobile species occupying large home ranges of approximately 1000-3000 ha in tall sclerophyll forests with pairs of birds holding territories are rarely found within 4-5 kilometres of another territory. The Powerful Owl often nests in trees growing near creeks along drainage lines (McNabb 1996; Kavanagh 1997) and have occasionally been recorded nesting in parkland next to forest (Pavey <i>et al.</i> 1994). Roost sites are traditional and used year after year but the number of roost sites can vary considerably (e.g. McNabb 1996, Kavanagh 1997). Kavanagh (1997) found the most important roost sites are trees in the roost or nest-grove which can be used for many months of the year. Prey are generally hollow dwelling (Garnett and Crowley 2000).	> 1m DBH located on steep slopes	12 - 45	450 -750	2000		Feather identified as belong to this species off this species was recorded in the vicinity of chainage 8420 during the hollow bearing tree survey. There has been no record of this species utilising artificial nest boxes (Carbery 2004).
Masked Owl (<i>Tyto novaehollandiae</i>)	Inhabitant of dry sclerophyll forests and woodlands generally with a low sparse understorey but is known to utilise open and partially cleared habitat (Kavanagh and Peake 1993). This species is mainly encountered in coastal areas and tablelands but can extend far inland along riparian habitats. Nest and roost sites are often associated with large hollows in wet sclerophyll gullies where hollows may be used for several years.		10 - 30	450 - 550	400-5000		The Masked Owl may also roost in caves and rock crevices (Gibbons and Lindenmayer 1997). There has been no record of this species utilising artificial nest boxes (Carbery 2004).

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Sooty Owl (<i>Tyto tenebricosa</i>)	Occurs in wet eucalypt forest and rainforest on fertile soils with tall emergent trees. Typically found in old growth forest with a dense understorey, however, it is known to utilise younger forests if suitable nesting trees occur nearby. Nest site selection is normally within a large eucalypt hollow (Garnett and Crowley 2000).	Smooth barked eucalypts 400-600 mm DBH	16 - 30		400- 3000		The Sooty Owl may also roost in caves, rock overhangs and dense gully vegetation (Gibbons and Lindenmayer 1997). There has been no record of this species utilising artificial nest boxes (Carbery 2004).
Small Owls							
Southern Boobook (<i>Ninox novaeseelandiae</i>)	Inhabits most vegetated landscapes from heathlands to dense forest and open deserts where it often feeds on insects, small mammals (such as the House Mouse, <i>Mus musculus</i> and small dasyurids) along with other small animals including frogs (Pizzey and Knight 2008).	Vertical hollow in live or dead tree	3-30	200-300	300-2500		
Barn Owl (<i>Tyto alba</i>)	This species is found throughout Australia where its distribution is limited only by habitat and food availability (Pizzey and Knight 2008). Its preferred habitat is open, often arid landscapes, fragmented farming landscapes, heath and lightly wooded forest.	Hollow in live or dead tree	0-20	200-250	600-2000		
Australian Owlet Nightjar (<i>Aegothesles cristatus</i>)	Most treed habitats that support tree hollows and nearby adjacent areas. During the day this species roosts in a limb or trunk hollow (Pizzey and Knight 2008).	Hollow in live or dead tree	0.2-30	70-250	200-3500		May use multiple roost hollows over short periods (Brigham <i>et al.</i> 1998)
Parrots/Lorikeets & Rosellas							
Australian King Parrot (<i>Alisterus scapularis</i>)	An inhabitant of rainforests, sclerophyll forests and woodlands particularly near riparian habitats where it forages for seeds and fruits (Pizzey and Knight 2008).	Deep vertical hollow in trunk of large Eucalypt	6-25	600	50-18000		
Rainbow Lorikeet (<i>Trichoglossus haematodus</i>)	This species inhabits a range of treed landscapes from heathlands to woodlands, sclerophyll forests and rainforests (Pizzey and Knight 2008). It is largely sedentary although some nomadic movements are undertaken in response to seasonal flowering and fruiting of plants.	Live or dead tree	3-30	220	300-600		Will readily use artificial sites

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Musk Lorikeet (<i>Glossopsitta concinna</i>)	A nomadic species following the flowering and fruiting of trees in tall, open and dry forest or woodlands dominated by eucalypts and <i>Corymbia</i> . Treed suburban areas, parks and landscaped street trees are also used. This species may also feed upon the seeds, fruits and insects and their larvae found within its preferred habitat.	Live or dead tree often close to water	3-8	40	500		
Scaly-breasted Lorikeet (<i>Trichoglossus chlorolepidotus</i>)	This species inhabits lowland eucalypt forests, woodlands heathlands and well-treed urban areas, including parks and gardens (Pizzey and Knight 2008). Numbers within any particular area often fluctuate in response to seasonal flowering of eucalypts, <i>Melaleuca</i> , <i>Callistemon</i> and <i>Banksia</i> .	Live or dead tree with an inclined hollow	3-20	50-150	200-1980		
Little Lorikeet (<i>Glossopsitta pusilla</i>)	A nomadic species that mostly occurs in dry, open eucalypt forests and woodlands (Pizzey and Knight 2008). They have been recorded from both old-growth and logged forests in the eastern part of their range, and in remnant woodland patches and roadside vegetation on the western slopes.	Hollows and knot holes usually in senescent trees	6-18	29-32	180-500		Very small entrance used.
Eastern Rosella (<i>Platycercus eximius</i>)	An inhabitant of open woodlands, grasslands, farmlands and remnant bushland. May also occur in urban habitats such as parks, gardens and golf courses (Pizzey and Knight 2008). Within these habitats it forages on the ground, especially amongst grasses in lawns, pastures and other clearings.	Hollow in any part of usually large Eucalypt	1-30	60-410	180-2440		Will utilise artificial structures.
Kookaburra/Kingfishers							
Laughing kookaburra (<i>Dacelo novaeguineae</i>)	Open Sclerophyll forest or woodland, with open or sparse understorey or grass ground cover (Pizzey and Knight 2008).	Live or dead tree often a Eucalypt	2-60	80-400	200-1500		Often utilises burrows and termitaria as well as artificial sites.
Sacred Kingfisher (<i>Todiramphus sanctus</i>)	An inhabitant of woodlands, mangroves and paperback forests, tall open eucalypt forest and <i>Melaleuca</i> forest. Sacred Kingfishers spend the winter in the north of their range and return south (including NSW) in the spring to breed (Pizzey and Knight 2008).		0.5-35				Often utilises burrows and termitaria.

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Dollarbird <i>(Eurystomus orientalis)</i>	An inhabitant of open wooded areas, normally with mature, hollow-bearing trees suitable for nesting (Pizzey and Knight 2008).	Mostly in senescent Eucalypt	6-35				May occasionally use termitaria.
White-throated Treecreeper <i>(Cormobates leucophaeus)</i>	An inhabitant of sclerophyll forests, rainforests, woodlands and timbered watercourses where it maintains permanent territories (Pizzey and Knight 2008).		4-5				
Striated Pardalote <i>(Pardalotus striatus)</i>	Striated Pardalotes are found in almost any habitat with trees or shrubs, but favor eucalypt forests and woodlands where they forage in the tops of trees, occasionally coming close to the ground in low shrubs (Pizzey and Knight 2008).	Maybe a burrow in a termite mound, hollow branch or river bank.					Often nests in burrows constructed in roadside cuttings, riverbanks and steep hillsides.
Reptiles							
Southern Leaf-tailed Gecko <i>(Phyllurus platurus)</i>	Sclerophyll forests, rainforests often with exposed rock and/or abundant fallen timber and old growth trees.	Under rock or exfoliating bark or tree hollow					Nothing known of its hollow habits.
Tree Skink <i>(Egernia mcphreei)</i>	Arboreal inhabitant of sclerophyll forests, rainforest margins and woodlands from coastal floodplains to upland areas of the Great Dividing Range (Wilson and Swan (2004).	Under rock or exfoliating bark or tree hollow, particularly fissures on dead stags					Little known on its hollow habits.
Lace Monitor <i>(Varanus varius)</i>	Arboreal inhabitant of sclerophyll forests, rainforest margins and woodlands (Wilson and Swan (2004).	Hollows with nearby large limbs for sunning	1->10m	>150	>300		
Frogs							
Bleating Tree Frog <i>(Litoria dentata)</i>	Coastal swamps and lagoons, rainforests, wet and dry sclerophyll forests and urban bushland. During the day it often hides beneath stones and bark (Barker <i>et al.</i> 1995).	Any hollow form but particular those that hold water					

Fauna Group Common Name (Latin Name)	Habitat	Tree hollow characteristics (Gibbons and Lindenmayer 2003)					Comment
		Den tree type	Height (m)	Entrance diameter (mm)	Depth (mm)	Density of hollow use within home range	
Common Green Tree Frog (<i>Litoria caerulea</i>)	Inhabitant of forests, woodlands, shrublands and open areas. Tends to take refuge in tree hollows, cracks and beneath exfoliating bark and occasionally under rocks (Barker <i>et al.</i> 1995).	Any hollow form but particular those that hold water					
Eastern Dwarf Frog (<i>Litoria fallax</i>)	Inhabitant of sclerophyll forest and occasionally rainforest and coastal heaths and woodlands where it normally occurs in permanent dams, swamps and ponds (Barker <i>et al.</i> 1995).	Mainly foliage but known to use tree hollows					
Graceful Tree Frog (<i>Litoria gracilentia</i>)	Inhabitant of mainly moist forest associated along coastal seaboard where it normally selects permanent dams, swamps and ponds for breeding (Barker <i>et al.</i> 1995).	Mainly foliage but known to use tree hollows					
Perons Tree Frog (<i>Litoria peronii</i>)	Inhabitant of forests, woodlands, shrublands and open areas. Tends to take refuge in tree hollows, cracks and beneath exfoliating bark (Barker <i>et al.</i> 1995).	Any hollow form but particular those that hold water	Ground level to >10 m	20-400	50-750		
Tyler's Tree Frog (<i>Litoria tyleri</i>)	Inhabitant of sclerophyll forest and occasionally rainforest and coastal heaths and woodlands where it normally occurs a short distance from permanent dams, swamps and ponds (Barker <i>et al.</i> 1995).	Any hollow form but particular those that hold water					

APPENDIX C

Hollow Bearing Tree Locations and Tree Hollow Field data

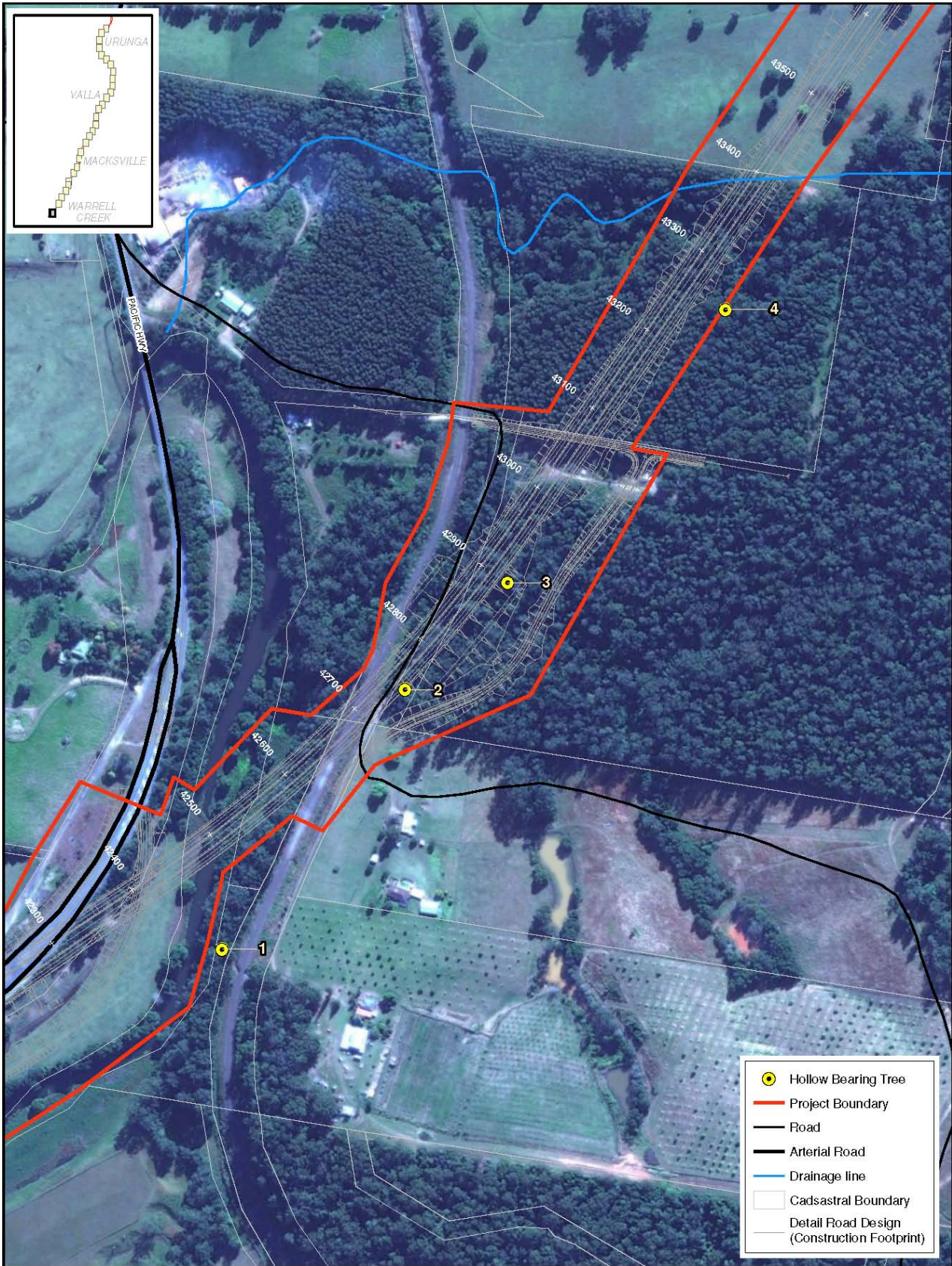


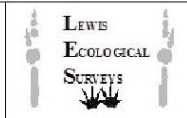
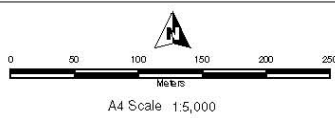
Figure 2 :

HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Caddisive: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia, 2008

Highway Design (footprint): RTA, 2011
 Project Boundary: RTA, 2011
 Drainage: Geoscience Australia, 2009
 State Forests: NSW DPI, 2008

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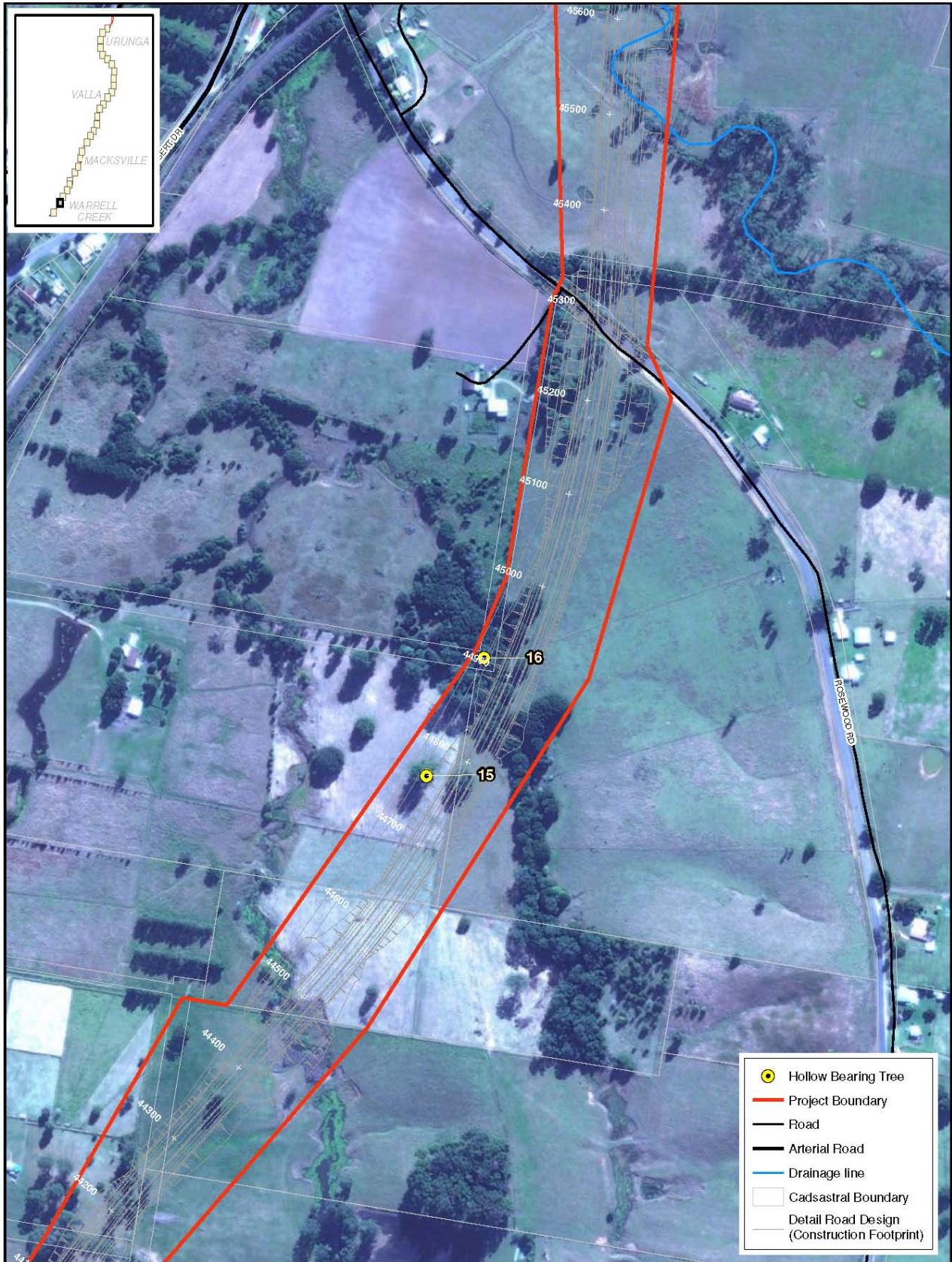


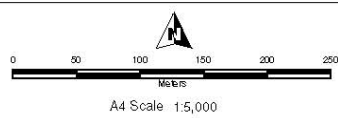
Figure 3 :

HOLLOW BEARING TREES

Source: Geoscience Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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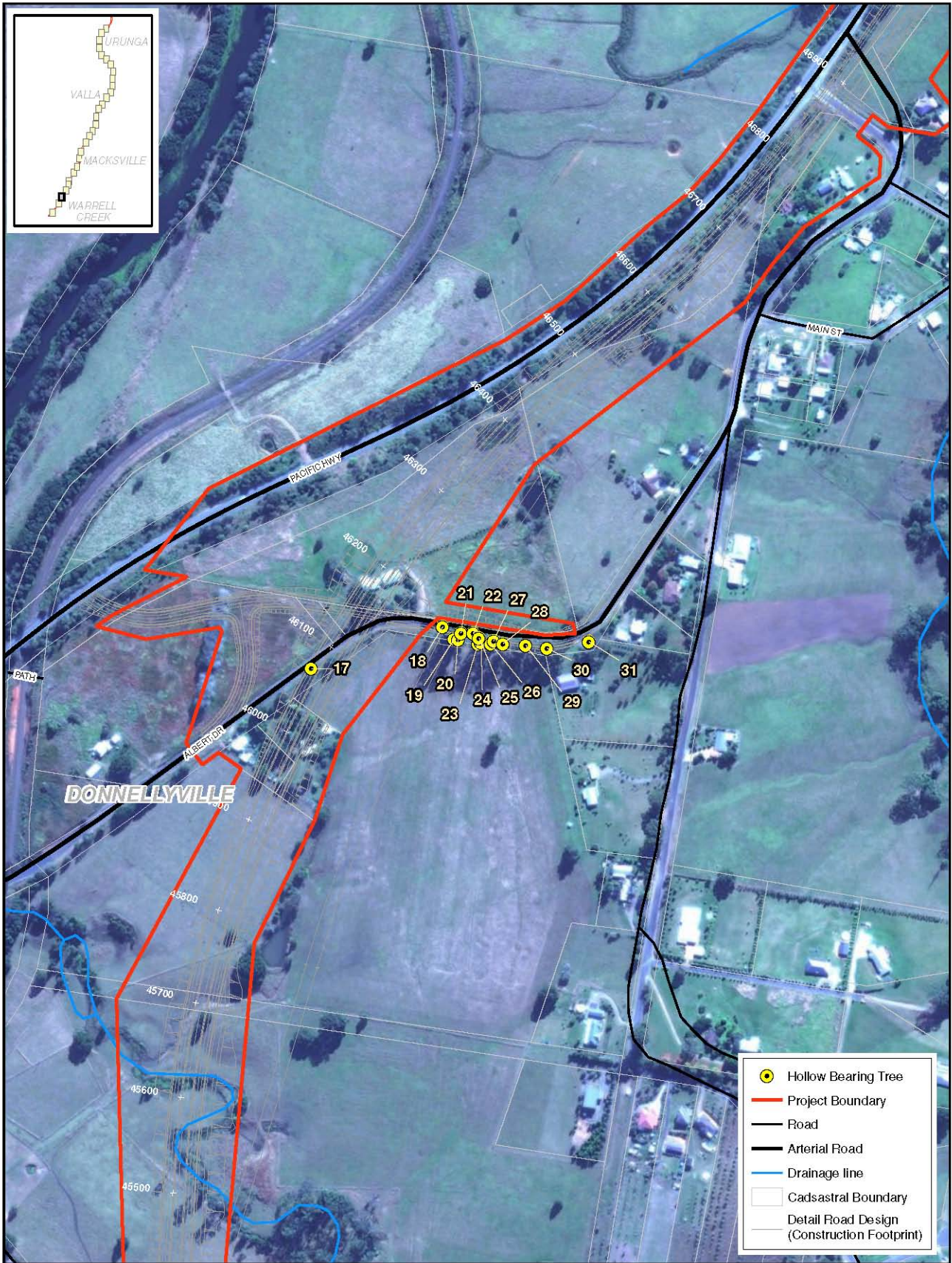


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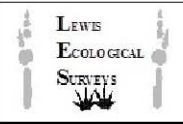
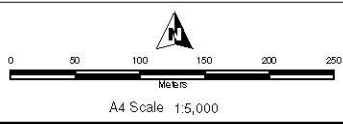
- Hollow Bearing Tree
- Project Boundary
- Road
- Arterial Road
- Drainage line
- Cadastral Boundary
- Detail Road Design (Construction Footprint)

Figure 4 : HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastral: Lewis Ecological Surveys April 2012
 Road: Geoscience Australia 2009

Highway Design (Footprint): RTA 2011
 Project Boundary: RTA 2011
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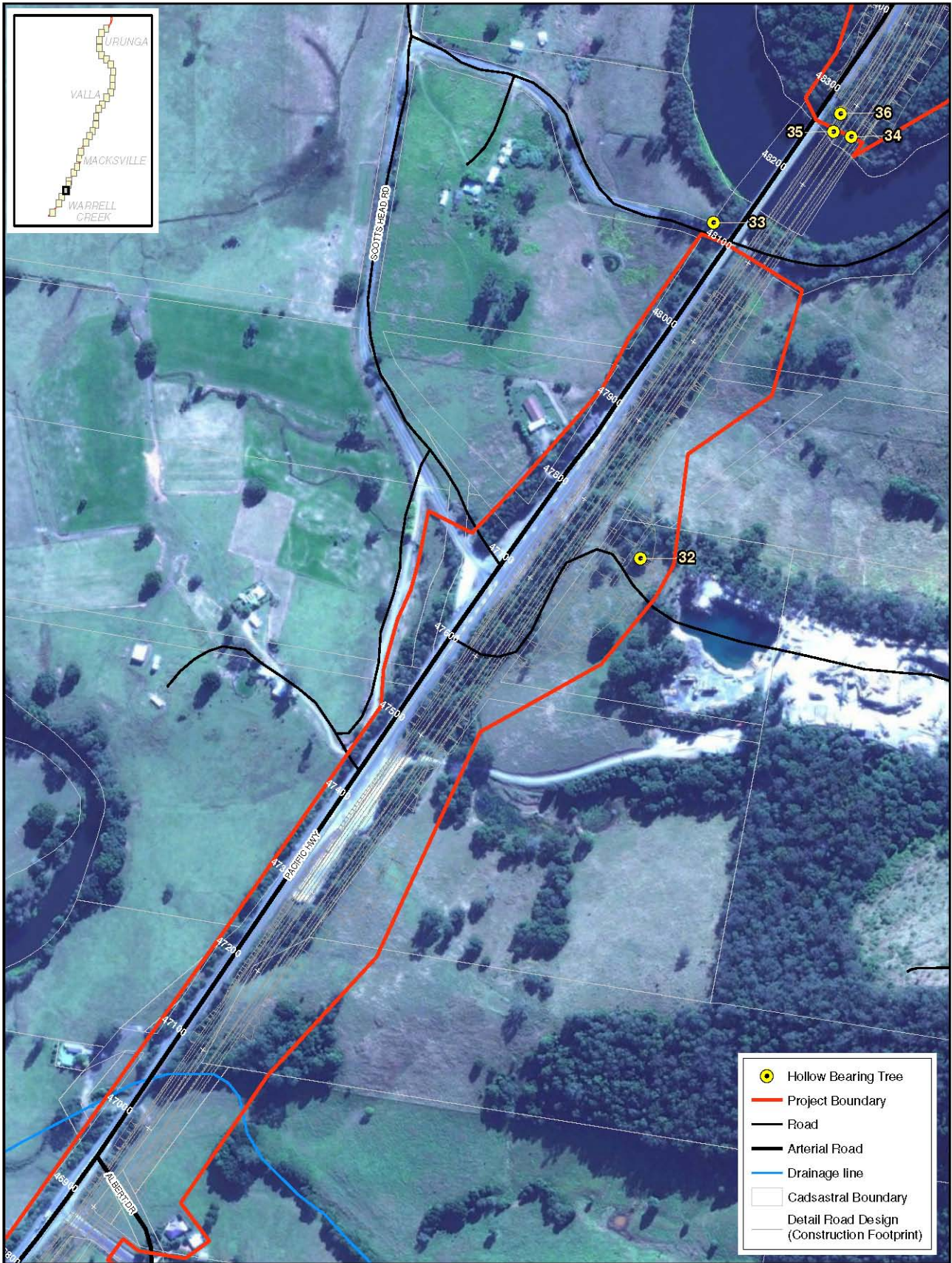


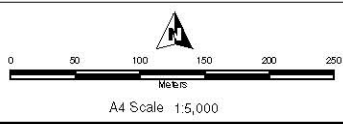
Figure 5 :

HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
 Road: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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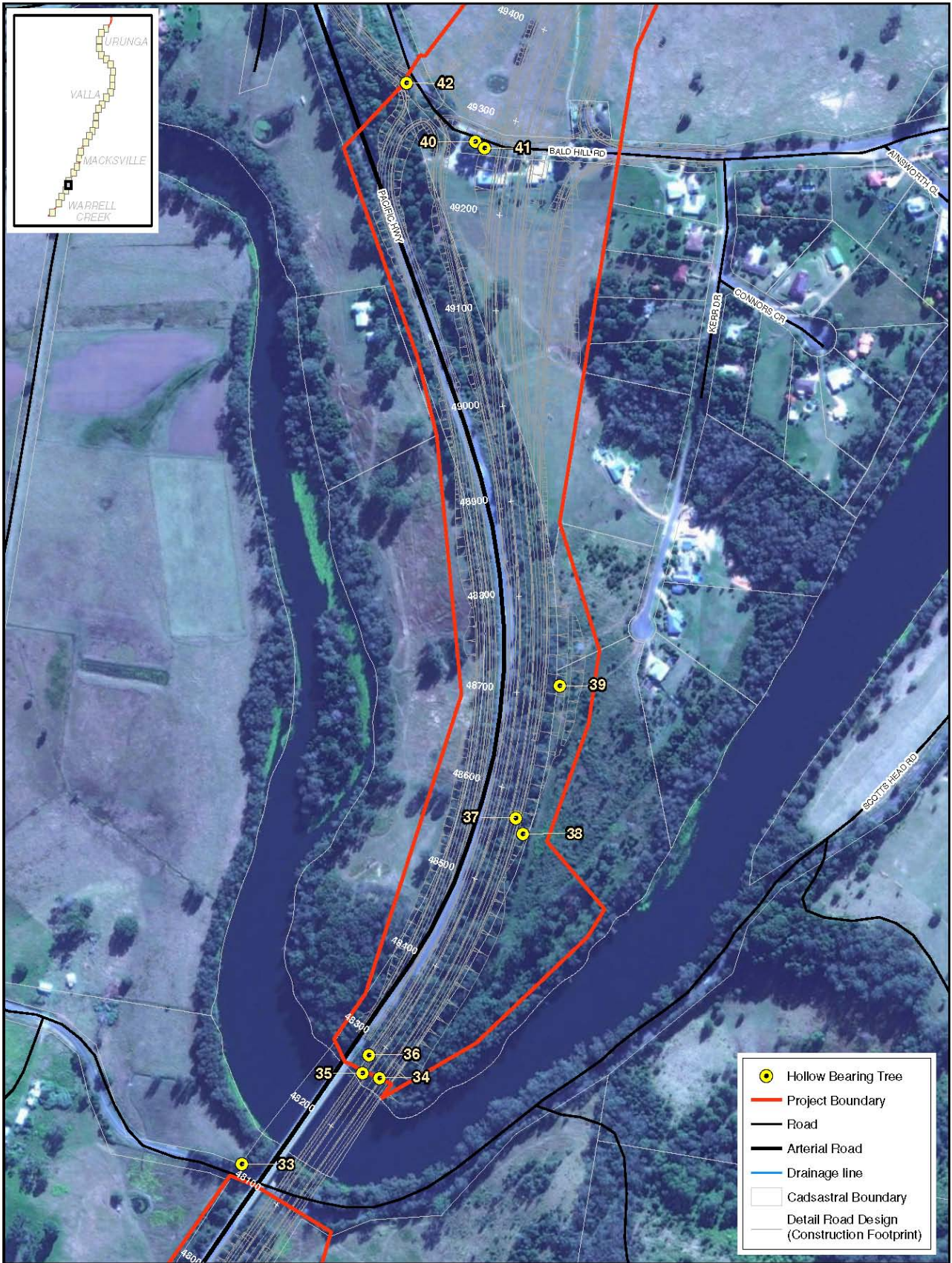


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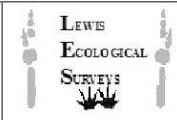
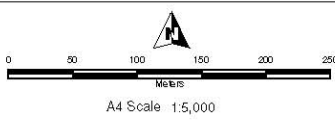
HOLLOW BEARING TREES

Source: Cadastral: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
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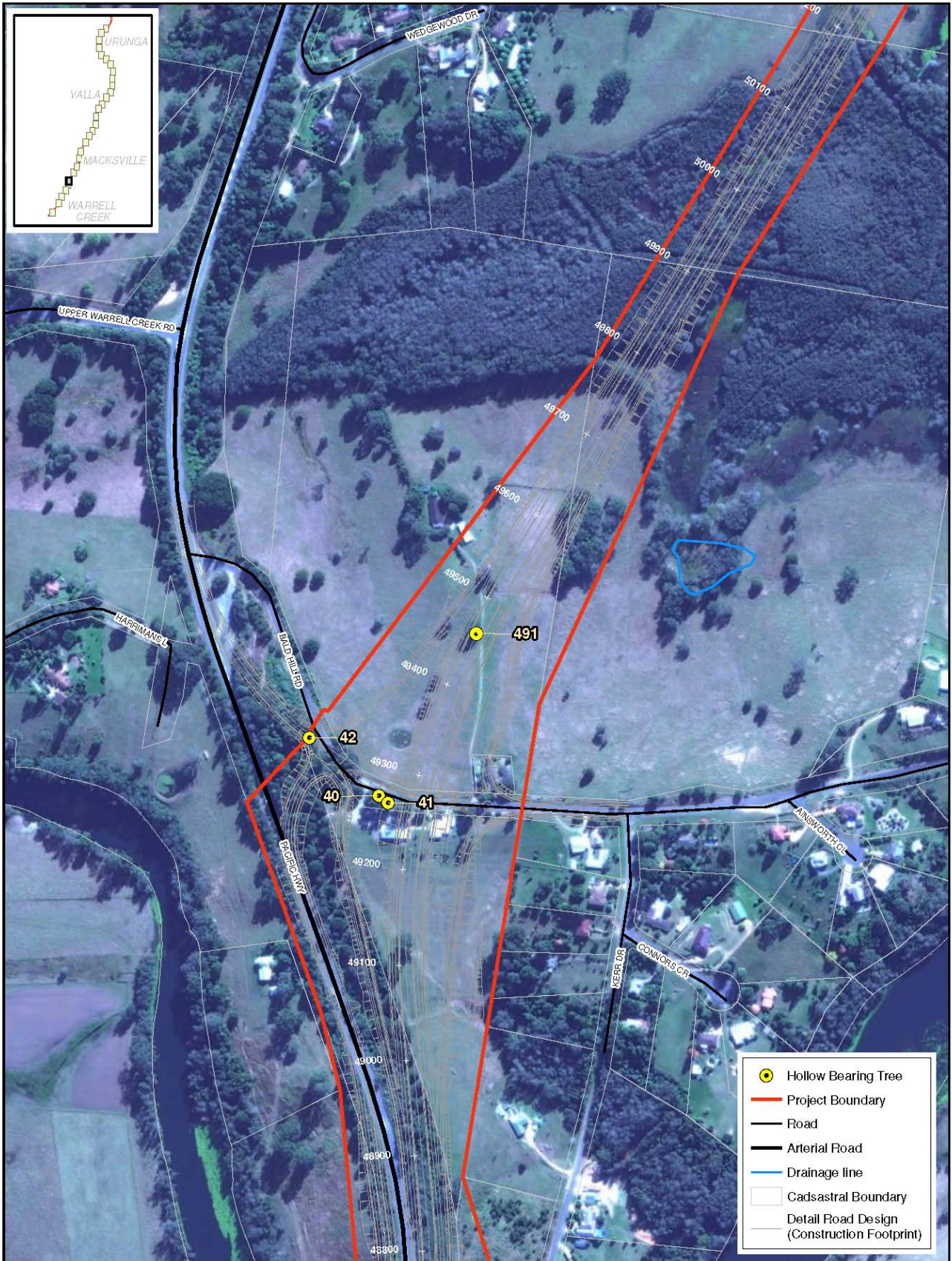


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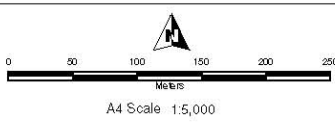
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastral: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
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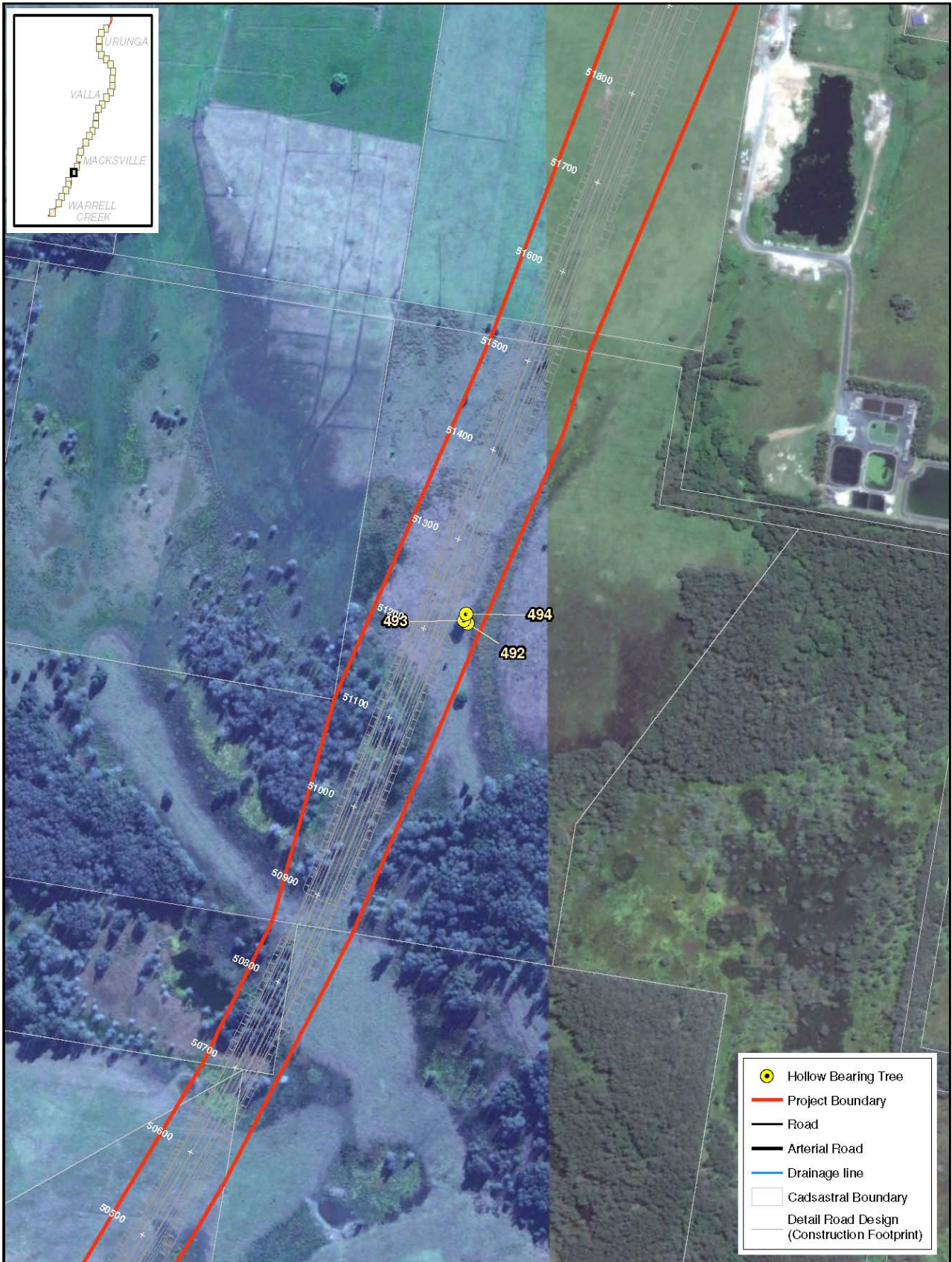


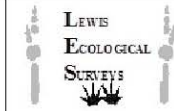
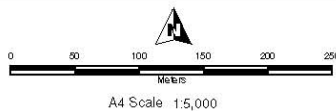
Figure 8 :

HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
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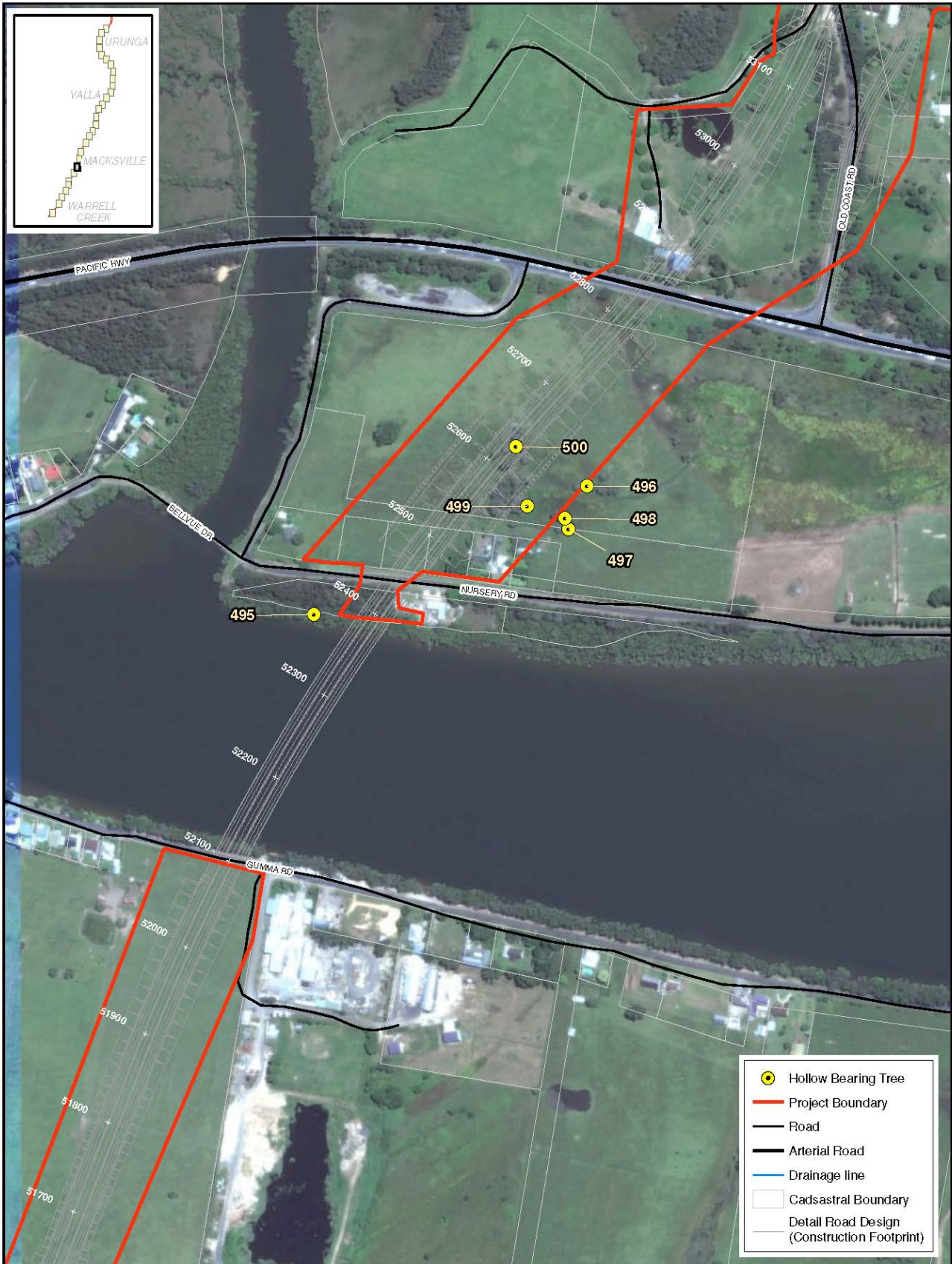


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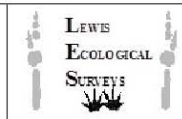
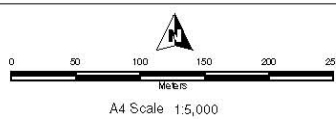
HOLLOW BEARING TREES

Source: Cadastral: Roads and Traffic Authority 2007
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 Roads: Geopreference Aerials, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geopreference Aerials, 2009
 State Forests: NSW DPI 2009

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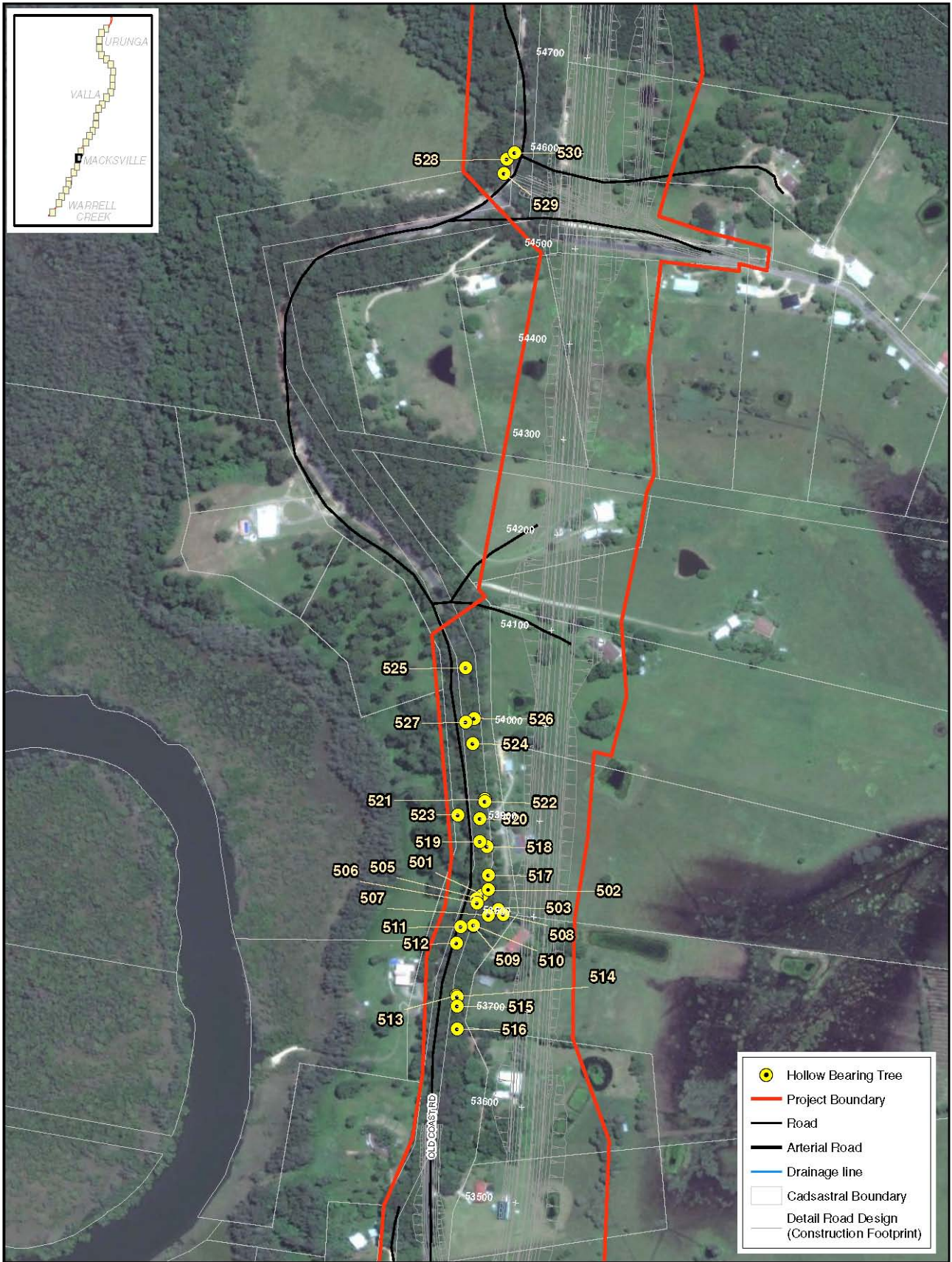


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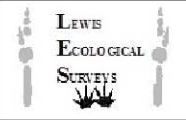
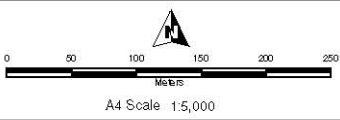
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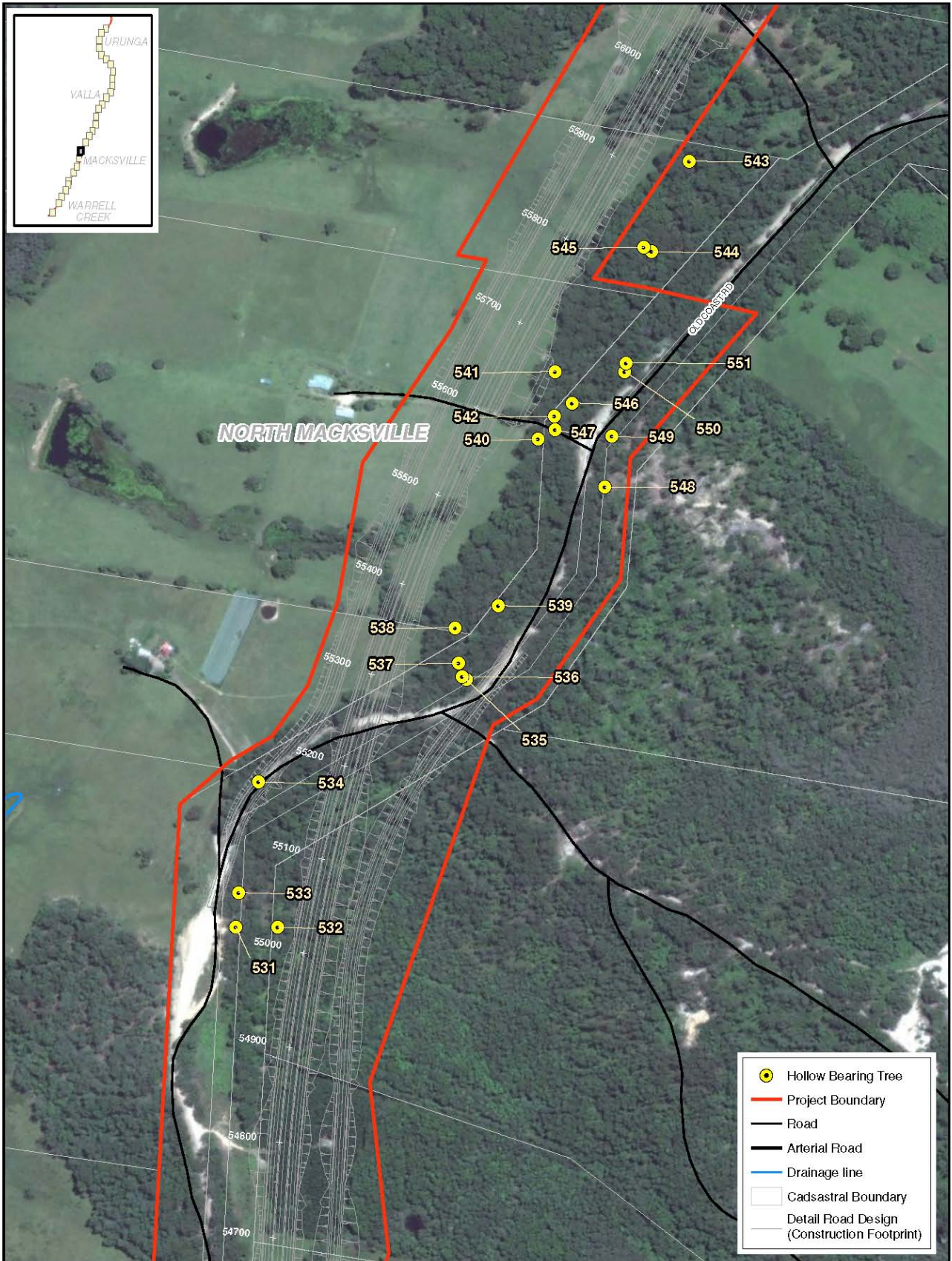


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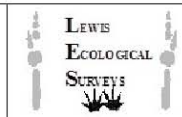
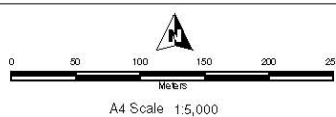
HOLLOW BEARING TREES

Source: Cadastral: Roads and Traffic Authority 2007
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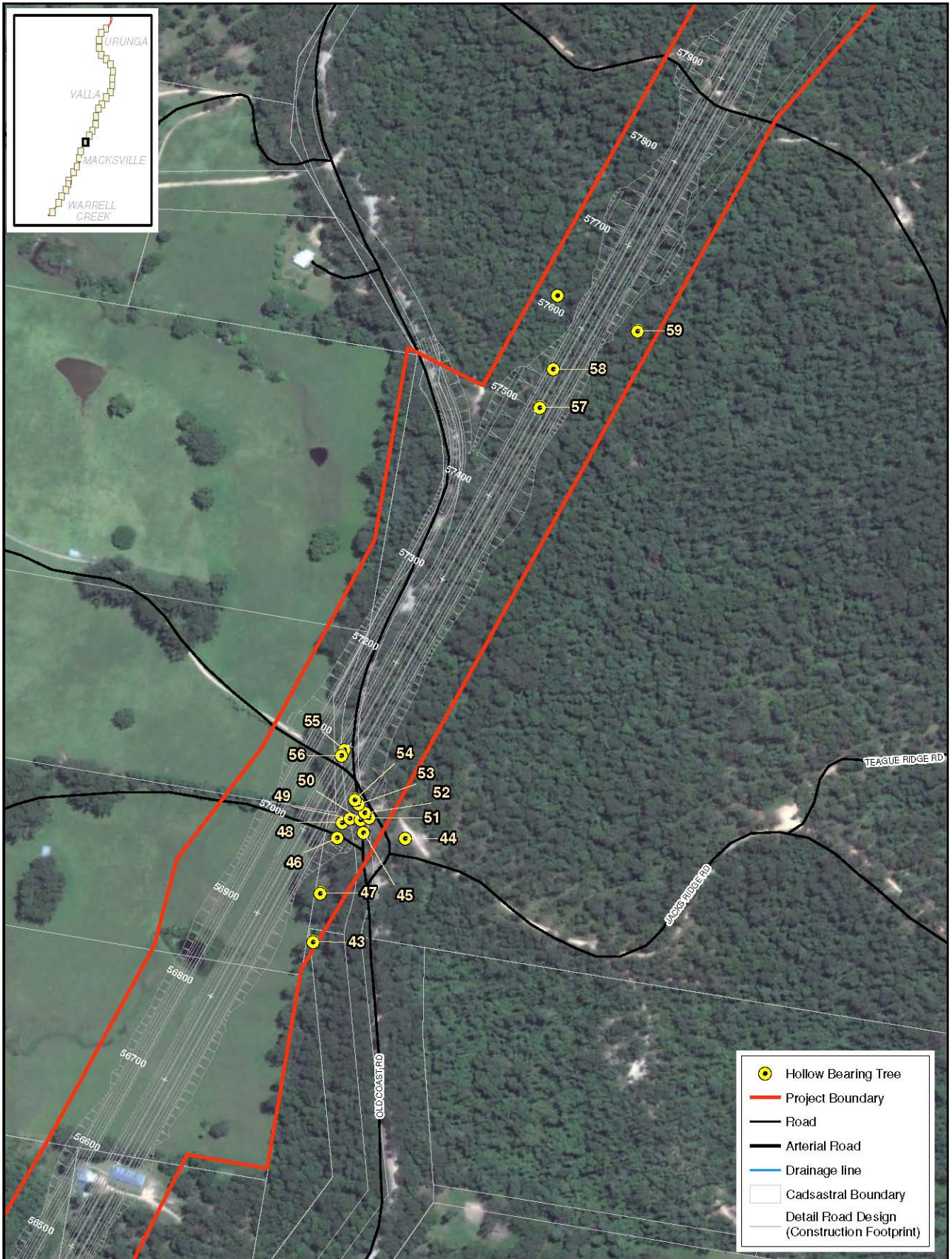


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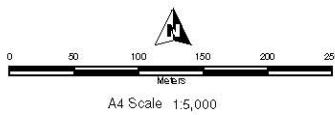
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
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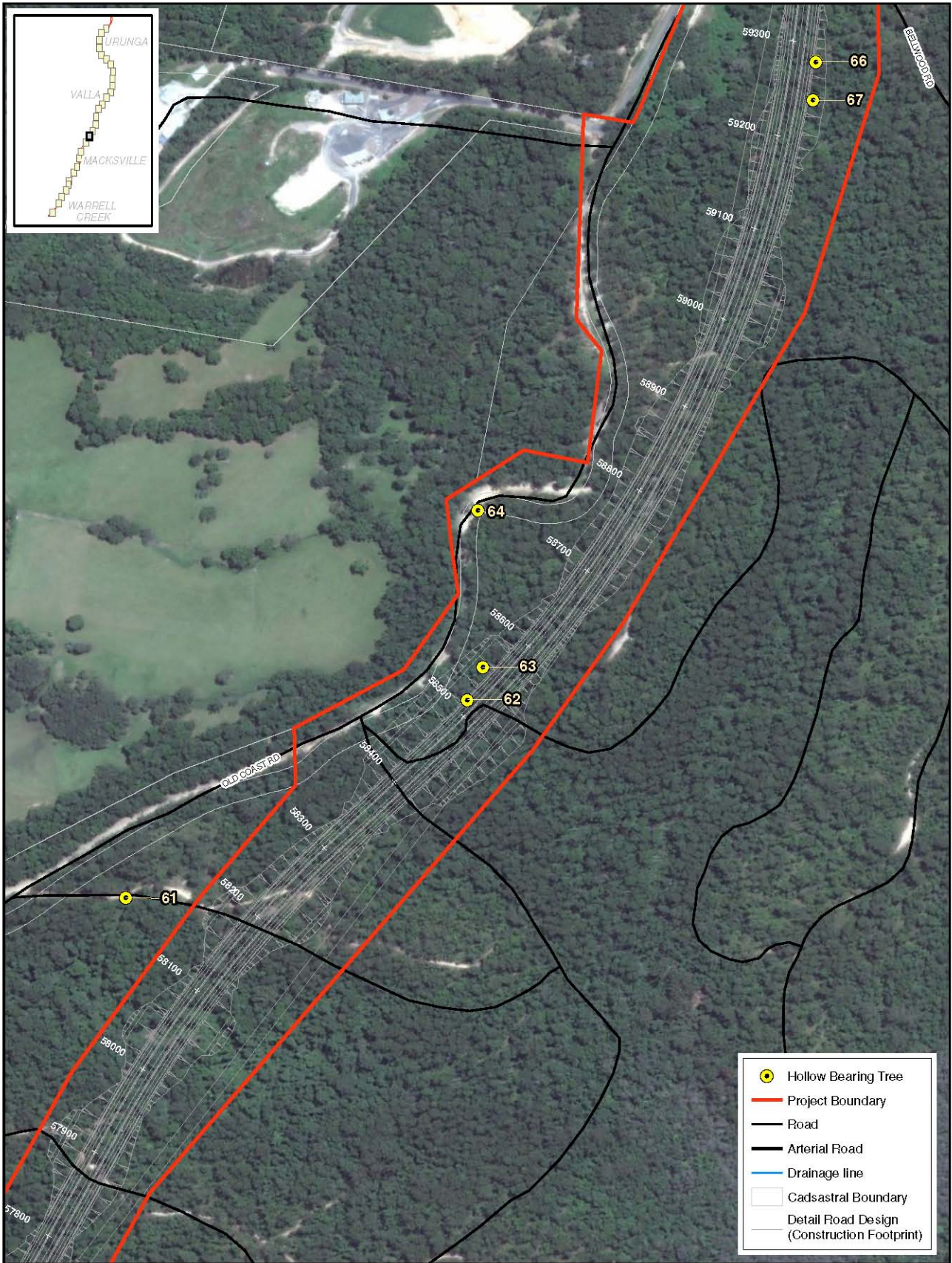


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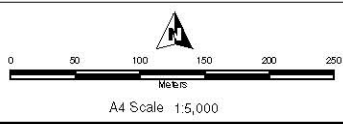
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
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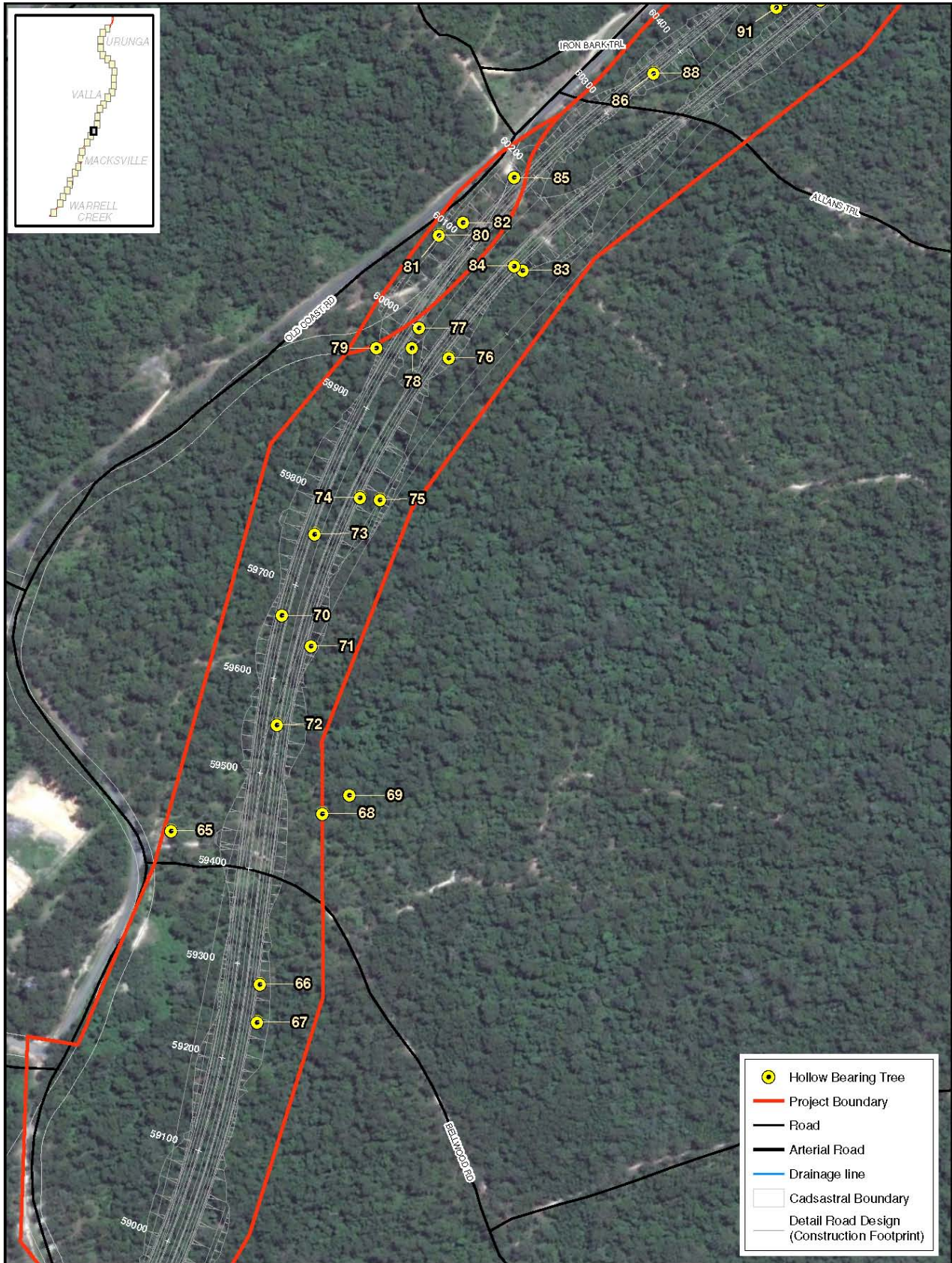


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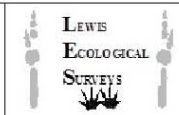
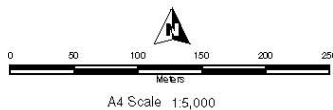
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
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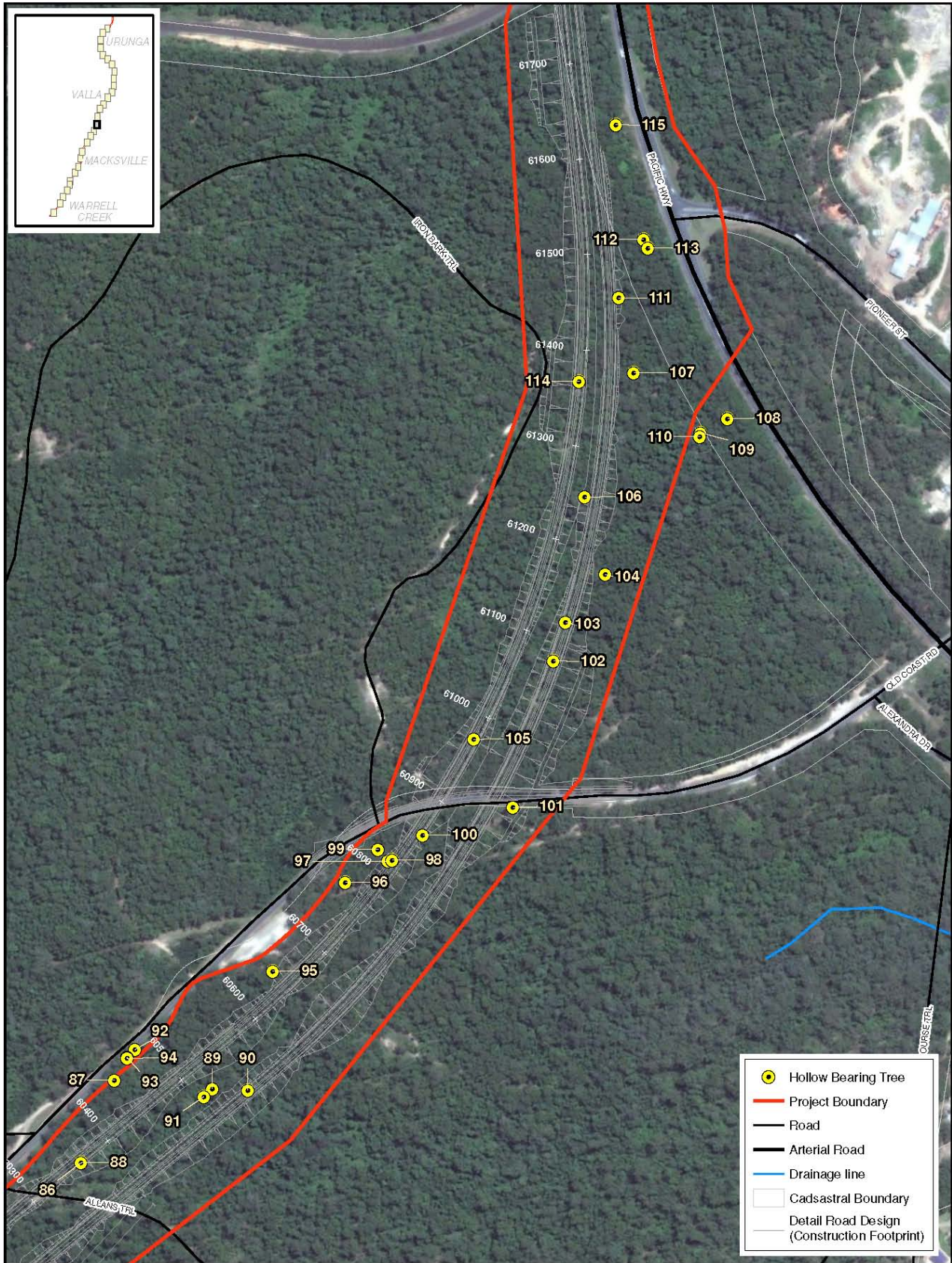


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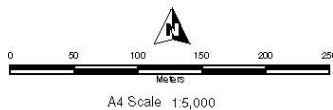
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia, 2009
 State: Roads: NSW DPI, 2009

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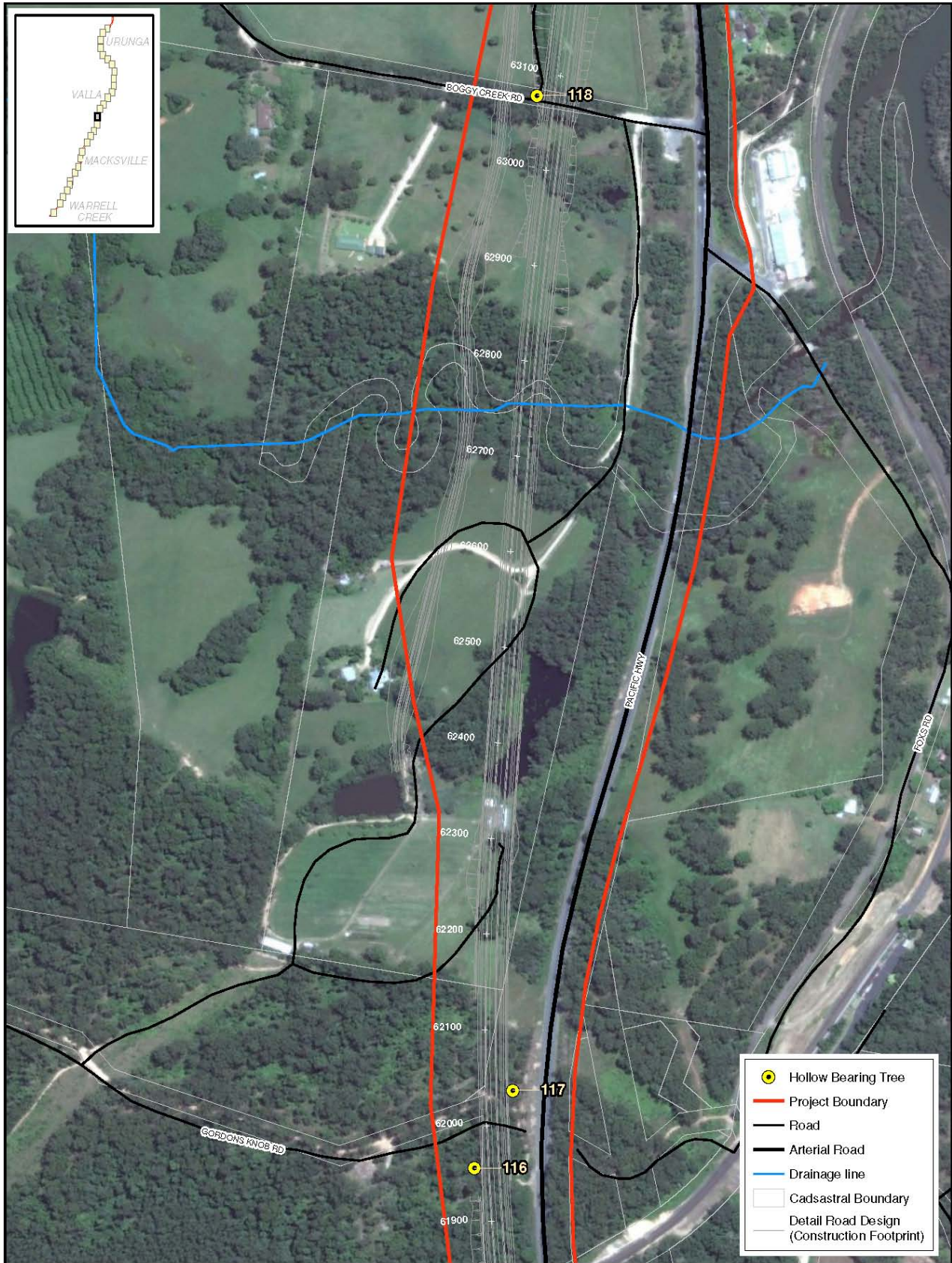


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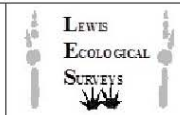
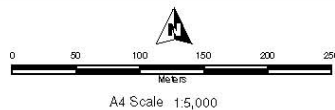
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia, 2009
 State: Roads: NSW DPI, 2009

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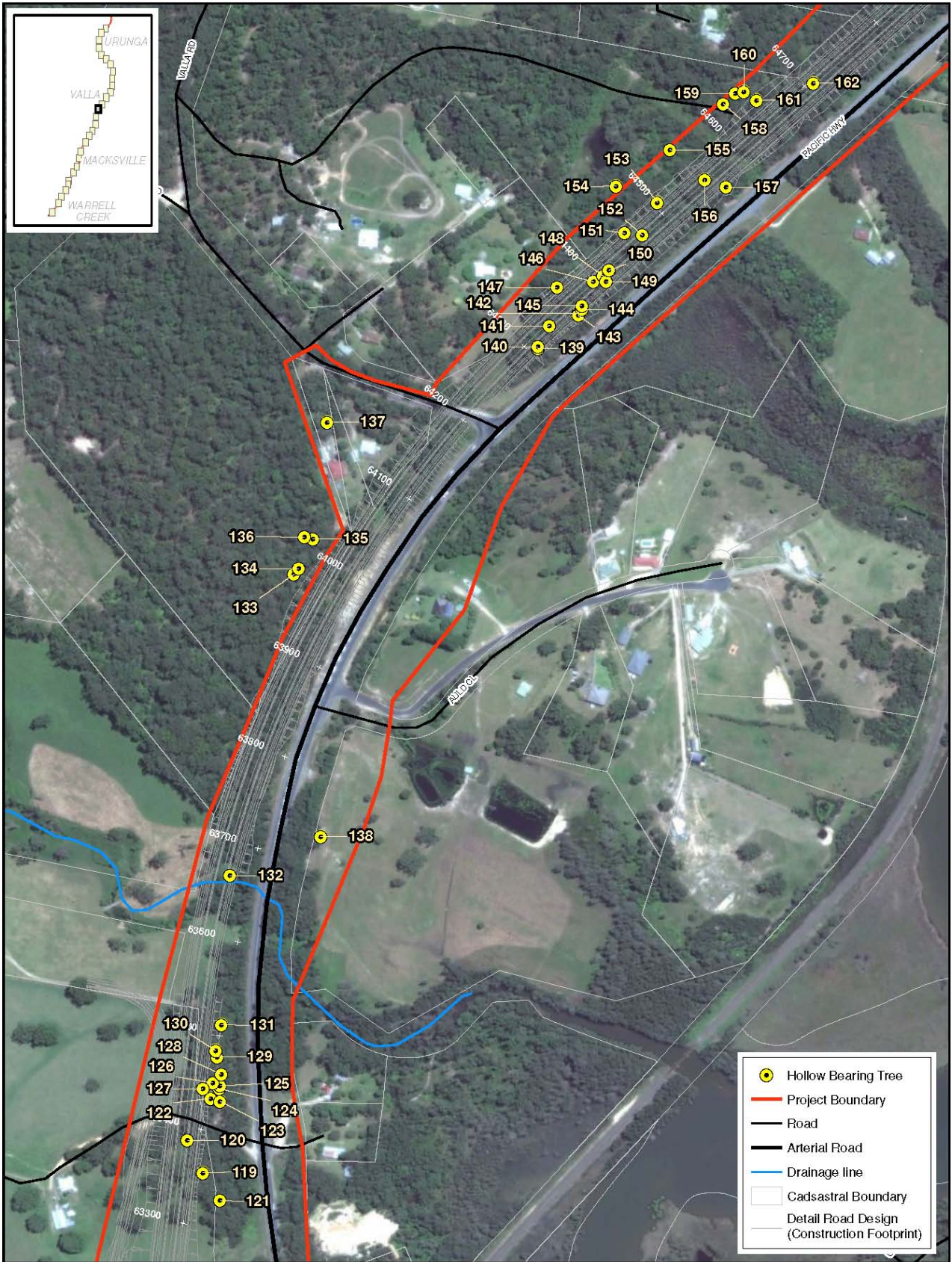


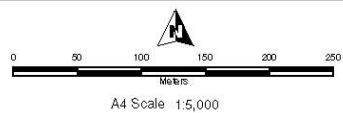
Figure 17 :

HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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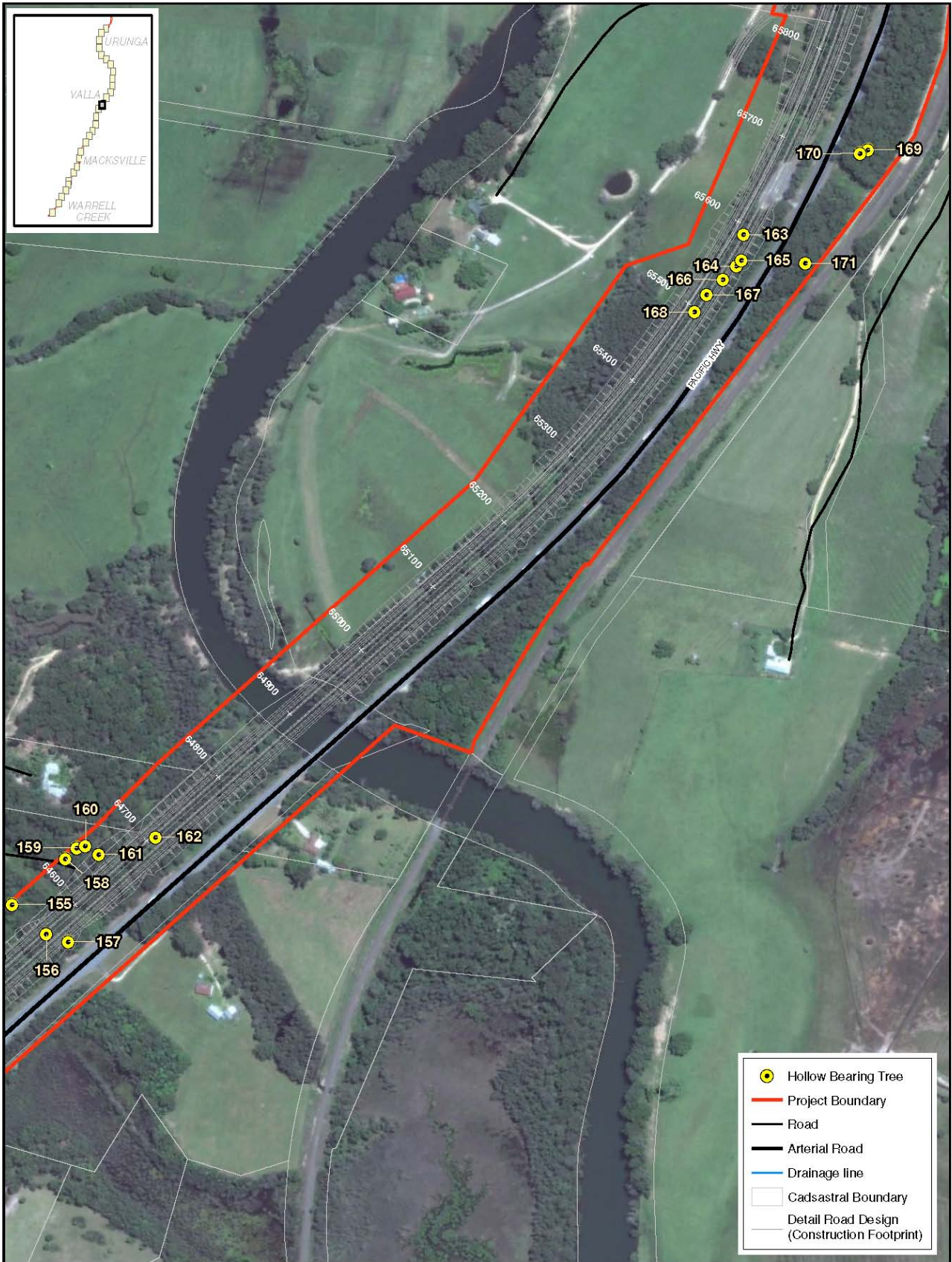


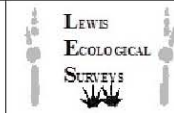
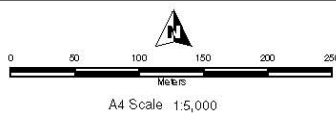
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HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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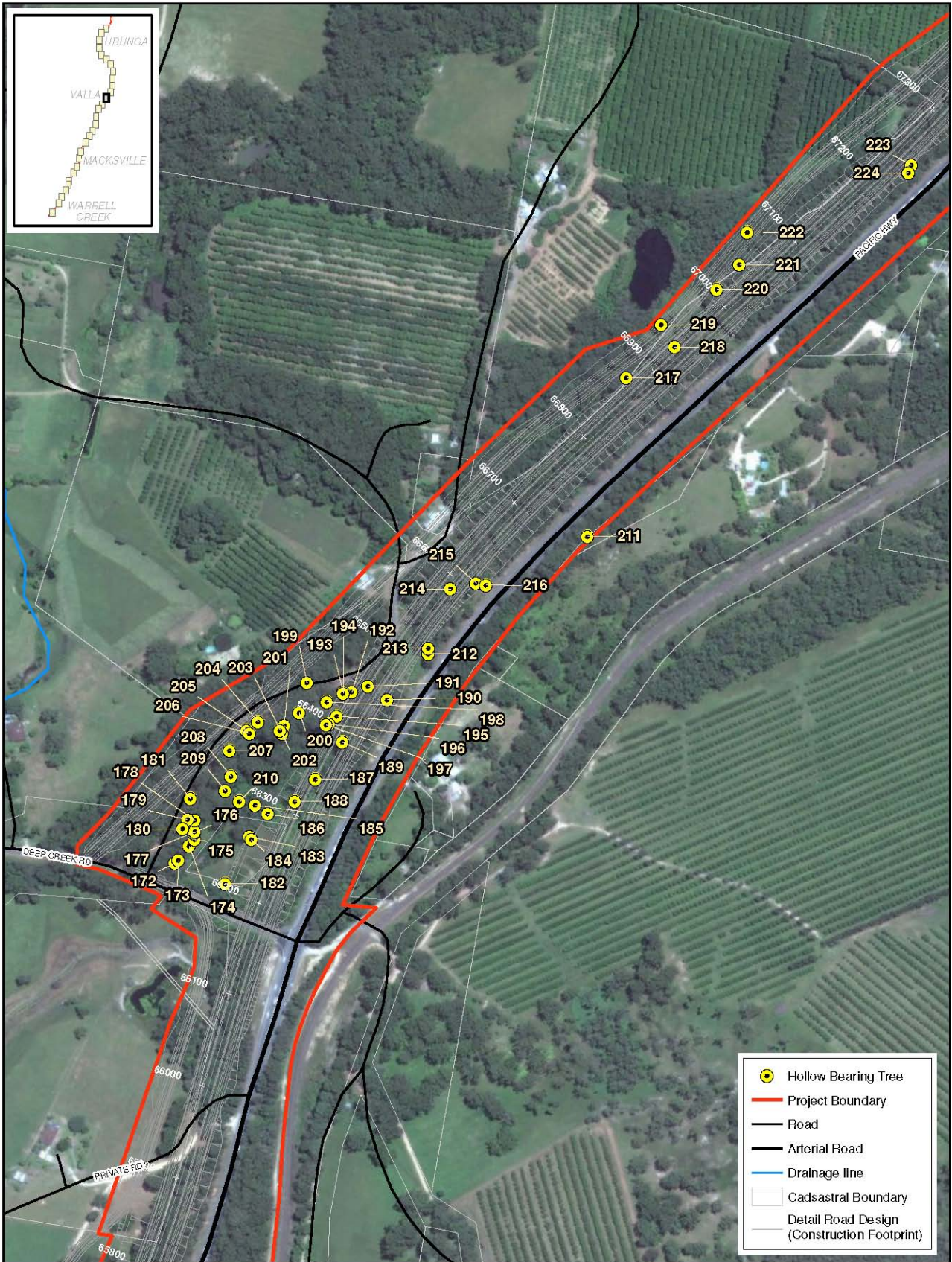


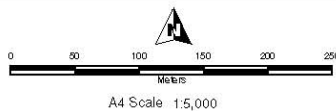
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HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia, 2009
 State Forests: NSW DPI 2008

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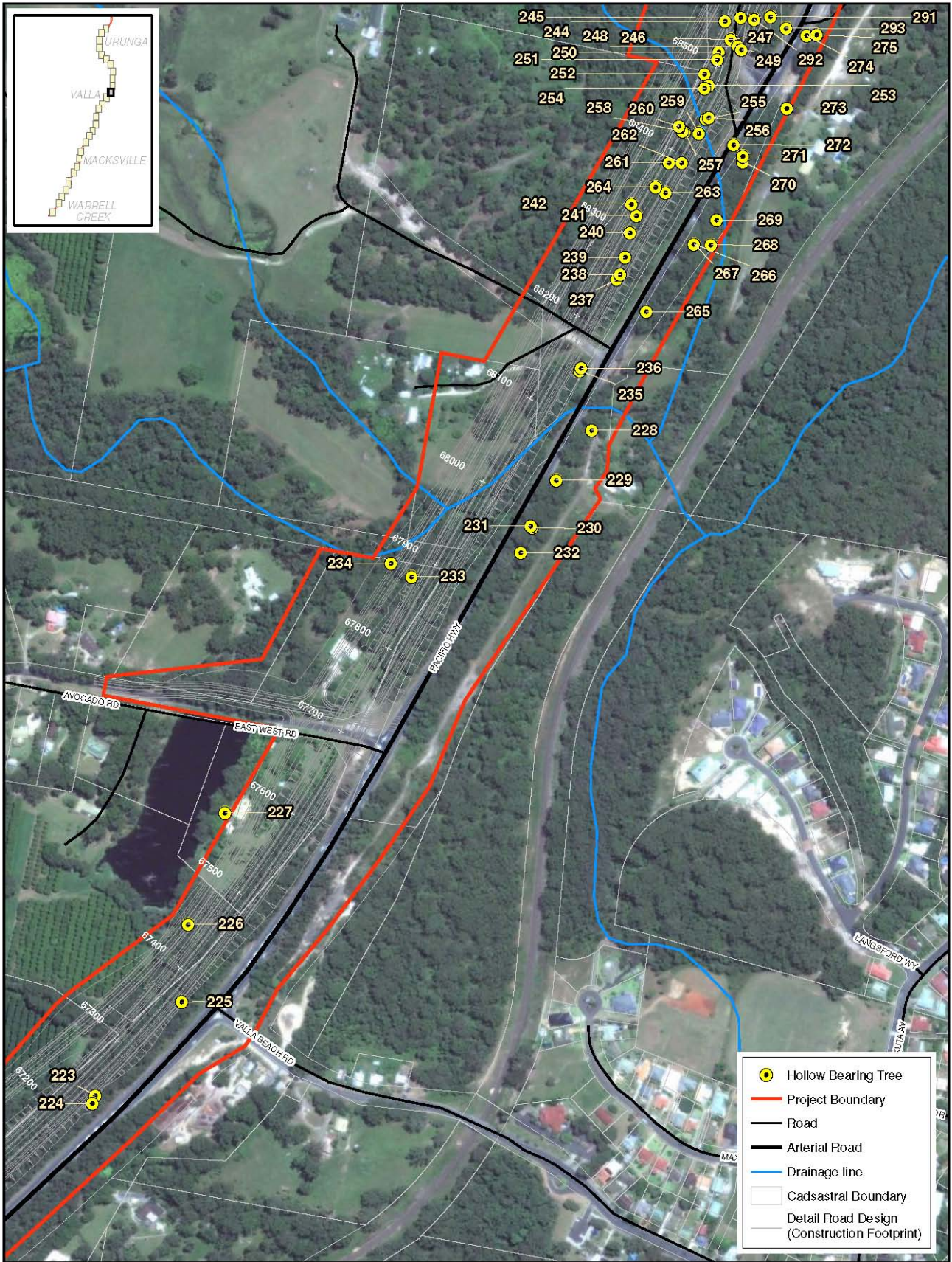


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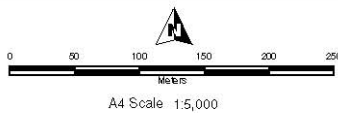
HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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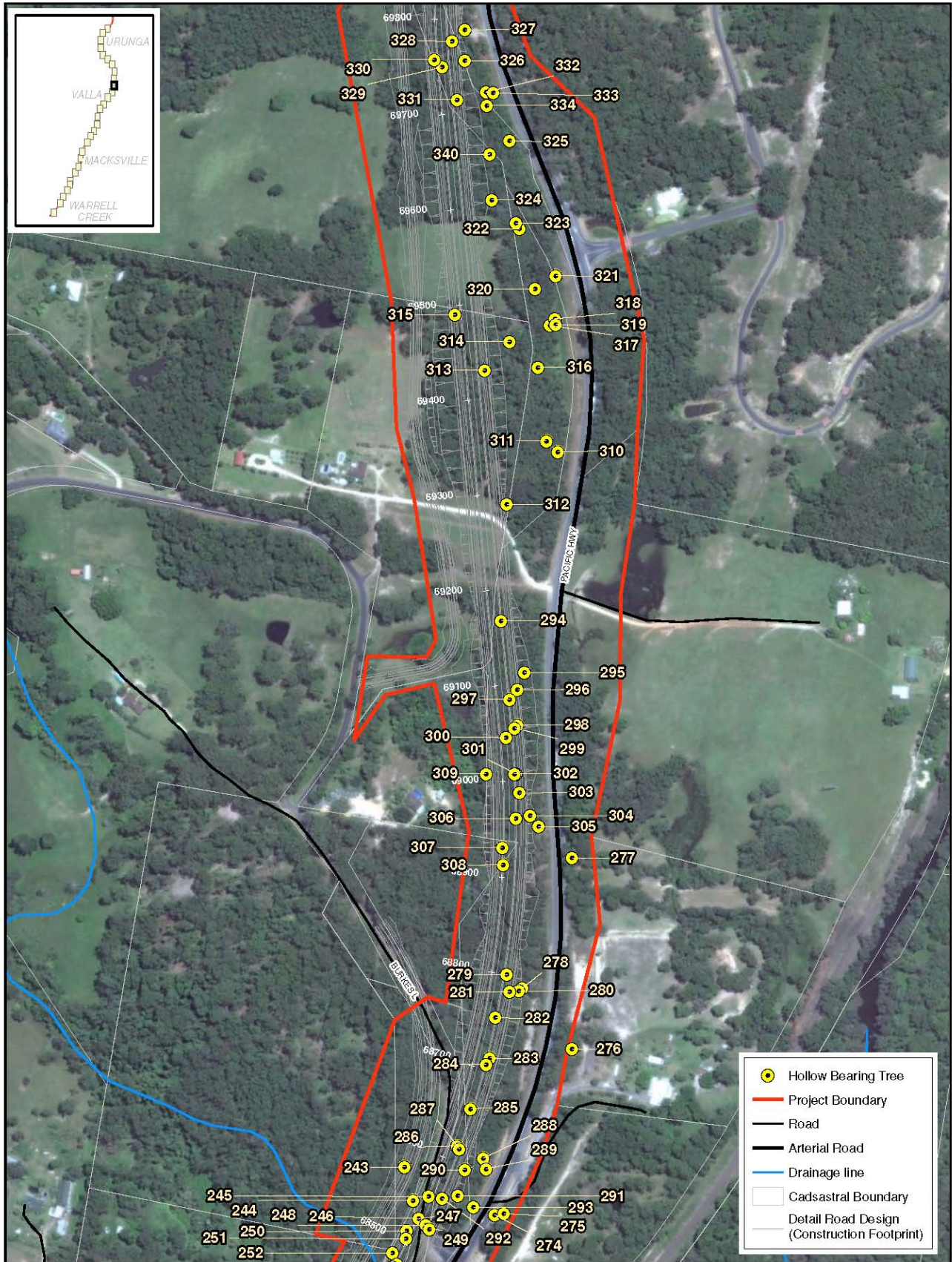


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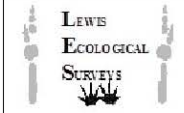
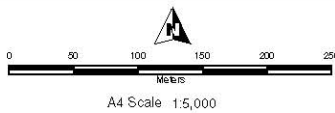
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
 HBT Survey: Lewis Ecological Surveys April 2012
 Road: Geoscience Australia, 2009

Highway Design (Footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia, 2009
 State Forest: NSW DPI 2008

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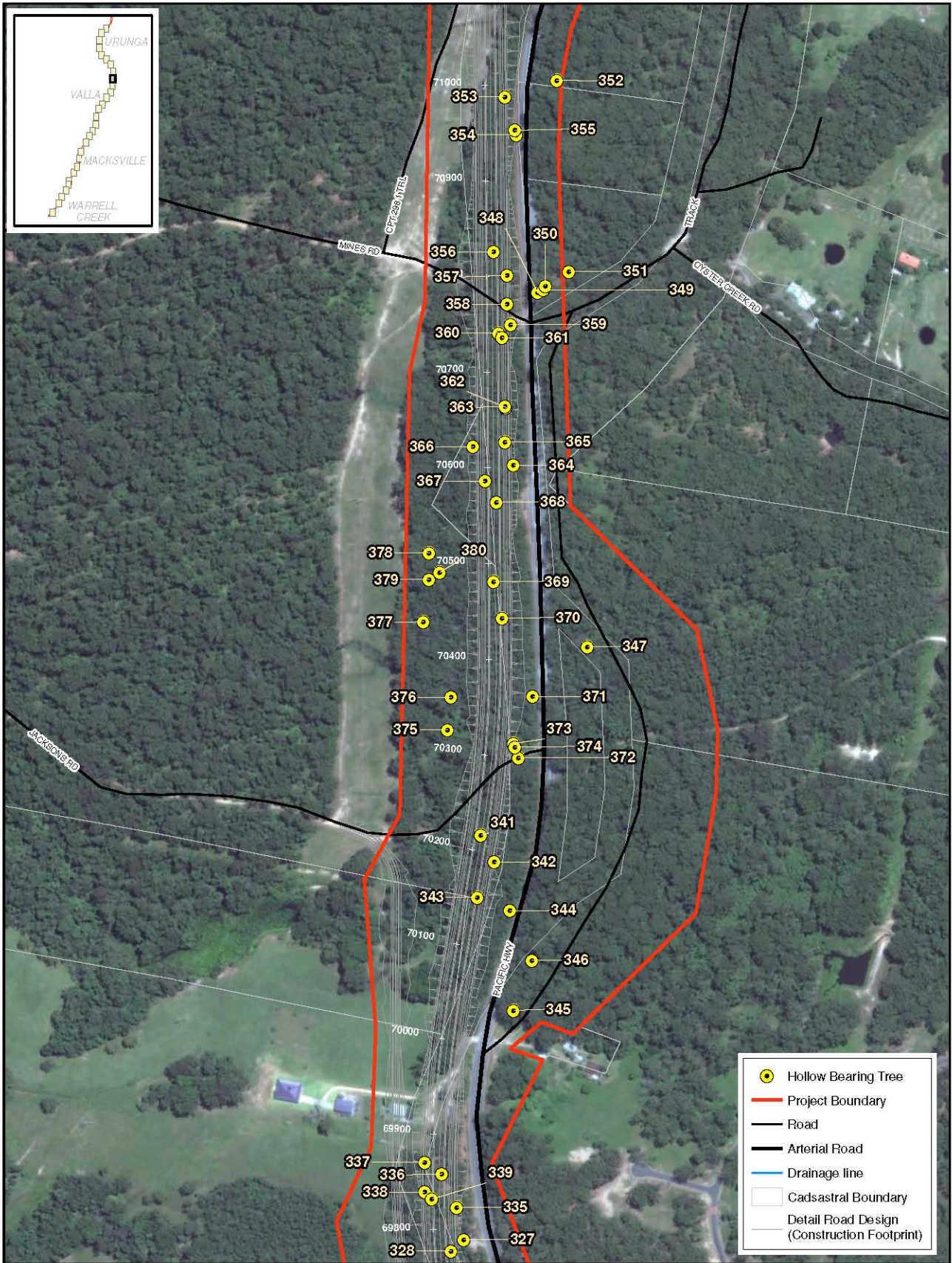


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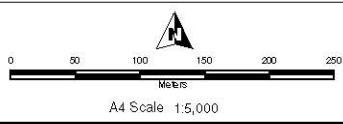
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastral: Lewis Ecological Surveys April 2012
 Road: Geoscience Australia 2009

Highway Design (Footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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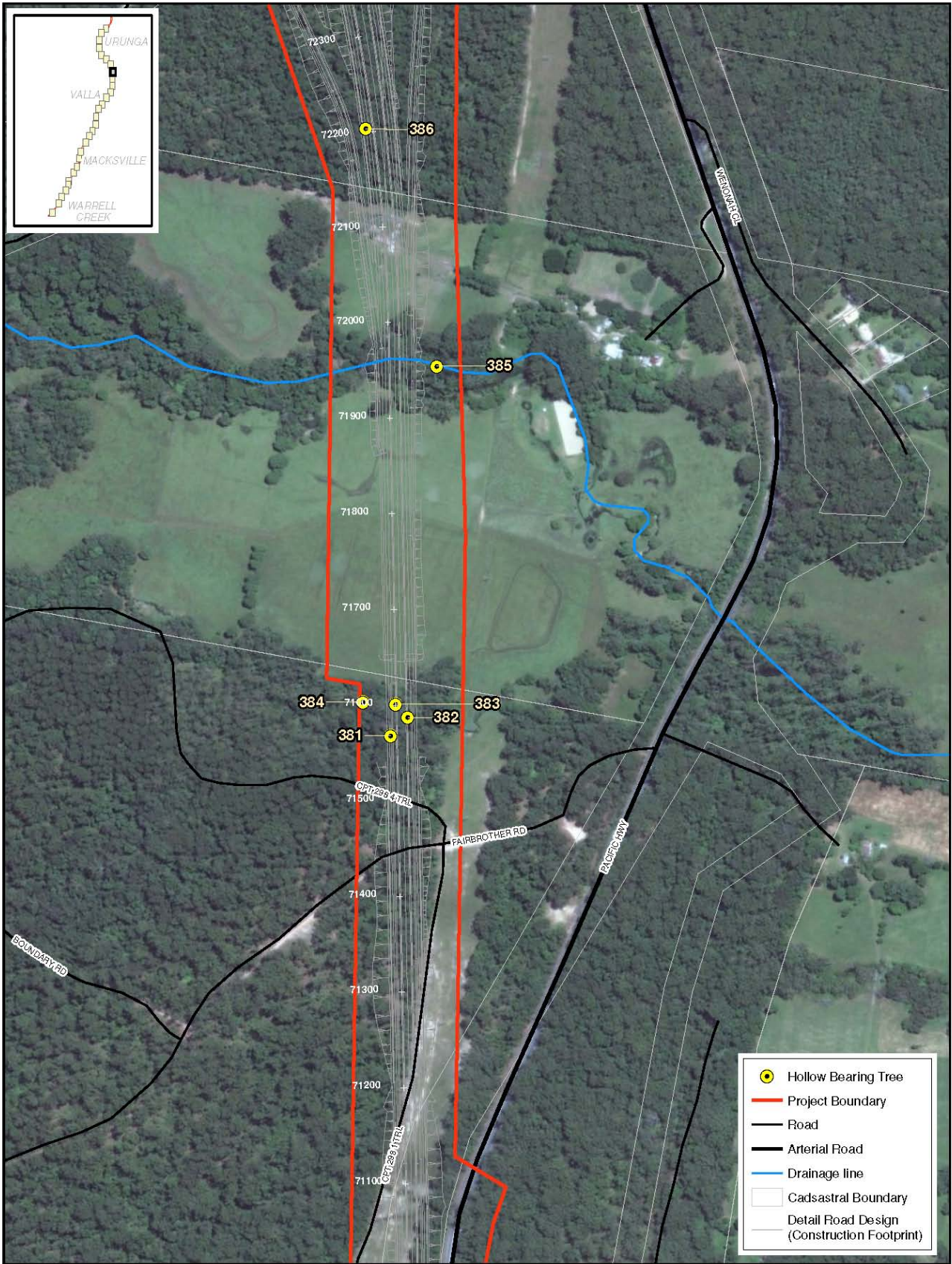


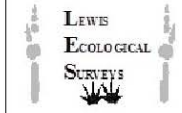
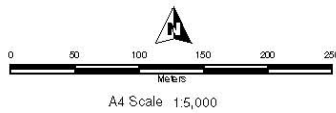
Figure 23 :

HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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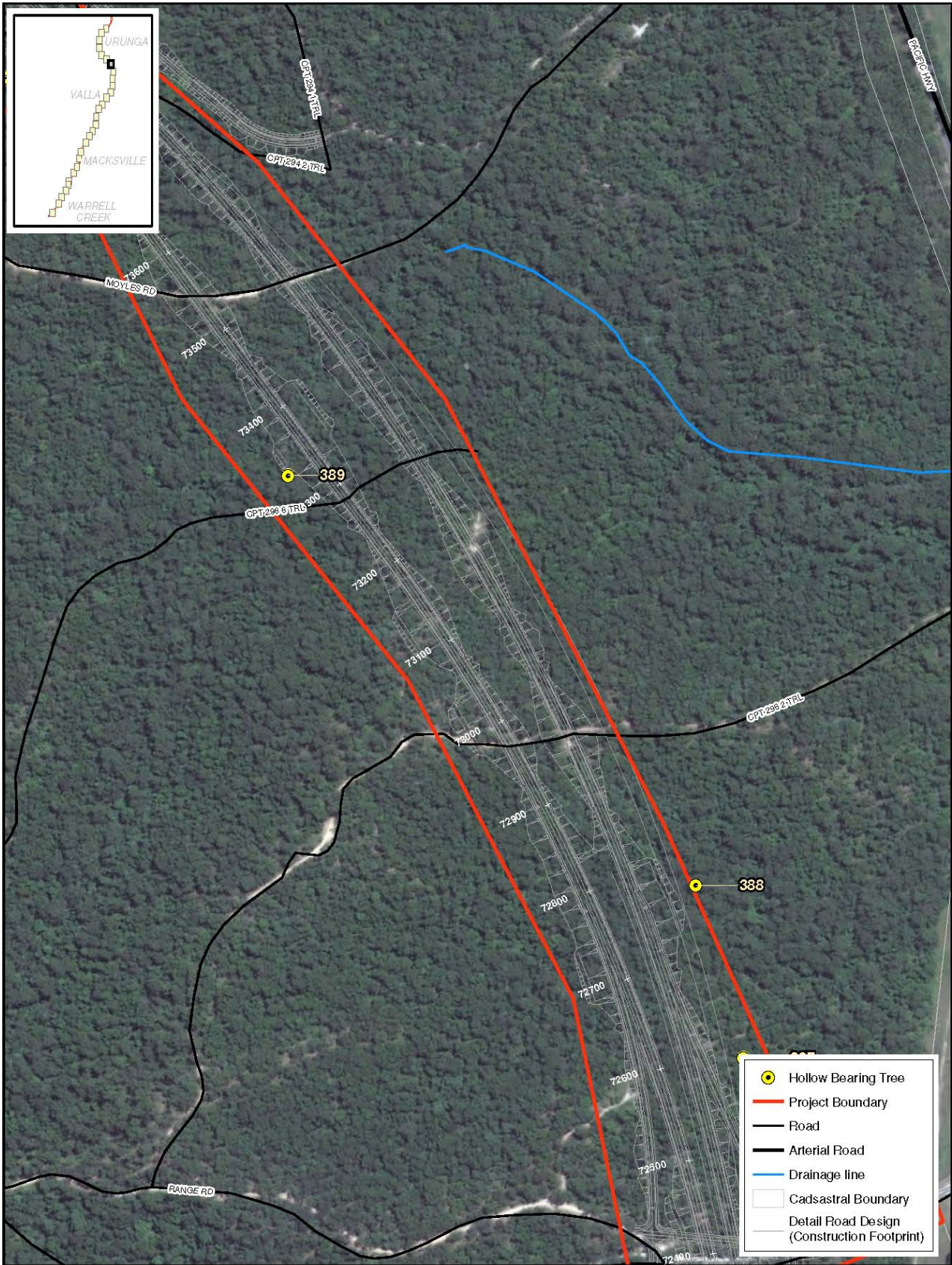


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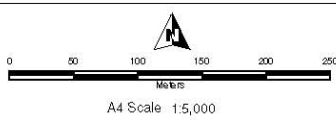
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Cadastre: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia, 2009
 State Forests: NSW DPI 2008

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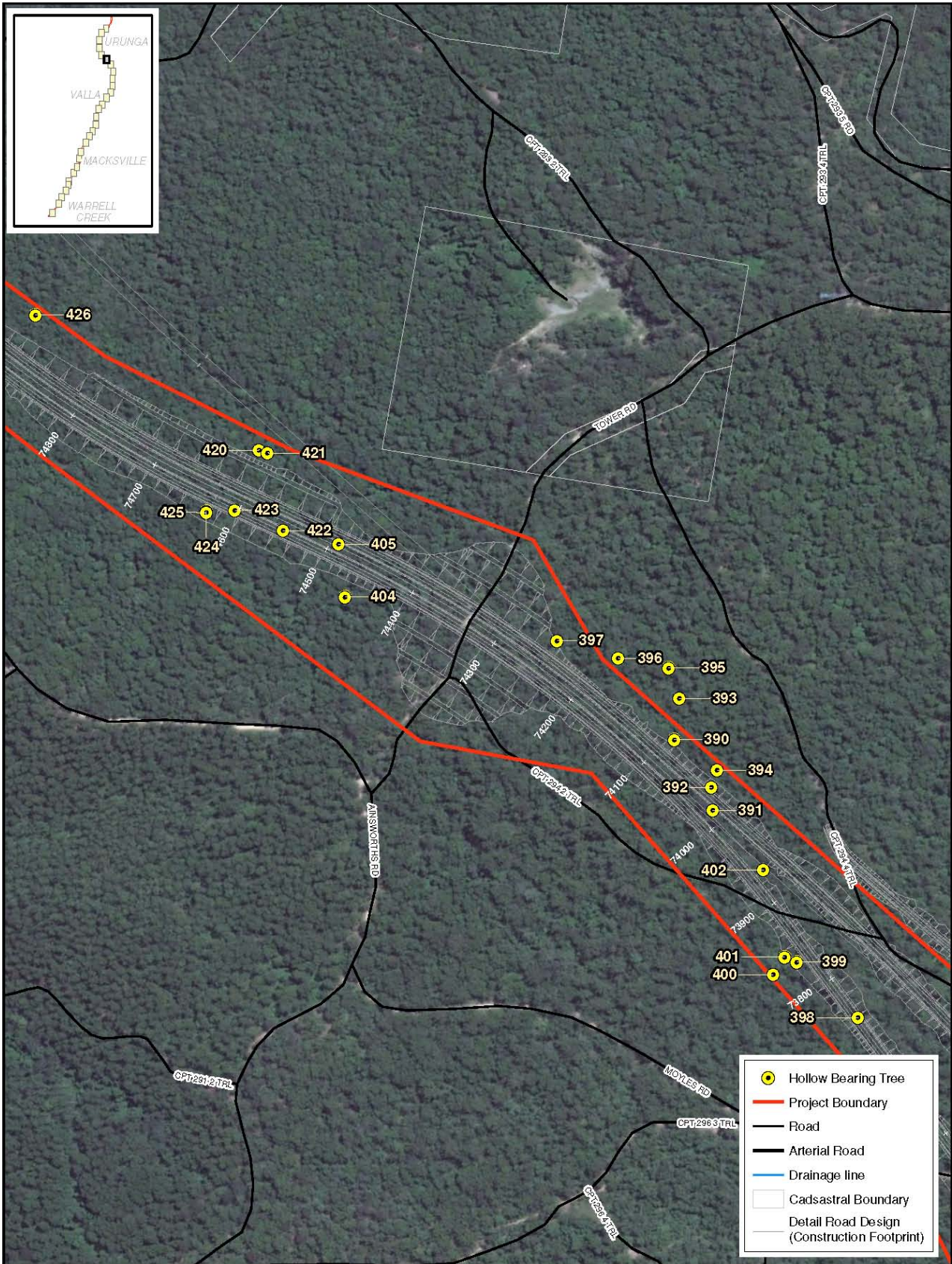


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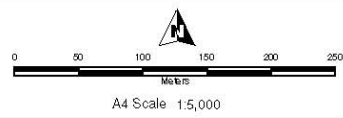
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Grafton: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (Footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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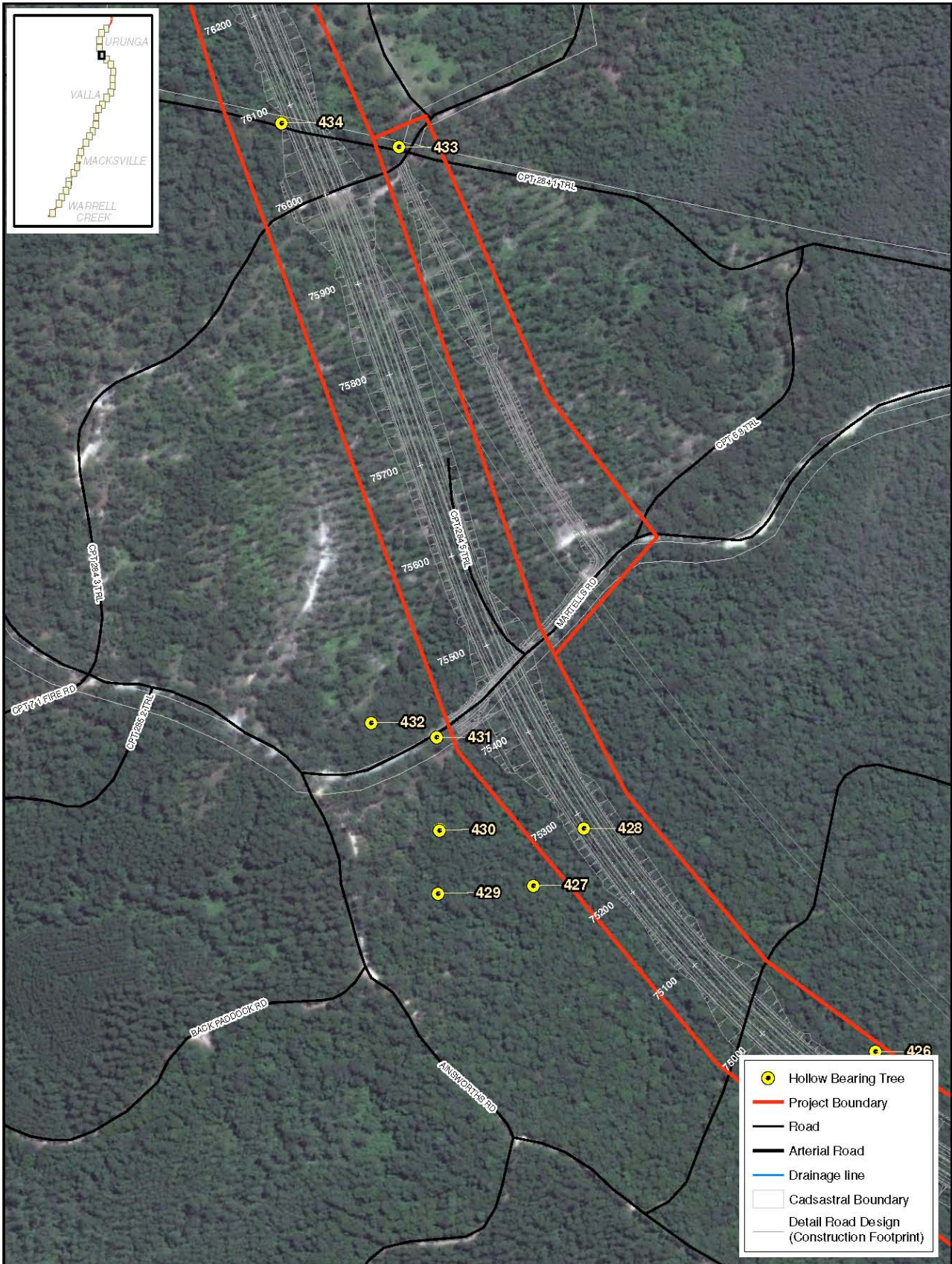


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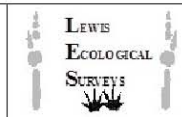
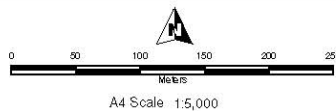
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Caddastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geopreference Australia 2009
 State Powers: NSW DPI 2009

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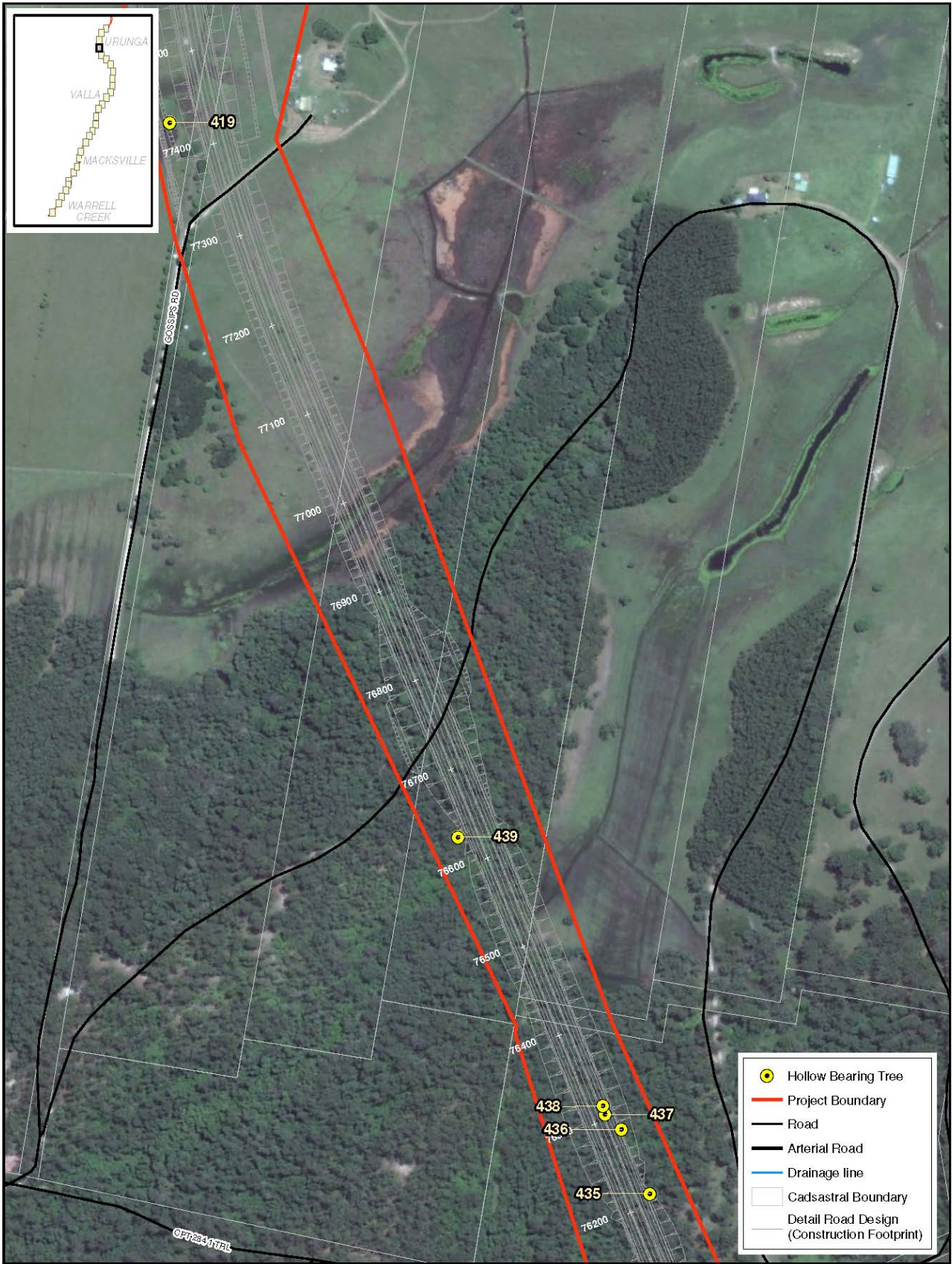


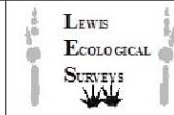
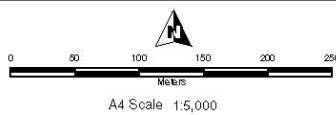
Figure 27 :

HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geoscience Australia 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geoscience Australia 2009
 State Forests: NSW DPI 2008

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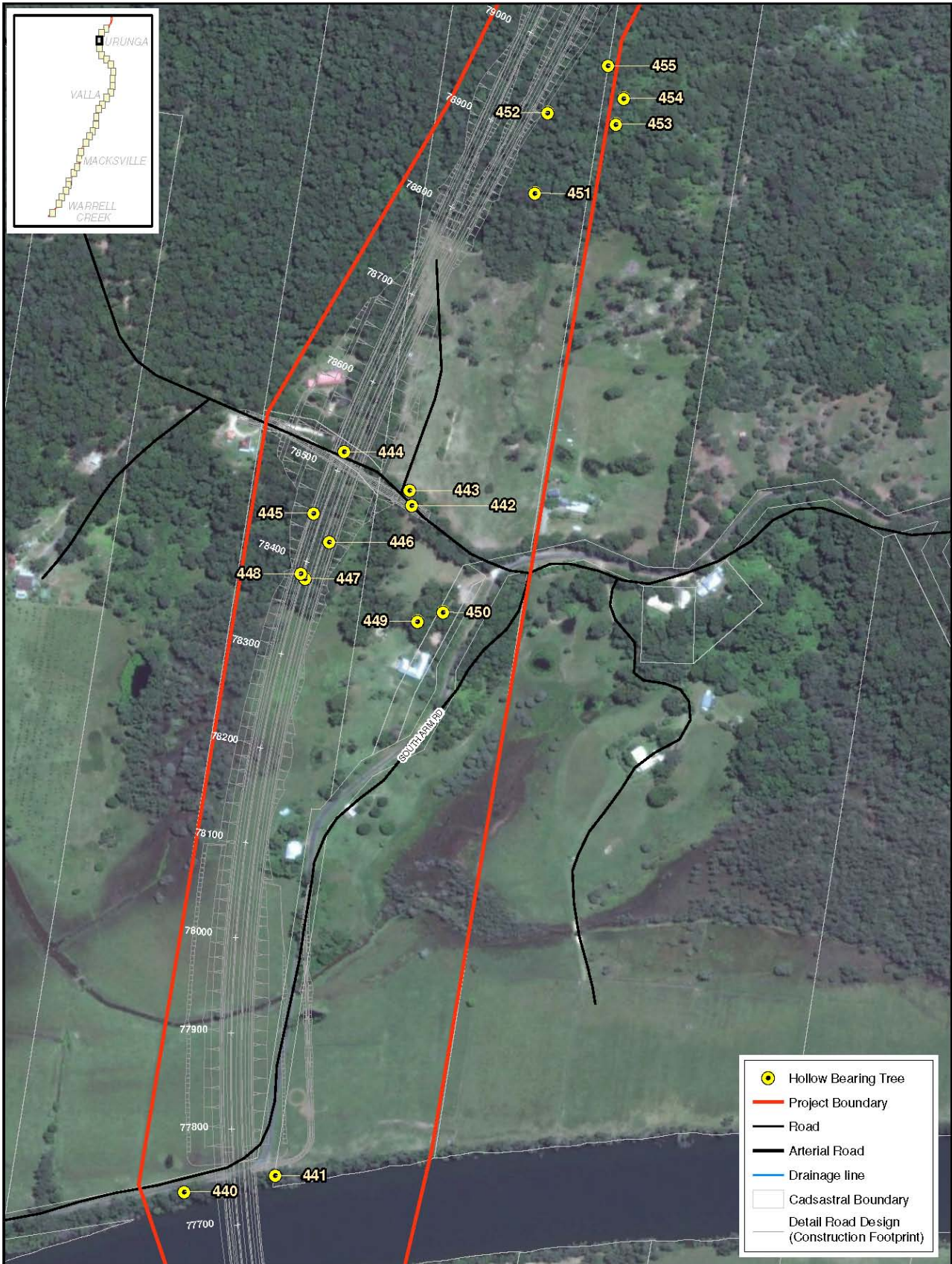


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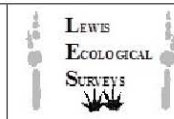
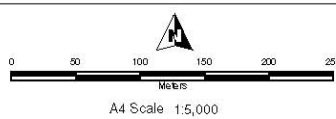
HOLLOW BEARING TREES

Source: Roads and Traffic Authority 2007
 Caddastre: Lewis Ecological Surveys April 2012
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geopreference Australia, 2009
 State Forests: NSW DPI 2009

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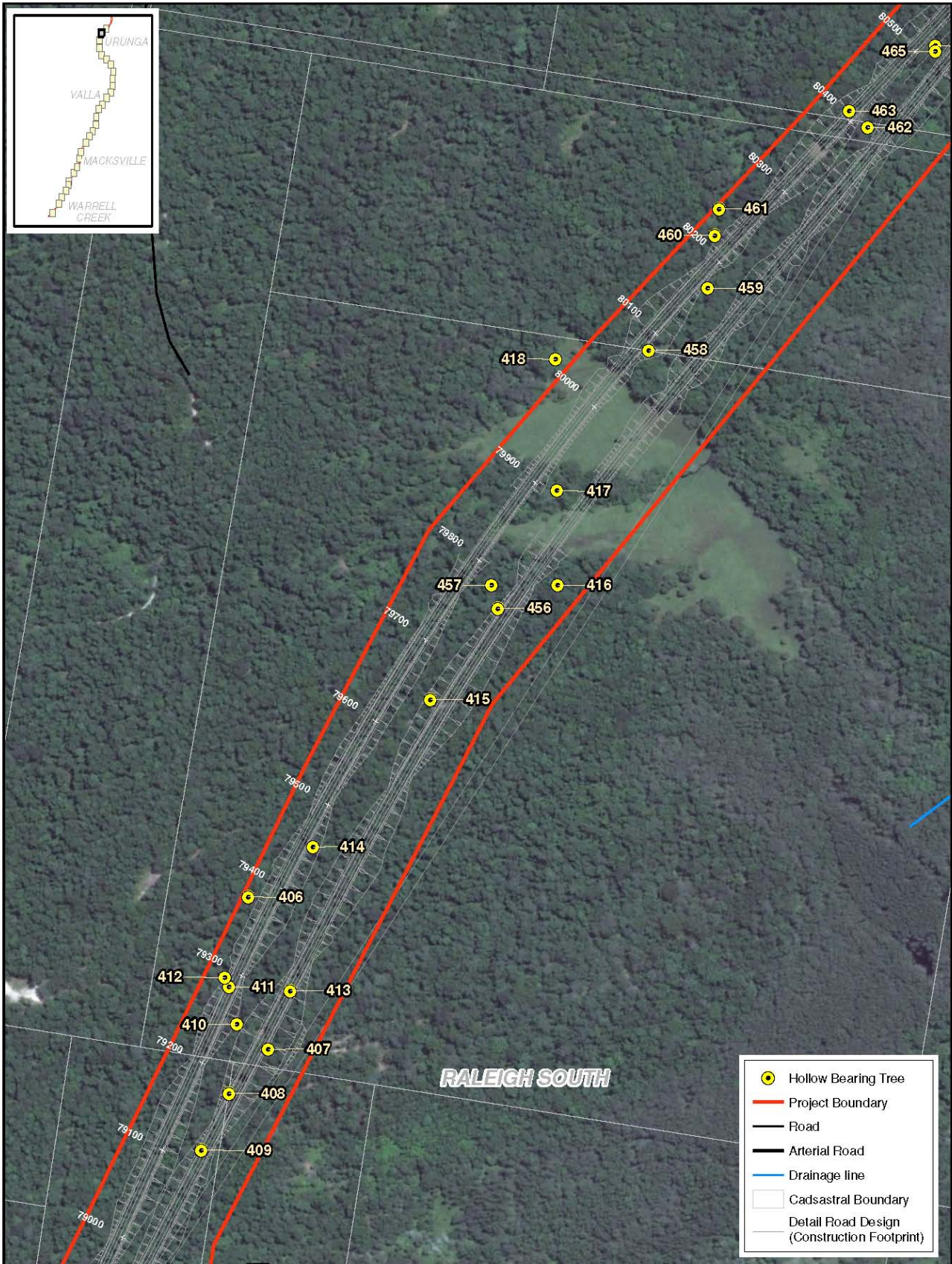


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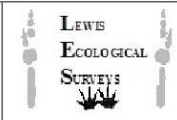
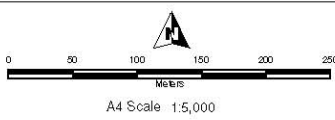
HOLLOW BEARING TREES

Source: Cadastre: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
 Drainage: Geopreference Australia 2009
 State Powers: NSW DPI 2009

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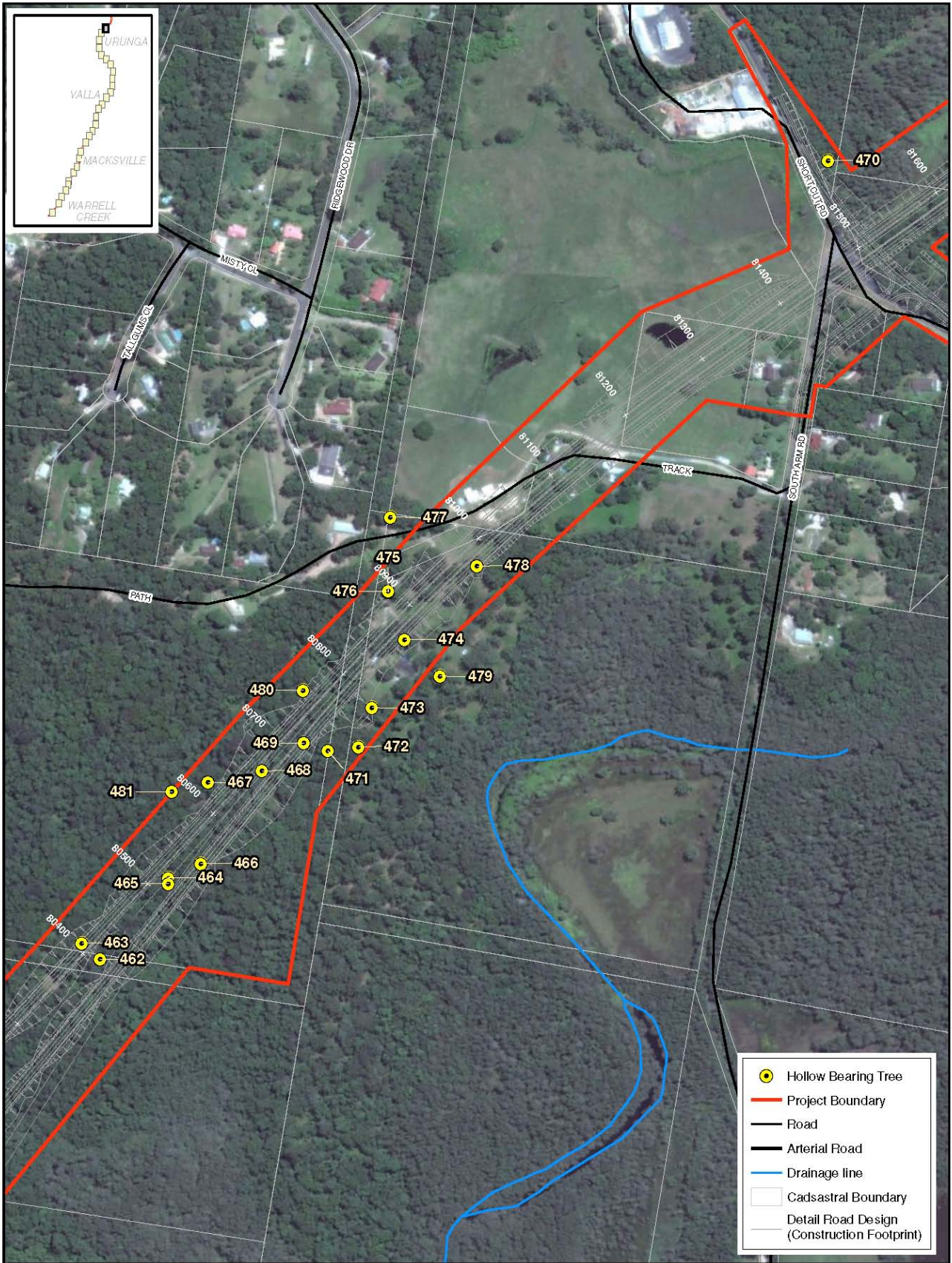


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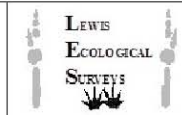
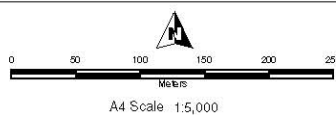
HOLLOW BEARING TREES

Source: Cadastral: Roads and Traffic Authority 2007
 HBT Survey: Lewis Ecological Surveys April 2012
 Roads: Geopreference Australia, 2009

Highway Design (footprint): RTA 2011
 Project Boundary: RTA 2011
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 State Forests: NSW DPI 2009

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Table C. Summary data from the hollow bearing tree survey conducted on those accessible properties for the Warrell Creek to Urunga Pacific Highway Upgrade between December-March 2012.

HBT = Hollow bearing tree and reference number, ~ = approximate or estimate, No. Func. Holl. = Number of function hollows SF = Scansorial fauna, MB = Microbats, Small gliders, LG = Larger Gliders, Po = Possums, Pa = Parrots, Lorikeets, Treecreeper, SO = Small owls, LFO = Large forest owls, EB = European Bees, LM = Lace Monitor, AH = Arboreal herpetofauna.

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm														
1	Stag	489292	6594149	100	21	4		1				2	1		1	1	1										1	Several ringtail possum dreys in the area as associated with upper Warrell Creek
2	Stag	489482	6594420	130	9	2		1			1				1	1			1						1	1		
3	Stag	489589	6594531	230	30	20		1	2	2	4	4	4	3	1	1	1	1	1	1	1	1		1	1	1	European bees using small trunk hollow at 11 m	
4	White Mahogany	489816	6594816	130	21	4						3	1		1	1	1									1		
15	White Mahogany	490637	6596069	180	22	4				1	1	2				1			1	1							Landowner states tree has been aged at 250 years. Brushtail possum probably using the large hollow	
16	Sydney Blue Gum	490697	6596192	120	23	3						2	1		1	1			1							1		
17	Tallowwood	490973	6597308	110	22	5			1			4				1										1	Small birds such as Pardolotes probably use this tree. Start of Albert Road trees	
18	Stag	491110	6597352	125	22	9						6	3			1	1			1						1	Scaly-breasted Lorikeets observed using medium hollow. European bees using base of stag to the north	
19	Coastal Blackbutt	491122	6597339	120	23	4						4				1	1									1		
20	Coastal Blackbutt	491126	6597338	130	24	3						3				1	1									1		
21	Coastal Blackbutt	491129	6597345	120	17	7						4	3			1	1			1						1	Scaly-breasted Lorikeets observed using medium hollow.	
22	Stag	491142	6597345	65	22	6		1				4	1			1	1			1						1		
23	Coastal Blackbutt	491147	6597334	170	24	7				1		4	2			1	1			1						1	twin trunk trees	
24	Coastal Blackbutt	491150	6597335	75	20	2						2				1	1			1								
25	Coastal Blackbutt	491148	6597340	115	22	12						4	6	2		1	1		1	1								Small gliders doubtful in this Albert road area. Scaly-breasted Lorikeets using medium hollow
26	White Mahogany	491160	6597334	70	19	5			1	1		3				1				1						1		
27	Tallowwood	491163	6597337	90	22	2						2				1										1		
28	Coastal Blackbutt	491173	6597334	140	20	3						3				1										1		
29	Coastal Blackbutt	491197	6597332	105	18	4						2	2			1				1								
30	Coastal Blackbutt	491219	6597329	120	23	3						3				1												
31	Coastal Blackbutt	491263	6597336	190	17	5						5				1												Finish of trees in Albert Driver area
32	White Mahogany	492100	6598598	130	14	6		1	2			3			1	1	1									1		
33	Flooded Gum	492176	6598949	105	18	5						5			1	1	1									1		
34	Tallowwood	492320	6599039	95	16	5						3	2		1	1	1									1	Bald Hill Road area	
35	Tallowwood	492302	6599044	110	17	5						3	2		1	1	1									1		
36	White Mahogany	492309	6599063	100	17	3						3			1	1	1									1		
37	Grey Ironbark	492462	6599311	75	13	1						1			1	1												
38	Coastal Blackbutt	492470	6599294	115	23	5						2	2	1	1	1	1	1	1	1						1		
39	Coastal Blackbutt	492508	6599449	135	20	4						2	2		1	1	1	1	1	1						1		
40	Flooded Gum	492420	6600018	55	23	1				1					1		1	1		1						1	Broken limb and decay	
41	Flooded Gum	492430	6600011	80	18	3			1			2				1	1									1		
42	Coastal Blackbutt	492348	6600079	155	18	2						2				1	1									1	Nambucca State Forest	
43	Pink Bloodwood	495362	6606905	80	22	6						3	2	1	1	1	1	1	1	1						1		
45	Coastal Blackbutt	495415	6607019	63	17	3						2	1			1	1									1	Jacks Ridge Road	
46	Coastal Blackbutt	495388	6607014	115	18	3						3				1	1									1		
47	Coastal Blackbutt	495370	6606956	118	26	3						3				1	1									1		
48	Coastal Blackbutt	495393	6607030	60	18	2						2				1	1									1		
49	Coastal Blackbutt	495401	6607034	50	19	4			2			2				1	1									1		

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm													
50	Coastal Blackbutt	495412	6607033	75	17	4						2	2		1	1	1	1		1						1	
51	Coastal Blackbutt	495421	6607035	90	19	7						4	3		1	1	1	1	1	1						1	
52	Coastal Blackbutt	495417	6607040	80	19	10			1			5	3	1	1	1	1	1	1	1						1	
53	Coastal Blackbutt	495410	6607049	40	14	4			1			2	1			1	1									1	
54	Coastal Blackbutt	495406	6607054	85	20	6			1			3	2		1	1	1	1	1	1						1	
55	Coastal Blackbutt	495395	6607106	85	23	4				2		2			1	1	1	1	1	1						1	
56	Coastal Blackbutt	495392	6607100	115	23	6						3	3		1	1	1	1	1	1						1	
57	Stag	495600	6607465	115	20	3						3				1	1									1	
58	Stag	495614	6607505	80	15	20		1				5	8	6	1	1	1	1	1	1	1	1			1	1	
59	Coastal Blackbutt	495702	6607545	95	24	4						2	2			1	1	1		1						1	
60	Pink Bloodwood	495618	6607582	70	21	2						2				1	1									1	
62	Brushbox	496179	6608282	40	16	1					1				1				1						1	1	
63	Stag	496195	6608316	100	17	2					2					1			1						1	1	
64	Coastal Blackbutt	496190	6608480	220	27	8					1	4	3		1	1	1	1	1	1						1	
65	Coastal Blackbutt	496450	6609109	105	22	3						3			1	1	1										
66	Coastal Blackbutt	496543	6608949	120	27	2						1	1		1	1	1								1	Potential Square-tailed Kite nest in this tree	
67	Coastal Blackbutt	496540	6608909	125	28	4						2	2		1	1	1	1		1						1	
68	Coastal Blackbutt	496608	6609127	125	26	8						5	3		1	1	1	1	1							1	
70	Stag	496566	6609334	80	21	5						3	2		1	1	1	1	1					1	1		
71	Coastal Blackbutt	496596	6609302	95	24	2						2				1	1										
72	Flooded Gum	496561	6609220	90	22	4						2	2		1	1	1	1								1	
73	Red Mahogany	496600	6609419	125	23	5						2	3		1	1	1	1		1						1	
74	Flooded Gum	496647	6609457	125	26	3						2	1		1	1	1	1		1						1	
75	Flooded Gum	496668	6609455	125	21	4						3	1		1	1	1	1		1						1	
76	Coastal Blackbutt	496740	6609603	85	25	3						3				1	1									1	
77	Coastal Blackbutt	496709	6609634	100	26	2						2				1	1									1	
78	Coastal Blackbutt	496702	6609613	130	28	8						6	2		1	1	1	1	1	1						1	
79	Coastal Blackbutt	496664	6609613	125	27	5						4	1		1	1	1	1	1	1						1	
80	Coastal Blackbutt	496730	6609731	135	25	5						4	1		1	1	1	1	1	1						1	
81	Coastal Blackbutt	496730	6609731	100	25	3						3			1	1	1									1	
82	Coastal Blackbutt	496755	6609744	115	19	5			2			3			1	1	1									1	
83	Stag	496817	6609694	90	15	11						4	4	3		1	1	1	1	1	1					1	
84	Coastal Blackbutt	496808	6609699	120	27	9						6	3		1	1	1	1	1	1						1	
85	Coastal Blackbutt	496808	6609791	85	20	4						4				1	1									1	
86	Red Mahogany	496954	6609900	100	25	3						3				1	1									1	
87	Coastal Blackbutt	496989	6609986	120	23	10						5	3	2	1	1	1	1	1	1	1	1			1	1	
88	Coastal Blackbutt	496954	6609900	120	26	4						4				1	1									1	
89	White Mahogany	497091	6609977	45	17	3			1			2				1	1									1	
90	Coastal Blackbutt	497128	6609976	120	26	7						5	2		1	1	1	1		1						1	
91	Coastal Blackbutt	497082	6609969	115	28	5						3	2		1	1	1	1		1						1	
92	Coastal Blackbutt	497010	6610018	95	25	5						3	2		1	1	1	1		1						1	
93	Coastal Blackbutt	497002	6610010	75	20	3						2	1		1	1	1	1		1						1	
94	Coastal Blackbutt	497002	6610009	95	24	5						3	2		1	1	1	1		1						1	
95	Coastal Blackbutt	497154	6610100	90	22	2						2			1	1	1									1	

HBT Ref No.	Species	Eastings	Northings	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
		<5cm	5-15 cm						>15 cm	<5cm	5-15 cm	>15 cm																
96	Coastal Blackbutt	497230	6610193	125	27	6			1			3	2		1	1	1	1	1	1		1			1	1		
97	Coastal Blackbutt	497274	6610215	130	26	6						3	3		1	1	1	1	1	1		1			1	1		
98	Coastal Blackbutt	497279	6610216	125	27	10						6	3	1	1	1	1	1	1	1		1			1	1		
99	Coastal Blackbutt	497264	6610227	135	26	4						3	1		1	1	1	1								1		
100	Coastal Blackbutt	497311	6610242	70	23	3						2	1		1	1	1	1								1		
101	Coastal Blackbutt	497405	6610271	115	25	4						3	1		1	1	1			1						1		
102	Coastal Blackbutt	497447	6610424	110	27	3						3			1	1	1									1		
103	Coastal Blackbutt	497460	6610464	125	30	4						4			1	1	1									1		
104	Coastal Blackbutt	497501	6610514	105	20	3						3			1	1	1									1		
105	Coastal Blackbutt	497364	6610342	105	21	5						3	2		1	1	1	1		1						1		
106	Coastal Blackbutt	497480	6610595	125	30	3						3				1	1									1		
107	Coastal Blackbutt	497531	6610725	125	28	3						3			1	1	1	1	1	1						1		
111	Pink Bloodwood	497515	6610803	100	20	2						2				1	1									1		
112	Pink Bloodwood	497541	6610864	95	20	2						2				1	1	1								1		
113	White Mahogany	497546	6610855	85	19	5			2			2	1		1	1	1	1		1						1		
114	Coastal Blackbutt	497474	6610716	55	17	3						3				1	1									1		
115	Pink Bloodwood	497512	6610984	90	19	5			1			2	1	1	1	1	1	1	1	1		1				1		
116	Coastal Blackbutt	497428	6611302	115	26	3						3			1	1	1									1		
117	Coastal Blackbutt	497468	6611383	60	20	2						2			1	1	1									1		
118	Coastal Blackbutt	497494	6612422	115	23	4						2	2		1	1	1									1		
119	Coastal Blackbutt	497575	6612692	125	20	4						4				1	1	1	1	1						1		
120	Coastal Blackbutt	497559	6612726	190	20	10						7	2	1		1	1	1	1	1						1		
121	Coastal Blackbutt	497593	6612663	115	20	7						4	3			1	1	1	1	1	1					1		
122	Coastal Blackbutt	497583	6612770	100	20	5			1	1		3			1	1	1			1						1		
123	Coastal Blackbutt	497593	6612767	125	21	5						4	1		1	1	1	1		1						1		
124	Coastal Blackbutt	497592	6612780	95	21	3						2	1		1	1	1			1						1		
125	Coastal Blackbutt	497593	6612783	65	19	4			1			2	1		1	1	1			1						1		
126	Coastal Blackbutt	497585	6612786	70	15	2						2				1	1											
127	Coastal Blackbutt	497575	6612780	110	22	6						3	3		1	1	1	1	1	1						1		
128	Coastal Blackbutt	497594	6612795	105	22	6						3	3		1	1	1	1		1						1		
129	Coastal Blackbutt	497590	6612813	120	23	4						2	2		1	1	1	1		1						1		
130	Stag	497588	6612820	75	16	8					1	2	2	2	1	1	1	1	1	1		1			1	1		
131	Coastal Blackbutt	497594	6612847	135	24	3						2		1	1	1	1	1		1						1		
132	Stag	497603	6613003	40	10	2		1			1				1	1									1	1		
133	Coastal Blackbutt	497670	6613318	90	16	2						1	1		1	1	1	1		1					1	1		
134	Pink Bloodwood	497675	6613324	115	20	8						3	3	2	1	1	1	1	1	1		1			1	1		
135	Pink Bloodwood	497690	6613355	95	20	2						2				1	1									1		
136	Pink Bloodwood	497681	6613357	100	22	6						4	2		1	1	1	1								1		
137	Swamp Mahogany	497705	6613477	105	20	8			2	1		2	3		1	1	1	1		1						1		
138	Coastal Blackbutt	497698	6613044	115	21	3						2	1		1	1	1									1		
139	Smooth-barked Apple	497925	6613554	40	14	2						1			1	1	1	1	1							1		
140	Pink Bloodwood	497925	6613556	90	21	6			1	1		2	2		1	1	1	1	1							1		
141	Stag	497937	6613578	90	22	9						4	4	1	1	1	1	1	1	1		1			1	1		
142	Pink Bloodwood	497967	6613591	80	19	3							2	1	1		1	1								1		

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm													
143	Pink Bloodwood	497967	6613589	45	11	4			1			1	2			1	1	1								1	
144	Stag	497971	6613595	70	20	8		1				2	3	2		1	1	1	1	1						1	
145	Stag	497971	6613599	40	18	5			1	1		2	1		1	1	1	1								1	
146	Stag	497983	6613624	55	18	5			2	1		2			1	1	1	1								1	
147	Stag	497945	6613618	85	15	9						4	3	2	1	1	1	1	1	1		1			1		
148	Stag	497993	6613630	30	10	3							3		1	1	1	1								1	
149	Pink Bloodwood	497996	6613624	70	21	3						3			1	1	1									1	
150	Pink Bloodwood	497999	6613636	95	18	3				1		1		1	1	1	1	1								1	
151	White Mahogany	498016	6613675	110	22	7						3	3	1	1	1	1	1	1							1	
152	Stag	498034	6613673	75	18	11			1			4	2	4	1	1	1	1	1							1	
153	Coastal Blackbutt	498050	6613707	125	23	2						2				1	1									1	
154	White Mahogany	498007	6613724	90	18	3						2	1		1	1	1	1		1						1	
155	Coastal Blackbutt	498063	6613762	110	17	5					1	2	2		1	1	1	1	1	1		1			1	1	
156	Pink Bloodwood	498099	6613731	75	17	8				1		2	3	2	1	1	1	1	1	1		1			1	1	
157	Coastal Blackbutt	498122	6613723	145	19	14						6	5	3	1	1	1	1	1	1		1			1	1	
158	Coastal Blackbutt	498119	6613810	190	20	18						11	4	3	1	1	1	1	1	1		1			1	1	
159	White Mahogany	498131	6613821	95	18	4						2	2		1	1	1	1	1	1						1	
160	Coastal Blackbutt	498140	6613823	140	19	13				1	2	4	3	3	1	1	1	1	1	1	1	1			1	1	
161	Stag	498154	6613814	30	8	3						2	1		1	1	1									1	
162	Coastal Blackbutt	498213	6613832	120	23	13			1		1	7	4		1	1	1	1	1	1		1			1	1	
163	Swamp Mahogany	498827	6614462	110	17	6					2	2	2		1	1	1	1	1	1					1	1	
164	Swamp Mahogany	498820	6614429	75	18	4						2	2		1	1	1	1	1							1	
165	Swamp Box	498825	6614435	35	8	1								1	1				1						1	1	
166	Swamp Mahogany	498806	6614415	110	17	6						3	3		1	1	1	1	1							1	
167	Stag	498789	6614399	75	12	12						5	5	2	1		1	1	1						1	1	
168	Swamp Mahogany	498776	6614381	95	17	10			2			3	3	2	1	1	1	1	1	1					1	1	
169	Coastal Blackbutt	498957	6614551	95	17	4		1	1			2			1	1	1								1	1	
170	Coastal Blackbutt	498949	6614547	105	17	2						1	1		1	1	1									1	
171	Coastal Blackbutt	498892	6614432	150	22	14						5	7	2	1	1	1	1	1	1	1	1			1	1	
172	Coastal Blackbutt	498937	6615080	100	24	4						3	1		1	1	1	1								1	Start of Blackbutt Lane
173	Coastal Blackbutt	498941	6615083	130	27	5						3	2		1	1	1	1								1	
174	Coastal Blackbutt	498952	6615098	130	27	7						4	3		1	1	1	1								1	
175	Coastal Blackbutt	498958	6615105	115	28	7						3	3	1	1	1	1	1	1	1	1	1			1	1	
176	Coastal Blackbutt	498957	6615112	95	19	3						2	1		1	1	1									1	
177	Coastal Blackbutt	498958	6615113	100	25	4						2	2		1	1	1									1	
178	Coastal Blackbutt	498958	6615125	100	24	6						5	1		1	1	1									1	
179	Coastal Blackbutt	498950	6615126	125	25	6						4	2		1	1	1									1	
180	Coastal Blackbutt	498945	6615116	105	24	5						3	2		1	1	1									1	
181	Coastal Blackbutt	498953	6615148	105	27	5						2	3			1	1	1									
182	White Mahogany	498990	6615059	140	23	19			1		1	6	7	4	1	1	1	1	1	1	1	1			1	1	Rainbow Lorikeets using medium limb hollow
183	Coastal Blackbutt	499015	6615108	135	24	9						4	3	2	1	1	1	1	1	1	1					1	
184	White Mahogany	499017	6615105	100	22	5						3	2		1	1	1	1	1	1						1	
185	Pink Bloodwood	499021	6615141	105	18	4					1		2	1					1			1			1	1	
186	Pink Bloodwood	499034	6615132	80	13	4							2	2					1			1			1	1	

HBT Ref No.	Species	Eastings	Northings	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments
		<5cm	5-15 cm						>15 cm	<5cm	5-15 cm	>15 cm															
187	Coastal Blackbutt	499084	6615168	135	25	3						3				1	1									1	
188	White Mahogany	499062	6615145	140	22	14						7	4	3	1	1	1	1	1	1	1	1			1	1	
189	Pink Bloodwood	499112	6615207	95	20	16				1	1	7	3	4	1	1	1	1	1	1	1	1			1	1	
190	Coastal Blackbutt	499159	6615251	150	20	19						5	6	8	1	1	1	1	1	1	1	1			1	1	
191	Stag	499139	6615265	30	8	3				1			2		1										1	1	
192	Coastal Blackbutt	499122	6615259	100	21	2							1	1	1		1	1	1	1						1	
193	Coastal Blackbutt	499113	6615259	100	21	10						5	3	2	1	1	1	1	1	1						1	
194	Coastal Blackbutt	499113	6615258	105	22	4						2	2		1	1	1	1		1						1	
195	Coastal Blackbutt	499106	6615234	105	22	7						4	2	1	1	1	1	1	1	1						1	
196	Coastal Blackbutt	499098	6615226	85	23	4							3	1	1	1	1									1	
197	Coastal Blackbutt	499095	6615225	100	24	4						3	1		1	1	1									1	
198	Coastal Blackbutt	499096	6615249	135	24	5						3	2		1	1	1									1	
199	Coastal Blackbutt	499075	6615269	85	16	2					1		1		1		1	1	1						1	1	
200	Coastal Blackbutt	499067	6615238	115	23	3						2	1		1	1	1	1		1						1	
201	Coastal Blackbutt	499051	6615224	135	23	7						4	3		1	1	1	1		1						1	
202	Stag	499049	6615216	40	6	2		1				1			1										1		
203	Coastal Blackbutt	499047	6615219	110	23	2							2				1	1	1	1							
204	Coastal Blackbutt	499024	6615228	135	23	7						5	2		1	1	1	1								1	
205	Coastal Blackbutt	499012	6615219	165	23	19					3	2	4	6	4	1	1	1	1	1	1	1			1	1	Native bees using small limb hollow
206	Coastal Blackbutt	499015	6615216	105	25	8					2	3		2	1	1	1	1	1	1		1			1	1	
207	Coastal Blackbutt	498994	6615198	110	18	5						2	3		1	1	1	1	1							1	
208	Coastal Blackbutt	498996	6615171	90	21	5						3	2		1	1	1	1	1							1	
209	Coastal Blackbutt	498990	6615156	120	23	6						4	2		1	1	1	1	1							1	
210	Coastal Blackbutt	499005	6615145	105	23	7						5	2		1	1	1	1	1							1	End of Blackbutt Lane HBT's
211	Coastal Blackbutt	499368	6615422	95	20	2						1	1		1	1	1	1								1	
212	White Mahogany	499202	6615299	125	20	20					1	1	8	6	4	1	1	1	1	1	1	1			1	1	
213	Coastal Blackbutt	499202	6615305	60	19	3						2	1		1	1	1	1								1	
214	Coastal Blackbutt	499225	6615367	115	22	8				1		3	4		1	1	1	1								1	Scaly and Rainbows using hollows
215	Coastal Blackbutt	499252	6615373	105	20	7						3	4		1	1	1	1								1	
216	Coastal Blackbutt	499262	6615371	90	20	7						4	2	1	1	1	1	1	1	1						1	
217	Coastal Blackbutt	499409	6615588	125	23	4						3	1		1	1	1	1	1	1	1					1	
218	Coastal Blackbutt	499459	6615620	140	23	8						5	3		1	1	1	1	1	1	1					1	
219	Pink Bloodwood	499445	6615643	75	16	3						3			1	1	1									1	
220	Coastal Blackbutt	499503	6615680	140	21	8						5	2	1	1	1	1	1	1	1	1		1		1	1	
221	Coastal Blackbutt	499527	6615706	105	20	3						2	1		1	1	1	1		1						1	
222	Swamp Mahogany	499535	6615740	105	14	5					2	1	2		1	1	1	1	1	1	1					1	
223	Coastal Blackbutt	499706	6615810	90	17	3						3			1	1	1									1	
224	Coastal Blackbutt	499703	6615802	135	17	8						5	3		1	1	1	1		1						1	
225	Coastal Blackbutt	499796	6615908	130	17	6						3	3		1	1	1	1		1						1	
226	Coastal Blackbutt	499803	6615989	130	18	10						4	4	2	1	1	1	1	1	1	1	1		1		1	open hive in branch
227	Coastal Blackbutt	499842	6616106	130	22	9						4	3	2	1	1	1	1	1	1	1	1				1	tree not marked as beside house to east of large dam
228	Coastal Blackbutt	500225	6616506	190	19	5						3	2		1	1	1	1								1	
229	Coastal Blackbutt	500188	6616454	155	17	5						3	2		1	1	1	1								1	
230	Coastal Blackbutt	500163	6616404	115	17	7						4	2	1	1	1	1	1	1	1	1				1	1	

HBT Ref No.	Species	Eastings	Northings	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
		WGS84	WGS84						<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm														
231	Stag	500161	6616406	35	9	3			1	1	1				1		1	1							1	1		
232	Coastal Blackbutt	500151	6616378	115	17	12						7	4	1	1	1	1	1	1	1					1	1		
233	Coastal Blackbutt	500037	6616353	95	16	6	1				1	2	2		1	1	1	1	1	1					1	1	Antechinus scats at base	
234	Small-fruited Grey Gum	500015	6616367	85	19	3						3			1	1	1									1		
235	Swamp Mahogany	500213	6616568	90	14	5							2	3	1	1	1									1		
236	Swamp Mahogany	500214	6616571	70	14	4						3	1		1	1	1	1	1	1		1			1	1		
237	Stag	500251	6616664	135	13	10	1				1	3	3	2	1	1	1	1	1	1		1			1	1	Oyster Creek area from here	
238	Tallowwood	500255	6616669	95	19	2						1	1		1	1	1	1								1		
239	Stag	500260	6616687	75	15	7						3	4		1	1	1	1		1						1		
240	Narrow-leaved Red Gum	500265	6616713	95	20	5				2		2	1		1	1	1	1		1						1		
241	Coastal Blackbutt	500272	6616731	105	21	4						2	1	1	1	1	1	1		1						1		
242	Stag	500267	6616743	40	18	9						2	7		1	1	1	1		1						1		
243	Coastal Blackbutt	500356	6616969	100	24	4						2	2		1	1	1	1		1						1		
244	Tallowwood	500365	6616934	220	28	21					3	5	4	9	1	1	1	1	1	1	1	1	1	1	1	1	1	using large limb hollow
245	Coastal Blackbutt	500381	6616938	95	26	4						2	2		1	1	1	1		1						1		
246	Coastal Blackbutt	500371	6616915	105	24	4						3	1		1	1	1	1		1						1		
247	Coastal Blackbutt	500371	6616915	85	21	5			2			2	1		1	1	1	1		1						1		
248	Coastal Blackbutt	500378	6616908	105	24	6	1		1		1	2	1		1	1	1	1		1					1	1		
249	Coastal Blackbutt	500382	6616904	80	19	2						2			1	1										1		
250	Coastal Blackbutt	500358	6616902	105	24	5	1					3	1		1	1	1	1		1						1		
251	Stag	500357	6616894	95	16	8						2	3	3	1	1	1	1	1	1		1			1	1		
252	Coastal Blackbutt	500343	6616879	110	24	6						3	3		1	1	1	1		1						1	lots of small black ants unknown if they using the canopy but tree may have low occupancy rates	
253	Coastal Blackbutt	500348	6616867	130	24	5						3	2		1	1	1	1		1						1		
254	Coastal Blackbutt	500343	6616864	205	20	9					4	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	head of tree broken in recent storm
255	Coastal Blackbutt	500345	6616832	105	24	4						2	1	1	1	1	1	1	1	1						1	1	
256	Coastal Blackbutt	500348	6616833	100	21	4						2	2		1	1	1	1	1	1						1	1	
257	Stag	500322	6616818	105	20	9					1	3	3	2	1	1	1	1	1	1	1					1	1	
258	Pink Bloodwood	500320	6616819	105	22	4						1	1	2	1	1	1	1	1	1	1					1	1	
259	Coastal Blackbutt	500337	6616817	60	21	2							1	1	1	1	1	1								1		
260	Coastal Blackbutt	500316	6616824	115	22	5						2	1	2	1	1	1	1	1	1						1		
261	Stag	500306	6616786	95	22	11					1	1	4	3	2	1	1	1	1	1	1	1	1	1	1	1	1	
262	Coastal Blackbutt	500319	6616786	140	24	7						4	3		1	1	1	1		1						1		
263	Coastal Blackbutt	500302	6616755	140	23	19		1	2			7	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	bees using trunk fissure of dead leader
264	Stag	500292	6616761	90	23	9			1	1		1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	
265	Flooded Gum	500282	6616630	85	26	7						2	2	3	1	1	1									1	1	eastern side of road
266	Stag	500332	6616701	70	11	0									1				1							1	1	
267	Coastal Blackbutt	500332	6616701	110	23	5						3	2		1	1	1	1		1						1		
268	Coastal Blackbutt	500350	6616700	95	23	3						3			1	1	1									1		
269	Coastal Blackbutt	500356	6616726	110	21	5						3	2		1	1	1	1		1						1		
270	Coastal Blackbutt	500383	6616787	100	21	6			1	1		2	2		1	1	1	1		1						1		
271	Coastal Blackbutt	500383	6616793	120	24	11						5	3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	
272	Coastal Blackbutt	500374	6616805	110	23	3						3			1	1	1									1		
273	Coastal Blackbutt	500429	6616843	115	26	4						3	1		1	1	1	1		1						1	1	ref tree to south of driveway
274	Stag	500450	6616919	65	12	7		1				3	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
																												<5cm
275	Coastal Blackbutt	500460	6616920	65	21	2						1	1		1	1	1	1		1						1		
276	Coastal Blackbutt	500531	6617092	100	19	2						1	1		1	1	1	1		1						1		
277	White Mahogany	500531	6617292	105	20	4						3	1		1	1	1	1		1						1		
278	Coastal Blackbutt	500479	6617156	70	12	2	1				1				1	1	1	1		1						1		
279	Coastal Blackbutt	500463	6617170	135	23	13						4	5	4		1			1						1			
280	Turpentine Stag	500475	6617153	40	8	7		1		1		2	2	1	1	1	1	1	1	1	1	1			1	1		
281	Stag	500466	6617152	70	15	16		1		2	3	3	4	3	1	1	1	1	1	1	1	1			1	1		
282	Coastal Blackbutt	500451	6617125	135	19	11	1				3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	roost grove of trees nearby for things like Powerful owl, Saltasaurus gecko skin in basal hollow	
283	Coastal Blackbutt	500445	6617083	110	22	8				3		4	1		1	1	1	1		1						1		
284	Pink Bloodwood	500441	6617076	35	9	10			1			3	4	2	1	1	1	1	1	1	1	1			1	1	stag stage	
285	Coastal Blackbutt	500425	6617030	230	23	32			1		1	10	11	9	1	1	1	1	1	1	1	1	1	1	1	1	very good tree for owls	
286	Pink Bloodwood	500411	6616991	105	11	5							2	3	1				1						1	1	these hollows are low 3 and 6 respectively	
287	Coastal Blackbutt	500413	6616988	110	22	6						3	2	1	1	1	1	1	1	1	1	1	1		1	1		
288	Coastal Blackbutt	500438	6616978	135	22	19						9	6	4	1	1	1	1	1	1	1	1	1		1	1	native bees using small limb hollow	
289	Coastal Blackbutt	500441	6616967	150	24	18				1	1	8	5	3	1	1	1	1	1	1	1	1	1		1	1	on edge of highway	
290	Coastal Blackbutt	500419	6616966	130	22	9						5	4		1	1	1	1		1						1		
291	Coastal Blackbutt	500412	6616939	100	21	4						2	1	1	1	1	1	1	1	1	1				1	1		
292	Pink Bloodwood	500395	6616936	100	18	6						3	2	1	1	1	1	1	1	1	1				1	1		
293	Coastal Blackbutt	500428	6616927	125	22	4						4				1	1									1		
294	Coastal Blackbutt	500457	6617540	105	21	4						2	2		1	1	1	1								1		
295	Swamp Mahogany	500481	6617486	95	20	5						2	2	1	1	1	1	1		1						1		
296	Swamp Mahogany	500474	6617468	60	17	2				1	1								1		1				1			
297	Coastal Blackbutt	500466	6617458	105	24	6						4	2		1	1	1	1		1						1		
298	Coastal Blackbutt	500474	6617431	105	23	6						4	2		1	1	1	1		1						1		
299	Coastal Blackbutt	500471	6617428	120	23	3						3				1	1									1		
300	Pink Bloodwood	500462	6617418	55	14	6						2	3	1	1	1	1	1	1	1	1				1	1		
301	Coastal Blackbutt	500472	6617380	110	23	3						2	1		1	1	1	1								1		
302	Turpentine	500471	6617380	50	14	1					1				1										1		very low at 2 mts	
303	Coastal Blackbutt	500476	6617360	110	22	9		1		1		2	3	2	1	1	1	1								1		
304	Stag	500487	6617336	65	16	10					1	3	4	2	1	1	1	1	1	1	1				1	1		
305	Stag	500496	6617325	45	9	1						1				1			1						1		Broken at the base	
306	Pink Bloodwood	500472	6617333	115	26	5						3	1	1	1	1	1	1	1	1	1							
307	Pink Bloodwood	500458	6617303	100	23	10						4	3	3	1	1	1	1	1	1	1	1	1		1	1		
308	Stag	500459	6617285	40	11	1					1								1						1			
309	Coastal Blackbutt	500441	6617380	115	26	7						5	2		1	1	1	1		1						1	Oyster Creek Finish	
310	Coastal Blackbutt	500516	6617717	125	27	3						3			1	1	1									1		
311	Coastal Blackbutt	500504	6617728	125	24	8						3	3	2	1	1	1	1	1	1	1					1		
312	Turpentine	500463	6617662	115	20	3		1				2			1	1	1									1		
313	Coastal Blackbutt	500440	6617802	160	25	10						4	3	3	1	1	1	1	1	1	1	1	1		1	1		
314	Coastal Blackbutt	500466	6617832	145	22	9						3	4	2	1	1	1	1	1	1	1	1	1		1	1		
315	Coastal Blackbutt	500409	6617860	100	21	6						2	2	2	1	1	1	1	1	1	1	1	1		1	1	shallow large hollow	
316	Coastal Blackbutt	500495	6617805	90	24	4						2	2		1	1	1	1	1	1	1				1	1		
317	Stag	500508	6617849	105	11	3					1					1			1							1	1	
318	Coastal Blackbutt	500513	6617856	110	24	3						1	1	1	1	1	1	1	1	1	1	1	1		1	1		

HBT Ref No.	Species	Eastings	Northings	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
		WGS84	WGS84						<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm														
319	Coastal Blackbutt	500514	6617850	95	20	4						4			1	1	1									1		
320	Pink Bloodwood	500492	6617887	115	18	12					1	4	3	4	1	1	1	1	1	1	1	1			1	1		
321	Pink Bloodwood	500514	6617901	110	19	7						3	2	2	1	1	1	1	1	1	1	1			1	1		
322	Pink Bloodwood	500476	6617950	130	24	6			1			2	2	1	1	1	1	1	1	1	1	1			1	1		
323	Coastal Blackbutt	500472	6617956	100	24	6						3	3		1	1	1	1			1					1		
324	Swamp Mahogany	500447	6617980	130	21	4						2	2		1	1	1	1			1					1		
325	Pink Bloodwood	500466	6618042	90	16	7			1	2		3	1		1	1	1	1			1					1		
326	White Mahogany	500419	6618126	130	22	11						5	3	3	1	1	1	1	1	1	1					1		
327	Tallowwood	500419	6618158	170	21	28						13	11	4	1	1	1	1	1	1	1	1			1	1		
328	Stag	500406	6618146	50	11	7		1	2			3	1		1	1	1									1		
329	Coastal Blackbutt	500395	6618119	125	22	8						5	3		1	1	1	1			1					1	twin trunk tree	
330	Coastal Blackbutt	500387	6618127	105	24	6						3	3		1	1	1	1			1					1		
331	Coastal Blackbutt	500411	6618085	120	25	5						3	2		1	1	1	1			1					1		
332	Coastal Blackbutt	500441	6618093	100	26	7			1			3	3		1	1	1	1			1					1	Sugar Glider at base of tree	
333	Coastal Blackbutt	500449	6618092	115	25	14						5	7	2	1	1	1	1	1	1	1	1			1	1		
334	Coastal Blackbutt	500442	6618079	105	24	5						2	2	1	1	1	1	1	1	1	1	1	1			1	1	
335	Tallowwood	500412	6618192	95	22	2						2			1	1	1									1		
336	Coastal Blackbutt	500396	6618227	95	19	3						3			1	1	1									1		
337	Coastal Blackbutt	500378	6618239	125	21	4						2	1	1	1	1	1	1			1					1		
338	Coastal Blackbutt	500378	6618208	100	21	5						3	2		1	1	1	1			1					1		
339	Coastal Blackbutt	500386	6618201	105	21	6						4	2		1	1	1	1			1					1		
340	White Mahogany	500445	6618028	120	22	8			2			3	3		1	1	1	1			1					1	tree not flagged growing in swamp	
341	Coastal Blackbutt	500437	6618581	125	29	4						2	2		1	1	1	1			1					1		
342	Coastal Blackbutt	500451	6618553	110	28	3						2		1	1	1	1		1	1						1		
343	Turpentine	500433	6618516	115	15	6		1	2	1		1		1	1	1			1						1	1		
344	Coastal Blackbutt	500467	6618502	85	23	4						2	2		1	1	1	1	1	1	1					1		
345	Coastal Blackbutt	500471	6618398	115	26	3						3			1	1	1									1	east of road	
346	Coastal Blackbutt	500490	6618450	130	28	6						3	3		1	1	1	1			1				1	1	east of road	
347	Coastal Blackbutt	500548	6618778	125	21	13					1	6	2	2	1	1	1	1	1	1	1	1	1			1	1	
348	Coastal Blackbutt	500496	6619148	85	22	4						3	1		1	1	1	1			1					1		
349	Coastal Blackbutt	500502	6619151	65	20	5						4	1		1	1	1	1			1					1		
350	Coastal Blackbutt	500504	6619155	105	20	7						5	2		1	1	1	1			1					1		
351	Coastal Blackbutt	500529	6619170	120	23	14						7	4	3	1	1	1	1	1	1	1	1	1			1	1	
352	Coastal Blackbutt	500516	6619370	60	17	2						2			1	1	1									1	eastern side on boundary so ref tree	
353	Coastal Blackbutt	500462	6619353	110	24	7			1	1		4	1		1	1	1	1			1					1		
354	Coastal Blackbutt	500474	6619313	100	20	5						3	2		1	1	1	1			1					1		
355	Coastal Blackbutt	500472	6619318	110	26	7						4	3		1	1	1	1			1					1		
356	Pink Bloodwood	500450	6619191	110	25	5						2	2	1	1	1	1	1	1	1	1					1		
357	Coastal Blackbutt	500464	6619166	115	19	14					1	3	4	6	1	1	1	1	1	1	1	1	1	1	1	1	1	
358	Stag	500464	6619136	75	24	10						7	3		1	1	1	1	1							1		
359	Coastal Blackbutt	500468	6619115	105	24	6						3	2	1	1	1	1	1	1	1	1	1	1			1	1	
360	Coastal Blackbutt	500455	6619106	100	27	4						2	1	1	1	1	1	1	1	1	1		1			1	1	native bees using small limb leader
361	Coastal Blackbutt	500459	6619101	110	27	4						3	1		1	1	1	1								1		
362	Coastal Blackbutt	500463	6619028	105	21	8						4	4		1	1	1	1								1		

HBT Ref No.	Species	Eastings	Northings	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
		<5cm	5-15 cm						>15 cm	<5cm	5-15 cm	>15 cm																
363	Pink Bloodwood	500462	6619029	45	19	1			1						1											1	medium trunk only 2.5 m above ground	
364	Coastal Blackbutt	500471	6618968	130	24	17						9	5	3	1	1	1	1	1	1	1	1			1	1		
365	Coastal Blackbutt	500462	6618992	115	20	8						4	4		1	1	1	1		1						1		
366	Coastal Blackbutt	500429	6618987	125	25	6						4	2		1	1	1	1		1						1		
367	Coastal Blackbutt	500441	6618951	125	22	9						7	2		1	1	1	1		1						1		
368	Pink Bloodwood	500453	6618929	100	21	3				1		2			1	1	1	1		1						1		
369	Coastal Blackbutt	500450	6618846	125	26	8						2	4	2	1	1	1	1	1	1	1					1		
370	Stag	500459	6618808	95	13	2		1			1				1	1			1						1	1		
371	Flooded Gum	500491	6618726	85	21	3				1		2			1	1	1	1		1						1		
372	Coastal Blackbutt	500476	6618662	105	26	7						4	3		1	1	1	1		1						1		
373	Coastal Blackbutt	500471	6618677	110	28	4						2	2		1	1	1	1		1						1		
374	Stag	500472	6618673	85	23	14						4	7	3	1	1	1	1	1	1	1	1			1	1		
375	Coastal Blackbutt	500402	6618691	125	27	5						2	2	1	1	1	1	1	1	1	1	1			1	1		
376	Coastal Blackbutt	500406	6618725	130	28	4						3	1		1	1	1	1	1	1					1	1		
377	Flooded Gum	500377	6618804	70	21	2						1	1		1	1	1	1	1						1	1		
378	Coastal Blackbutt	500383	6618876	130	29	10						5	3	2	1	1	1	1	1	1	1	1	1		1	1		
379	Coastal Blackbutt	500383	6618848	140	29	4						4			1	1	1									1		
380	Coastal Blackbutt	500394	6618856	120	21	4						3	1		1	1	1	1		1						1		
381	Coastal Blackbutt	500424	6619933	125	28	5						3	2		1	1	1	1		1						1		
382	Flooded Gum	500442	6619952	70	24	1						1				1										1		
383	Flooded Gum	500429	6619966	115	32	6						4	2			1	1	1		1						1		
384	Flooded Gum	500395	6619968	135	31	9						5	3	1	1	1	1	1	1							1		
385	Stag	500472	6620319	35	9	1					1				1											1		
386	Stag	500398	6620567	80	28	2						2				1	1											
387	Tallowwood	500402	6620965	55	14	1					1				1										1	1		
388	Coastal Blackbutt	500352	6621145	125	26	4						3	1		1	1	1	1		1						1	potential glider crossing tree	
389	Coastal Blackbutt	499927	6621573	105	23	13					1	7	4	1	1	1	1	1	1	1	1	1			1	1		
390	Coastal Blackbutt	499519	6622216	80	22	3						2	1		1	1	1	1		1							Ainsworth Cut area	
391	Grey Ironbark	499559	6622142	135	30	8						4	2	2	1	1	1	1	1	1	1	1			1	1	gully	
392	White Mahogany	499558	6622166	95	23	4						1	2	1	1	1	1	1	1	1	1	1			1	1	gully	
393	Coastal Blackbutt	499524	6622259	100	24	5						3	2		1	1	1	1	1							1		
394	Grey Ironbark	499564	6622184	110	22	4					1	2		1	1	1			1						1		large hollow probably just a cavity	
396	Stag	499461	6622301	35	6	1						1			1				1						1	1		
397	Coastal Blackbutt	499397	6622319	100	25	3						3				1	1									1		
398	Coastal Blackbutt	499711	6621926	80	23	3						2	1		1	1	1	1								1		
399	Small-fruited Grey Gum	499647	6621984	85	27	8						3	3	2		1	1	1	1	1	1					1		
400	Coastal Blackbutt	499622	6621971	85	25	4						3	1		1	1	1	1								1		
401	Tallowwood	499634	6621989	85	23	4						2	2		1	1	1	1								1		
402	Coastal Blackbutt	499612	6622080	95	29	5						3	2		1	1	1	1								1		
403	Stag	499156	5522360	50	13	5					1	1	2	1	1	1	1	1	1	1					1	1		
404	Stag	499176	6622365	60	19	9		1				3	3	2	1	1	1	1	1	1	1		1		1	1		
405	Stag	499169	6622420	75	11	3		1				1			1				1							1	1	
406	White Mahogany	498154	6626751	205	26	13						7	4	2	1	1	1	1	1	1	1	1			1	1	Significant habitat tree in immediate area	
407	White Mahogany	498175	6626592	125	25	9						1	1	3	1	1	1	1	1	1	1	1			1	1		

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm													
408	Tallowwood	498134	6626546	115	25	7						3	2	2	1	1	1	1	1	1					1	1	
409	Pink Bloodwood	498105	6626487	90	21	5					1	2	2		1	1	1	1	1	1					1	1	
410	Tallowwood	498142	6626618	100	21	3						2	1			1	1	1		1						1	
411	White Mahogany	498134	6626657	85	20	3						2	1			1	1	1		1						1	
412	Pink Bloodwood	498130	6626667	105	21	1					1				1				1						1	1	
413	Pink Bloodwood	498198	6626653	105	22	6						2	2	2	1	1	1	1	1	1	1	1			1	1	
414	Pink Bloodwood	498222	6626803	110	25	16			1	1		7	5	2	1	1	1	1	1	1	1	1			1	1	
415	White Mahogany	498344	6626957	110	26	4						2	2		1	1	1	1		1						1	3 m north of station 47 with blue tape
416	Stag	498477	6627076	135	20	2		1			1				1	1			1						1	1	
417	Flooded Gum	498476	6627175	215	30	18						8	6	4	1	1	1	1	1	1	1	1			1	1	
418	Flooded Gum	498475	6627312	140	24	3						1	2			1	1	1	1							1	
419	Swamp Mahogany	497723	6624879	95	14	8			3	2		2	1		1	1			1	1		1				1	north side of dam in open paddock
420	stag	499086	6622518	115	14	4		1	2		1				1	1			1						1	1	2 m inside eastern road corridor boundary ring barked this stag and next 12 as stand improvement (i.e. forestry technique)
421	Stag	499095	6622515	75	22	5		1				3	1		1	1	1	1								1	
422	stag	499111	6622434	55	8	2		1			1								1						1	1	
423	stag	499061	6622455	90	19	2		1			1				1				1						1		Turpentine
424	Stag	499031	6622454	50	10	2						2			1		1									1	
425	Stag	499031	6622453	60	12	4		1				2	1		1	1	1	1								1	
426	Stag	498853	6622659	45	7	2		1			1				1				1						1		
427	Stag	498496	6622832	80	18	8		1	1			4	2		1	1	1	1		1						1	
428	stag	498549	6622892	100	18	3		1			1	1			1	1			1							1	
431	Coastal Blackbutt	498395	6622987	85	21	4						2	2		1	1	1	1		1						1	Southern bank of Martell's Road
433	Coastal Blackbutt	498356	6623603	100	24	4						2	2		1	1	1	1		1						1	
434	Coastal Blackbutt	498233	6623628	105	21	4						2	2		1	1	1	1		1						1	
435	Pink Bloodwood	498225	6623759	65	18	7						4	2	1	1	1	1	1	1	1					1	1	
436	Red Mahogany	498195	6623826	120	21	8						3	3	2	1	1	1	1	1	1					1	1	
437	Swamp Mahogany	498178	6623842	50	14	2							2		1		1	1								1	
438	Swamp Mahogany	498176	6623851	55	15	3					1	1	1		1		1	1	1						1	1	
439	Coastal Blackbutt	498024	6624132	90	18	4			1			2	1		1	1	1	1		1						1	
440	Stag	497662	6625186			3						2	1		1	1	1									1	
441	Grey Ironbark	497757	6625203	115	16	5						3	2		1	1	1									1	
442	Tallowwood	497899	6625902	65	19	5						2	3		1	1	1	1								1	
443	Tallowwood	497897	6625918	105	19	6			2		1	2	1		1	1	1	1	1							1	
444	White Mahogany	497829	6625958	90	21	5						4	1		1	1	1	1								1	
445	Stag	497797	6625894	80	12	2					1			1	1				1							1	
446	Stag	497813	6625864	65	10	1					1				1				1							1	
447	Stag	497788	6625826	60	11	1					1				1				1							1	
448	Stag	497784	6625831	40	16	2					1	1			1	1			1							1	
449	White Mahogany	497905	6625781	100	17	1					1								1							1	
450	White Mahogany	497932	6625791	110	18	4						3	1		1	1	1	1		1						1	
451	Grey Ironbark	498028	6626228	145	27	8					1	4	3		1	1	1	1	1	1	1	1			1	1	
452	Pink Bloodwood	498041	6626312	130	23	5						2	1	2	1	1	1	1	1	1	1	1			1	1	
453	Pink Bloodwood	498112	6626300	150	28	10						4	3	3	1	1	1	1	1	1	1	1			1	1	

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm													
455	Turpentine	498104	6626361	95	19	5			2	1		1	1		1		1	1							1	1	
456	Stag	498414	6627052	85	18	3			1	1		1			1	1										1	
457	Pink Bloodwood	498408	6627076	105	25	4						3	1		1	1	1	1		1						1	
458	Stag	498572	6627321	50	8	1				1					1	1			1						1	1	
459	Swamp Mahogany	498633	6627386	105	22	6						4	2		1	1	1	1								1	
460	Flooded Gum	498641	6627441	115	24	7			4			2	1		1		1	1								1	
461	White Mahogany	498645	6627469	105	30	4						3	1		1	1	1	1		1						1	in gully on creek line
462	Grey Ironbark	498800	6627554	190	35	6						4	2		1	1	1	1		1						1	
463	Stag	498781	6627571	45	11	2		1			1				1				1						1	1	
464	Pink Bloodwood	498871	6627639	105	25	6						4	2		1	1	1	1	1							1	
465	Pink Bloodwood	498871	6627633	115	27	8						5	3		1	1	1	1	1							1	
466	Stag	498905	6627654	80	20	11		1	2	2	1	1	3	1	1	1	1	1	1	1	1	1			1	1	definite use by fauna
467	Stag	498913	6627739	75	13	2					1	1			1	1	1	1	1							1	
468	Stag	498969	6627751	65	15	7					1	1	2	3	1	1	1	1	1	1	1				1	1	
469	Stag	499013	6627780	65	20	11		1	2	1	1		3	3	1	1	1	1	1	1	1				1	1	
470	Swamp Mahogany	499561	6628389	140	18	7						4	3			1	1	1		1						1	
471	Pink Bloodwood	499038	6627772	105	24	4						3	1		1	1	1	1		1						1	
472	Stag	499070	6627776	70	19	10			1		1	5	3		1	1	1	1		1						1	
473	Turpentine	499084	6627817	90	19	2						1	1		1	1	1	1	1	1					1	1	
474	Stag	499118	6627888	65	14	2							1	1	1				1							1	1
475	Coastal Blackbutt	499101	6627938	105	22	3						3				1	1									1	
476	Coastal Blackbutt	499101	6627939	90	21	2						2				1	1									1	
478	Coastal Blackbutt	499194	6627965	105	22	2			1			1				1	1									1	
480	Stag	499012	6627835	125	32	7						2	2	3	1	1	1	1	1	1	1	1			1	1	
481	Stag	498875	6627729	35	7	1					1								1							1	
491	White Mahogany	492522	6600188	130	15	1				1					1				1	1						1	Eastern Rosella using tree hollow
492	Broad-leaved Paperbark	493396	6601717	200	11	5			3	2						1				1						1	
493	Broad-leaved Paperbark	493392	6601720	40	11	3			2	1						1				1						1	
494	Broad-leaved Paperbark	493394	6601727	55	10	2			2							1										1	
495	Grey Mangrove	493782	6602801	75	7	4			2			2				1										1	
496	Broad-leaved Paperbark	494067	6602935	130	7	4		1	2	1						1				1						1	
497	Broad-leaved Paperbark	494048	6602890	65	7	5			3	1		1				1			1	1						1	
498	Broad-leaved Paperbark	494044	6602901	125	7	1					1								1							1	Common Ringtail Possum using
499	Broad-leaved Paperbark	494005	6602914	220	9	5			3	2						1				1						1	
500	Broad-leaved Paperbark	493993	6602976	40	8	2				1				1													Eastern Rosella using large limb hollow
501	White Mahogany	494353	6604053	90	16	6					3	2	1		1	1	1	1	1	1					1	1	
502	White Mahogany	494360	6604059	65	15	3					3				1	1										1	
503	White Mahogany	494370	6604038	70	16	3					3				1	1										1	
504	Small-fruited Grey Gum	494370	6604038	45	16	3					3				1	1										1	
505	White Mahogany	494347	6604049	90	16	6				1		2	3		1	1	1	1		1							Medium trunk hollow currently being used as extensive wear marks
506	White Mahogany	494348	6604045	35	9	3			2					1	1											1	
507	White Mahogany	494360	6604032	75	18	8					5	3			1	1	1	1	1	1						1	
508	White Mahogany	494375	6604033	65	19	1			1							1	1									1	
509	White Mahogany	494344	6604021	95	19	5						3	2		1	1	1	1		1						1	

HBT Ref No.	Species	Easting	Northing	DBH (cm)	~ Tree Height (m)	No. Func. Holl.	Trunk Butt	Trunk Fissures	Trunk Small	Trunk Medium	Trunk Large	Limb Small	Limb Medium	Limb Large	SF	MB	SG	LG	Po	Pa	Co	SO	LFO	EB	LM	AH	Comments	
									<5cm	5-15 cm	>15 cm	<5cm	5-15 cm	>15 cm														
510	White Mahogany	494344	6604022	95	18	9			1	1		3	3	1	1	1	1	1	1	1						1		
511	White Mahogany	494331	6604020	55	14	3						2	1			1	1			1						1		
512	White Mahogany	494326	6604003	55	15	2						2				1	1									1		
513	White Mahogany	494326	6603948	95	15	3						3				1	1									1		
514	Turpentine	494327	6603947	30	8	1			1						1											1		
515	White Mahogany	494327	6603937	95	19	4						2	1	1	1	1	1	1	1	1						1		
516	Turpentine	494327	6603913	40	9	2						1	1			1				1						1		
517	White Mahogany	494360	6604074	95	16	3				2		1			1					1						1		
518	Tallowwood	494358	6604104	65	18	3						2	1		1	1	1									1		
519	White Mahogany	494351	6604109	95	16	5				1		2	2			1	1	1	1	1						1		
520	White Mahogany	494351	6604133	45	13	1				1								1	1	1							Medium trunk hollow show signs of current use	
521	Tallowwood	494356	6604153	105	23	6						4	2			1		1		1						1		
522	Tallowwood	494356	6604151	70	21	4						2	2			1		1		1						1		
523	White Mahogany	494328	6604137	105	20	9						4	3	2	1	1	1	1	1	1						1		
524	White Mahogany	494343	6604212	105	18	5						3	2		1	1	1	1	1	1						1		
525	Coastal Blackbutt	494336	6604291	130	23	3						3				1	1									1	Rainbow Lorikeet using medium trunk	
526	Turpentine	494345	6604238	40	14	3			1	2					1		1			1				1		1	8.5 m above ground in trunk hollow nth facing	
527	Turpentine	494336	6604234	75	15	4			2	2					1	1	1	1		1						1		
528	Coastal Blackbutt	494379	6604823	100	21	4						3	1			1	1	1		1						1		
529	Coastal Blackbutt	494376	6604808	100	21	3						3				1	1										1	
530	Coastal Blackbutt	494387	6604830	105	19	5						4	1			1	1	1	1	1						1		
531	Coastal Blackbutt	494424	6605254	95	16	6						3	3			1	1	1	1	1						1		
532	Stag	494468	6605254	45	12	9		1				5	3			1	1	1	1	1						1		
533	Coastal Blackbutt	494427	6605290	70	17	3						2	1			1	1	1	1	1						1		
534	Coastal Blackbutt	494448	6605406	55	15	2						2				1	1									1		
535	Coastal Blackbutt	494665	6605513	90	22	4						2	2			1	1	1		1						1		
536	Coastal Blackbutt	494661	6605516	105	22	10						4	5	1	1	1	1	1	1	1					1	1		
537	Coastal Blackbutt	494657	6605530	120	18	3						2	1		1	1	1	1	1	1						1		
538	Coastal Blackbutt	494653	6605567	100	20	5						3	2		1	1	1	1	1	1						1		
539	Coastal Blackbutt	494699	6605590	115	21	11			2			5	4		1	1	1	1	1	1						1		
540	Coastal Blackbutt	494740	6605764	115	21	4					1	3				1	1									1		
541	Coastal Blackbutt	494758	6605835	105	16	4						3	1			1	1	1		1						1		
542	Coastal Blackbutt	494757	6605788	135	21	4						2	2			1	1	1		1						1		
543	Coastal Blackbutt	494898	6606055	160	22	17	1	1	1			7	5	2	1	1	1	1	1	1		1			1	1		
544	Coastal Blackbutt	494859	6605960	80	17	4						3	1			1	1			1						1		
545	Coastal Blackbutt	494851	6605965	85	19	4						3	1			1	1			1						1		
546	Coastal Blackbutt	494776	6605802	85	17	5						4	1			1	1			1						1		
547	Coastal Blackbutt	494758	6605774	90	17	2						2				1	1									1		
548	Coastal Blackbutt	494810	6605714	125	24	16						8	6	2	1	1	1	1	1	1		1			1	1		
549	Coastal Blackbutt	494817	6605767	105	20	4						3	1		1	1	1	1	1	1						1		
550	Coastal Blackbutt	494831	6605835	105	26	8						5	3		1	1	1	1	1	1						1		
551	Coastal Blackbutt	494832	6605844	280	28	26						15	7	4	1	1	1	1	1	1	1	1			1	1	Near to the construction footprint. All efforts should be made to retain this tree as it contains the bulk of the immediate tree hollow resources	

APPENDIX D

WC2NH 2378-1318 Final Nest Box Installation Report – Final Calculations and Nest Box Locations