



Roads &
Maritime

Habitat Tree Assessment and Nest Box Management Plan for Section 2

**Woolgoolga to Ballina Pacific Highway
upgrade**

October 2014

Executive summary

New South Wales Roads and Maritime Services propose to upgrade the Pacific Highway between Woolgoolga and Ballina in northern NSW. The upgrade will increase the carriage way from two lanes to a divided four lane carriageway. Ecosure Pty Ltd (Ecosure) was commissioned to undertake surveys for hollow bearing trees and nest box management within Section 2 of the upgrade, a 15 km long stretch of road between Glenugie and Halfway Creek.

Approximately 70 fauna species in north-eastern NSW within the vicinity of the project boundary regularly use hollows in trees for roosting and nesting. Any decrease in the number of hollows in an area can have significant impacts on populations of hollow dependent species, in areas where they are a limiting resource.

Ecosure was commissioned to undertake surveys of hollow -bearing trees in the project sites, identify areas potentially suitable for nest boxes and develop a nest box management plan. Field surveys to locate and identify hollow-bearing trees (HBT's) within the project boundary were undertaken on 3 to 6 March 2014 and 6 May 2014.

A total of 906 hollow-bearing trees were identified and marked within the project boundary. These trees had approximately 2,347 hollows ranging in size from less than 5 cm in diameter to over 30 cm in diameter.

RMS requires nest boxes to be installed adjacent to parts of the corridor where HBT's are being removed and the surrounding habitat contains less than four hollow-bearing trees per hectare. Based on this criterion, 22 parts of the project boundary (including cleared areas) require nest box installation in adjacent habitat. Within these sections, a total of 227 nest boxes are required to compensate for the loss of hollow-bearing trees (including 17 additional boxes to reduce competition between parrots and possums). At time of writing, Roads and Maritime Services is developing a memorandum of understanding with the NSW Forestry Corporation to install 183 nest boxes within Glenugie State Forest and has verbal agreement with two private land holders for installation of a further 44 nest boxes.

Glossary

DBH	Diameter at breast height
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
HBT	Hollow-bearing tree
TSC Act	NSW <i>Threatened Species Conservation Act 1995</i>
RMS	Roads and Maritime Services

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1 Introduction

1.1 Background

New South Wales Roads and Maritime Services (RMS) propose to upgrade the Pacific Highway between Woolgoolga and Ballina in northern NSW. The upgrade will increase the road from two lanes to a divided four lane carriageway. Ecosure Pty Ltd (Ecosure) was commissioned to undertake surveys for hollow-bearing trees and determine suitable locations for nest box installation within Section 2 of the upgrade, a 15 km long stretch of road between Glenugie and Halfway Creek (the site) (Map 1: Appendix 2).

1.2 Importance of hollows

Approximately 70 fauna species in north-eastern NSW regularly use hollows in trees for roosting and nesting. Hollows in trees usually occur in old, dead or senescing trees which are usually over 100 years old (DEC 2004). Many species of fauna require hollows for breeding (e.g. parrots, microbats and owls) and populations are often limited by the availability of hollows in an area. Any decrease in the number of hollows in an area can have significant impacts on populations of hollow dependent species. Due to large scale land clearing, removal of hollow bearing trees is now listed as a key threatening process under the *Threatened Species Conservation Act 1995* (TSC Act) (OEH 2013) because of the threat it poses to hollow-dependent threatened species.

1.3 Scope and limitations

Ecosure was commissioned to undertake surveys of hollow-bearing trees within the project boundary, identify areas potentially suitable for nest boxes and develop a nest box management plan.

The nest box management plan aims to quantify:

- The number and type of hollows to be removed within the project boundary.
- The density of hollows in the area within the project boundary.
- The density of hollows in the area adjacent to the project boundary to determine suitable locations for nest boxes.
- The number and type of nest boxes which need to be installed to offset the loss of hollows to be removed within the project site.

Field surveys were used to confirm the number of hollow-bearing trees in the site and in adjacent areas. All attempts were made to identify every hollow within the site but hollows in trees can be difficult to identify from the ground. Many hollows identified from the ground may not be deep enough to support fauna following closer inspection. Conversely, many small hollows in trunks and branches may not be visible from the ground and may have been missed during surveys. Therefore, the number of hollows identified may not accurately reflect the actual number of hollows to be lost.

2 Hollow dependent fauna species in the local area

A total of 66 native species which use hollows for roosting or nesting have been recorded in the study area (RMS 2013a). Of these, 17 species are listed as threatened under the Threatened Species Act 1995 (TSC Act) and two are listed as endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These include:

- *Calyptorhynchus lathami* (glossy black-cockatoo)*
- *Glossopsitta pusilla* (little lorikeet)
- *Lathamus discolor* (swift parrot)
- *Ninox connivens* (barking owl)
- *Ninox strenua* (powerful owl)
- *Tyto novaehollandiae* (masked owl)
- *Tyto tenebricosa* (sooty owl)
- *Climacteris picumnus victoriae* (brown treecreeper (eastern subspecies))*
- *Dasyurus maculatus* (spotted-tailed quoll)
- *Phascogale tapoatafa* (brush-tailed phascogale)*
- *Petaurus australis* (yellow-bellied glider)*
- *Petaurus norfolcensis* (squirrel glider)*
- *Mormopterus norfolkensis* (eastern freetail-bat)
- *Myotis macropus* (large-footed myotis)*
- *Chalinolobus nigrogriseus* (hoary wattled bat)*
- *Falsistrellus tasmaniensis* (eastern false pipistrelle)*
- *Miniopterus australis* (little bentwing-bat)*
- *Scoteanax rueppellii* (greater broad-nosed bat).

*species confirmed to occur in Section 2

The removal of hollow-bearing trees is listed as a key threatening process pursuant to the TSC Act (OEH 2013). The project has the potential to remove hollow-bearing trees and therefore impact on threatened and non-threatened fauna species through:

- Increased inter- and intra-specific competition for roosting and nesting sites.
- Increased predation on some species due to lack of suitable shelter.
- Decreased breeding rates amongst hollow-dependent breeders such as glossy-black cockatoos, owls and gliders.

The installation of nest boxes in adjacent habitat can help to reduce the impact to hollow-dependent fauna in the area.

3 Existing tree hollows

3.1 Hollow-bearing tree surveys within the project boundary

Ecosure conducted surveys to map, identify and mark the existing hollow-bearing trees within the project boundary from 3 to 6 March 2014 and 6 May 2014 (Map 2: Appendix 2). For each hollow-bearing tree identified the following information was recorded:

- Tree species.
- Condition (alive or dead).
- Approximate height (m).
- Approximate diameter at breast height (DBH).
- Location of the hollows (limbs, trunk or both).
- Total number of hollows.
- Number of each hollow class (small <5 cm, medium 5-15 cm, large 15-30 cm and extra large > 30 cm).

Each hollow tree was mapped using a GPS or ArcPad on a Trimble and sprayed with white paint for future identification.

3.2 Identification of suitable nest box installation sites

Surveys adjacent to the site to assess possible offset areas were conducted on 7 March 2014 and 6 May 2014. In addition to areas of suitable vegetation remaining within the future road reserve and private property locations adjoining the project footprint, twenty-six sites were visited in areas which were identified on aerial imagery as possibly containing regrowth. At each site a 1 ha plat was assessed for potential fauna habitat including:

- Vegetation community.
- Dominant canopy species.
- Dominant mid-storey species.
- Dominant ground species.
- % canopy cover.
- % mid storey cover.
- % ground storey cover.
- Number of hollow bearing trees.
- Number of hollows (of each size class).
- Number of trees over 30 cm DBH.
- Abundance of logs.
- Abundance of dense grasses.
- Abundance of rocks.
- Abundance of leaf litter.
- Abundance of fruiting plants.
- Abundance of nectar producing plants.
- Abundance of seeding grasses.
- Presence of water.
- Presence of weeds.
- Presence of disturbances (e.g. logging, fire, grazing etc.).

3.3 Impact area

3.3.1 Distribution and density

A total of 906 hollow-bearing trees were mapped within the area surveyed in the site (Map 2). The majority of the hollow-bearing trees were recorded in the *Eucalyptus signata*, *Corymbia henryi* and *Eucalyptus bancroftii*. The Scribbly Gum- Red Bloodwood vegetation community contained the highest abundance of hollow-bearing trees (698) and the Blackbutt Grassy Open Forest contained the highest density of hollows per ha (34.76 hollows per ha).

Table 1 Average number of hollows in each vegetation community in the site.

Vegetation code	Vegetation Community	Number of HBT	Number of hollows	Area within project boundary (ha)	HBT density per ha	Hollow density per ha
NR110	Black Bean – Weeping Lilly Pilly riparian rainforest of the North Coast	0	0	0.004	0	0
NR119	Blackbutt - Tallowwood dry grassy open forest of the central parts North Coast	2	6	3.37	0.59	1.78
NR125	Blackbutt grassy open forest of the lower Clarence Valley of the North Coast	50	251	7.22	6.93	34.76
NR197	Narrow-leaved Red Gum woodlands of the lowlands of the North Coast	59	185	8.83	6.68	20.95
NR200	Needlebark Stringybark - Red Bloodwood heathy woodland on sandstones of the lower Clarence of the North Coast	29	67	4.12	7.04	16.26
NR216	Orange Gum (<i>Eucalyptus bancroftii</i>) open forest of the North Coast	110	285	15.39	7.15	18.52
NR217	Paperbark swamp forest of the coastal lowlands of the North Coast	23	53	5.01	4.59	10.58
NR227	Scribbly Gum - Needlebark Stringybark heathy open forest of coastal lowlands of the northern North Coast	100	233	9.44	10.59	24.68
NR228	Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast	300	698	26.11	11.49	26.73
NR244	Spotted Gum - Grey Box - Grey Ironbark dry open forest of the Clarence Valley lowlands of the North Coast	22	64	11.25	1.96	5.69
NR246	Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast	159	357	44.93	3.54	7.82
NR253	Swamp Box swamp forest of the coastal lowlands of the North Coast	1	1	0.28	3.57	3.57

Vegetation code	Vegetation Community	Number of HBT	Number of hollows	Area within project boundary (ha)	HBT density per ha	Hollow density per ha
NR254	Swamp Mahogany swamp forest of the coastal lowlands of the North Coast	27	74	7.12	3.79	10.39
	Cleared	24	73	42.49	0.56	5.46
Total		906	2347	185.5		

Table 2 shows the location of each of the vegetation communities within the project boundary and the number of hollow-bearing trees and hollows to be removed within each section. Some vegetation community sections did not contain any hollow-bearing trees and are not included in the table. The greatest density of hollows was recorded from chainage 24190 to 24530.

Table 2 Location of vegetation communities by chainage and the number of hollow-bearing trees and hollows to be removed.

Chainage from	Chainage to	Vegetation community code	Area to be removed in project boundary (ha)	No. of HBT in project boundary	No. of hollows in project boundary	HBT density (per ha)	Hollow density (per ha)
16990	17410	NR119	2.86	2	6	0.70	2.09
17410	17860	NR228	3.66	20	43	5.46	11.75
17570	18000	NR254	2.48	6	14	2.42	5.64
17680	17870	NR228	1.49	6	16	4.02	10.72
17850	17960	NR216	0.50	1	5	2.01	10.07
17960	18260	NR254	1.24	4	11	3.24	8.90
18010	18290	NR227	2.02	16	44	7.93	21.80
18290	18490	NR228	1.19	7	12	5.87	10.06
18370	18990	NR197	0.82	1	2	1.22	2.44
18490	18600	NR216	0.69	3	7	4.35	10.14
18600	18700	NR217	0.54	4	14	7.41	25.92
18680	18720	NR254	0.34	3	6	8.85	17.70
18720	19190	NR217	2.99	19	39	6.36	13.04
19190	19290	NR253	0.28	1	1	3.56	3.56
19190	19560	NR228	2.69	13	38	4.84	14.14
19290	19580	NR227	1.46	13	26	8.91	17.81
19570	20120	NR227	3.54	31	71	8.75	20.05
19580	20130	NR227	2.42	40	92	16.55	38.06
20130	20300	NR200	0.78	8	16	10.31	20.61
20230	20300	NR200	0.92	4	15	4.36	16.36
20300	20370	NR254	0.48	3	5	6.30	10.50
20700	20830	NR254	1.23	3	21	2.44	17.07
20760	21150	NR197	0.71	2	7	2.83	9.91
20790	21230	NR197	6.10	56	176	9.19	28.87

Chainage from	Chainage to	Vegetation community code	Area to be removed in project boundary (ha)	No. of HBT in project boundary	No. of hollows in project boundary	HBT density (per ha)	Hollow density (per ha)
21090	21600	NR125	6.87	49	249	7.13	36.23
21310	21540	NR125	0.35	1	2	2.88	5.76
21540	22380	NR228	4.41	62	146	14.05	33.09
21580	22290	NR228	3.23	23	90	7.12	27.88
22310	22450	NR254	1.19	8	17	6.72	14.28
22450	22710	NR228	2.32	20	50	8.63	21.57
22450	22870	NR216	4.23	23	49	5.43	11.58
22690	23310	NR246	6.84	65	122	9.51	17.85
22870	23100	NR200	2.01	13	27	6.48	13.45
23310	23850	NR228	7.12	149	303	20.93	42.57
23850	24110	NR216	2.22	24	67	10.80	30.14
23890	24000	NR200	0.42	4	9	9.58	21.55
24090	24320	NR216	2.50	3	5	1.20	2.00
24190	24530	NR216	0.72	11	33	15.36	46.08
24320	24520	NR216	1.89	30	84	15.87	44.42
24610	24790	NR246	2.24	15	30	6.69	13.39
24640	25310	NR246	1.42	12	35	8.42	24.57
24780	24920	NR216	1.28	15	35	11.68	27.24
24810	26350	NR246	21.33	44	114	2.06	5.34
25400	25920	NR246	1.43	5	13	3.49	9.08
26350	26850	NR246	0.86	1	4	1.16	4.64
26350	26850	NR246	4.01	4	9	1.00	2.24
26850	27200	NR244	3.39	11	32	3.24	9.43
27200	27600	NR246	5.77	13	30	2.25	5.20
27600	28170	NR244	7.57	11	32	1.45	4.22
		cleared	42.50	24	73	0.56	1.72
Total				906	2347		

3.3.2 Hollow characteristics

A total of 2,347 hollows in 906 trees were identified during the surveys within the project boundary and therefore likely to be removed or impacted by the highway upgrade. Size of hollows varied depending on the species and age of the tree. The majority of the hollows (45 %) recorded were small (less than 5 cm in diameter). Large (15 %) and extra large (11 %) hollows were less commonly recorded and were mostly found in large orange gums (*Eucalyptus bancroftii*) and scribbly gums (*Eucalyptus signata*) (Figure 1).

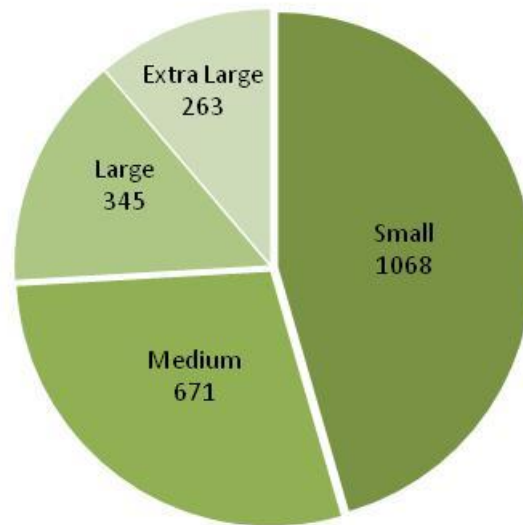


Figure 1 Number of each sized hollow recorded within the project footprint.

3.3.3 Suitability of tree hollows

The size of the hollows recorded varied from less than 50 mm to well over 300 mm. The large number of small hollows recorded would suit small gliders, small birds, micro-bats, reptiles and amphibians. The number of hollows suitable for each species group is listed in Table 3. A full list of the species potentially occurring within the project boundary can be found in Appendix 1.

Table 3 Hollow requirements for hollow-dependent species potentially inhabiting the site and the number of hollows for each group which will potentially be cleared.

Group	Likely species in the area	Hollow entrance requirement (mm)	Number of hollows surveyed as suitable
Possums	Short-eared possum, brushtail possum, common ringtail possum	85 - 100	671
Small gliders	Sugar glider, squirrel glider, feather-tail glider	30-45	1068
Large gliders	Greater glider	90	671
Other small mammals	Brush-tailed phascogale, yellow-footed antechinus	30-50. Brush-tailed phascogale require rough barked trees with a DBH greater than 250 mm	1068
Quolls	Spotted-tail quoll	150-300	345
Large parrots	Sulphur-crested cockatoo, yellow-tailed black-cockatoo, glossy-black cockatoo, galah, Australian king parrot	200	345
Small parrots	Little lorikeet, swift parrot, crimson rosella, eastern rosella, scaly-breasted lorikeet, rainbow lorikeet	55-100	1068
Ducks	Australian wood duck	150	345
Owls	Barking owl, southern boobook, powerful owl, eastern barn owl, masked owl, sooty owl	100 (small species)	608

Group	Likely species in the area	Hollow entrance requirement (mm)	Number of hollows surveyed as suitable
Other birds	Spotted pardalote, striated pardalote, dollarbird, red-browed treecreeper, forest kingfisher, sacred kingfisher, laughing kookaburra, brown treecreeper, white-throated treecreeper	40-100	1739
Micro-bats	Eastern freetail-bat, mastiff-bat, white-striped freetail-bat, Gould's wattled bat, chocolate wattled bat, hoary wattled bat, eastern false pipistrelle, little bentwing-bat, lesser long-eared bat, Gould's long-eared bat, greater broad-nosed bat, eastern broad-nosed bat, central-eastern broad-nosed bat, large forest bat, eastern forest bat, little forest bat	Various, bottom opening	2347
Reptiles	Robust velvet gecko, southern leaf-tailed gecko, Gould's goanna, lace monitor, carpet python	Various	2347
Frogs	Green tree frog	Various	2347

3.4 Adjacent area

A total of 26 one-hectare quadrats immediately adjacent to the road corridor were assessed for installation of nest boxes (Map 3). The majority of the sites assessed were within Glenugie State Forest. All of the sites visited showed some evidence of past logging (cut stumps and few mature trees) or clearing (very few large trees, dense mid-storey). Seventeen of the 26 sites contained some trees with hollows although the density varied from site to site. Four of the sites contained very few trees large enough to support nest boxes (over 30 cm DBH) which would limit their suitability to support a large numbers of nest boxes. Map 3 shows the sites which were surveyed and whether or not they are suitable for nest box installation.

Although many of the offset site surveys were conducted in the Glenugie State Forest, ideally nest boxes will be placed in suitable areas immediately adjacent to the areas requiring offset. To do this, some boxes may need to be placed in private property (with prior agreement of the land owner) or in areas of non-cleared road reserve. In the case of private property it is important that agreements with stakeholders are made for the long term protection of the nest boxes.

RMS requires nest boxes to be installed adjacent to sections of the corridor where HBT's are being removed and the surrounding habitat contains less than four hollow-bearing trees per hectare. Based on this criterion, 22 sections of the project boundary require nest box installation in adjacent habitat. Table 4 shows the number of hollow-bearing trees and hollows within the project boundary and in adjacent habitat.

Table 4 Number of hollow-bearing trees within the project boundary compared with habitat in adjacent vegetation (outside the project boundary).

Chainage from	Chainage to	Within project boundary			Adjacent area		Requires nest box offset ^A
		Area to be removed (ha)	No. of HBT	No. of hollows	No. of HBT per ha	No. of hollows per ha	
16990	17410	2.86	2	6	0.59*	1.79*	Yes
17410	17860	3.66	20	43	11.40*	26.73*	No
17570	18000	2.48	6	14	3.79*	10.39*	Yes
17680	17870	1.49	6	16	11.40*	26.73*	No
17850	17960	0.50	1	5	7.14*	18.52*	No
17960	18260	1.24	4	11	3.79*	10.39*	Yes
18010	18290	2.02	16	44	10.60*	24.71*	No
18290	18490	1.19	7	12	11.40*	26.73*	No
18370	18990	0.82	1	2	6.67*	20.98*	No
18490	18600	0.69	3	7	7.14*	18.52*	No
18600	18700	0.54	4	14	5.96*	10.6*	No
18680	18720	0.34	3	6	3.79*	10.39*	Yes
18720	19190	2.99	19	39	5.96*	10.6*	No
19190	19290	0.28	1	1	3.57*	3.57*	Yes
19190	19560	2.69	13	38	11.40*	26.73*	No
19290	19580	1.46	13	26	10.60*	24.71*	No
19570	20120	3.54	31	71	10.60*	24.71*	No
19580	20130	2.42	40	92	10.60*	24.71*	No
20130	20300	0.78	8	16	5.96*	14.82*	No
20230	20300	0.92	4	15	5.96*	14.82*	No
20300	20370	0.48	3	5	3.79*	10.39*	Yes
20700	20830	1.23	3	21	3.79*	10.39*	Yes
20760	21150	0.71	2	7	6.67*	20.98*	No
20790	21230	6.10	56	176	6.67*	20.98*	No
21090	21600	6.87	49	249	6.93*	34.8*	No
21310	21540	0.35	1	2	6.93*	34.8*	No
21540	22380	4.41	62	146	11.40*	26.73*	No
21580	22290	3.23	23	90	11.40*	26.73*	No
22310	22450	1.19	8	17	3.79*	10.39*	Yes
22450	22710	2.32	20	50	11.00*	21*	No
22450	22870	4.23	23	49	7.14*	18.52*	No
22690	23310	6.84	65	122	3.54*	7.82*	Yes
22870	23100	2.01	13	27	6	12	No
23310	23850	7.12	149	303	11.40*	26.73*	No
23850	24110	2.22	24	67	2	6	Yes
23890	24000	0.42	4	9	2	6	Yes

Chainage from	Chainage to	Within project boundary			Adjacent area		Requires nest box offset [^]
		Area to be removed (ha)	No. of HBT	No. of hollows	No. of HBT per ha	No. of hollows per ha	
24090	24320	2.50	3	5	2	6	Yes
24190	24530	0.72	11	33	2	6	Yes
24320	24520	1.89	30	84	1	20	Yes
24610	24790	2.24	15	30	6	13	No
24640	25310	1.42	12	35	6	20	No
24780	24920	1.28	15	35	6	13	No
24810	26350	21.33	44	114	0	0	Yes
25400	25920	1.43	5	13	1	1	Yes
26350	26850	0.86	1	4	0	0	Yes
26350	26850	4.01	4	9	0	0	Yes
26850	27200	3.39	11	32	0	0	Yes
27200	27600	5.77	13	30	0	0	Yes
27600	28170	7.57	11	32	0	0	Yes
	cleared	42.5	24	73	-	-	Yes

* Density of hollow-bearing trees and density of hollows based on averages for that vegetation community.

[^] RMS guidelines only require nest boxes to be installed in areas where the adjacent habitat (proposed offset area) has less than 4 hollow-bearing trees per ha

4 Nest boxes required to offset removal from project area

4.1 Number of boxes required to offset hollow-bearing tree removal

RMS requires that the number of nest boxes required to offset the loss of habitat from removal of hollow-bearing trees be determined by the equation (RMS 2013a):

A x B x 1.2 = required number of nest boxes where:

$$A \text{ (density HBT/ha)} = \frac{\text{Number of identified HBTs within the clearing footprint of a specified area}}{\text{Area (ha) of vegetated land identified for removal}}$$

$$B \text{ (mean number of hollows per HBT)} = \frac{\text{Total number of tree hollows identified}}{\text{Total number of HBTs within the area}}$$

1.2 = 20% 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.
- 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.

The equation was used to calculate the number of nest boxes required for each section of the road requiring nest boxes (Table 6).

According to the equation, four sections of the road corridor require a disproportionately large number of boxes. These are chainages:

- 18680 to 18720 (21 boxes in 0.34 ha).
- 23890 to 24000 (26 boxes in 0.42 ha).
- 24190 to 24530 (55 boxes in 0.72 ha).
- 24320 to 24520 (53 boxes in 1.89 ha).

These numbers are skewed due to the large number of hollows in a very small area. It would not be feasible to place such a large number of nest boxes in areas less than 2 ha in size. Therefore, Ecosure recommends using the average HBT density for that community to determine the number of nest boxes required. For example, vegetation community NR216 was recorded as having 7.15 HBTs per ha during the surveys. Based on the areas being cleared and this density it is recommended that 5 nest boxes be installed from chainage

24190 to 24530. Table 5 shows the chainages and the adjusted recommended number of nest boxes. If this recommendation was followed, then the total number of boxes required for proposed road upgrade would be 227 (including 17 additional nest boxes for possums) (Table 6).

Table 5 Recommended adjustments to the number of nest boxes required in areas with a disproportionately large number of nest boxes.

Chainage from	Chainage to	Area to be removed (ha)	Number of nest boxes required as per equation	Density of hollows in vegetation community	Recommended number of nest boxes
18680	18720	0.34	21	8.85	3
23890	24000	0.42	26	9.58	4
24190	24530	0.72	55	7.15	5
24320	24520	1.89	53	7.15	14

Table 6 Number of nest boxes for each part within the project boundary requiring nest box offsets.

Chainage from	Chainage to	Vegetation to be removed (ha)	Number of HBT to be removed	No. of hollows to be removed	Nest box offsets					
					No. of small boxes required	No. of medium boxes required	No. of large boxes required	No. of extra large boxes required	Additional medium possum boxes	Total number of nest boxes required
16990	17410	2.86	2	6	1	1	1	0	0	3
17570	18000	2.48	6	14	3	3	1	1	1	8
17960	18260	1.24	4	11	5	4	2	1	1	12
18680	18720	0.34	3	6	1^	1^	1^	0^	0^	3^
19190	19290	0.28	1	1	2	1	1	0	0	4
20300	20370	0.48	3	5	6	5	2	1	1	14
20700	20830	1.23	3	22	9	8	3	2	2	22
22310	22450	1.19	8	18	8	6	3	1	1	18
22690	23310	6.84	65	122	10	6	3	2	2	23
23850	24110	2.22	24	67	16	14	6	4	4	40
23890	24000	0.42	4	9	2^	1^	1^	0^	0^	4^
24090	24320	2.50	3	5	1	1	0	0	0	2
24190	24530	0.72	11	33	3^	1^	1^	0^	0^	5^
24320	24520	1.89	30	84	6^	4^	2^	2^	2^	16^
24810	26350	21.33	44	114	3	2	1	0	0	6
25400	25920	1.43	5	13	5	3	2	1	1	12
26350	26850	0.86	1	6	1	1	1	0	0	3
26350	26850	4.01	4	9	3	2	1	0	0	6
26850	27200	3.39	11	32	5	3	2	1	1	12
27200	27600	5.77	13	30	3	2	1	0	0	6
27600	28170	7.57	11	32	2	1	1	1	1	6
	Cleared	42.5	24	73	1	1	0	0	0	2
Totals					96	61	36	17	17	227

^ adjusted number. Refer to Table 5.

4.2 Types of box required

A total of 227 boxes are required to offset the loss of hollows in areas with few natural hollows (Table 6). RMS requires that the types of boxes used reflect the type of hollow lost (small, large etc.). Based on this RMS requires 96 small boxes, 61 medium boxes, 36 large boxes and 17 extra large boxes. In addition another 17 medium boxes for possums are required to reduce competition between possums and parrots (Table 7).

Table 7 Number of replacement boxes required for each group of fauna.

Size hollow	Species suitable for	Number to be removed	% of total removed	Number of replacement boxes required
Small	small gliders and birds, reptiles, bats	1068	45.5	96
Medium	possums, small parrots, birds large gliders, bats, reptiles	671	28.5	61 plus an additional 17
Large	large parrots (cockatoos) and smaller owls	345	14.8	36
Extra large	large parrots (cockatoos) and large owls	263	11.2	17

The small boxes should be a mixture of vertical bottom opening boxes for microbats and small boxes for gliders (Franks and Franks 2003).

4.3 Design and construction of nest boxes

The boxes should be constructed using timber that is either recycled or plantation timber. Nest boxes made from hollow limbs and trunks of cleared trees (preferably from the site) could also be used if available.

When considering the construction of the boxes the following should be taken into account (Franks and Franks 2003):

- The entrance hole should be no larger than that required for the target species. This will reduce the uptake by unwanted species.
- The entrance hole should generally be positioned toward the top of the nest box so the area remains dark. Boxes for ducks and kookaburras generally have the entrance hole close to the base of the box.
- Rear entrances should be used for gliders and bats to avoid competition from the common myna or other birds.
- Rough sawn timber on the outside of the box will allow animals to grip the exterior of the nest box.
- Furniture such as wood shavings should be added to each box (depending on the target species).
- There should be no sharp edges or exposed screws or nails.
- Shade cloth should be installed in bat boxes to give the bats something to cling to.

- Joins should be sealed with non-toxic glue to reduce drafts.
- All timber should be at least 30 mm thick to protect the inhabitant from heat and cold.
- Ensure that the lid overhangs by at least 25 mm to reduce the entrance of rain.
- Small drain holes should be placed in the box to allow water to drain.
- If the boxes are to be painted on the outside then the paint should be dark coloured water-based paint. The inside should not be painted.
- Deeper boxes should have a toe hold installed in the box to aid young to get out of the box.

To reduce the likelihood that the boxes will be taken by introduced pests such as common myna, European honey bees or ants then the following can be done:

- Rear entrances should be used for gliders and bats to avoid competition from the common myna or other birds.
- Anti pest devices such as buffalo fly ear tags should be installed to deter European honey bee (*Apis mellifera*) in areas where they could become a problem.

Table 8 shows the dimensions of each of the boxes, their recommended installation height and other installation instructions (Franks and Franks 2003, Lewis 2013).

Table 8 Nest box dimensions for each fauna group (Franks and Franks 2003).

Size hollow	Group	Hollow entrance requirement (mm)	Preferred depth (mm)	Inner dimensions (mm)	Placement height (m)	Comments
Small	Small mammals (antechinus, phascogales)	30 50	200-300	150 x 200	2 - 6	Choose location without nearby branches to reduce predation. Consider flap or carpet to reduce draft
Small	Micro-bats	Horizontal slit with bottom opening	400		3 - 5	Wedge shaped
Small	Small gliders	30-45	300	150-250	3 - 6	
Medium	Large gliders	90	400	250 x 250	6 – 10	Rear entry design will reduce uptake by birds, prefers a jagged spout entrance
Medium	Possums	85-100	300	250 x 250	2 – 4	
Large	Small owls	100	500	250 x 300	4 – 6	Prefers a horizontal entrance spout
Extra large	Large owls	200	800	550 x 550	12 - 20	
Large	Large parrots	200	1200	300 x 400	8 – 10	
Medium	Small parrots	55-100	400	200 x 200	5 -8	

5 Distribution and position of nest boxes

When choosing the final location for individual nest boxes, the following needs to be considered:

- Number of large trees over 30 cm DBH (larger trees are needed to support the weight of a box).
- Number of tree hollows identified for removal in the adjacent site.
- The number of hollows already occurring in the proposed offset site.
- The suitability of hollows in the proposed offset site.
- Availability and suitability of other resources such as food and water.
- Habitat connectivity for the proposed offset site.
- Tenure of the land and resident agreements.
- The location of other fauna mitigation devices (i.e. fauna underpasses and rope crossing).

The distribution of nest boxes within the selected sites should take into account the target species behaviours. For example, brush-tailed possums can be territorial and require a home range from 0.2 – 4 ha in size. Spacing boxes for this species greater than this distance would reduce inter-specific competition.

Nest boxes should be positioned in the trees in such a way as to:

- Reduce artificial light entering the box (from street lights etc.).
- Protect the entrance from rain and wind by facing the entrance away from the predominant winds and rain.
- Ensure that the target species can get access to the entrance e.g. birds like a perch near the box.
- Reduce the impacts to the trees growth.

The preferred hollow heights for each species (or group of species) are listed in Appendix 1. Ideally the boxes would be installed as high as possible in the tree to reduce predation. However, installation, monitoring and maintenance needs to undertaken safely so placing the boxes at the minimum height for the target species would be sufficient.

6 Nest box offset properties

Seven lot/plans were identified adjacent to areas requiring nest box offsets (Map 4: Appendix 2). Of these seven lots, three land owners were identified, including the Forestry Corporation of New South Wales. The land owners of these lots were contacted and permission was sought to install nest boxes within 20 m of the proposed road. Of these properties, all land owners have verbally agreed to nest box installation, with signed agreements currently in the process of being finalised. A memorandum of understanding (MoU) is being developed between RMS and the Forestry Corporation of NSW to allow the installation of nest boxes in both Glenugie State Forest and the Wells Crossing Naure Reserve.

The nest box locations and numbers of nest boxes per location (Map 4) are indicative only and nest boxes can be installed adjacent to these areas. As part of installation, no extra large nest boxes (suitable for owls) should be installed within 300 m of the planned rope bridge crossing location. The presence of owls may discourage native prey fauna from using the rope crossing.

Table 9 Properties proposed for nest box installation, the number of boxes to be installed and whether the properties were approved.

Chainage from	Chainage to	Vegetation to be removed (ha)	Total number of nest boxes required*	No. of small boxes required	No. of medium boxes required *	No. of large boxes required	No. of extra large boxes required	Offset site no	Proposed offset site LOT	Proposed offset site PLAN	Tenure	Approval	Notes
16990	17410	2.86	3	1	1	1	0	4	13	DP879175	Private	Verbal approval	Written approval has been requested.
17570	18000	2.48	8	3	3	1	1	5	13	DP879175	Private	Verbal approval	Written approval has been requested.
17960	18260	1.24	12	5	4	2	1	3	2	DP558503	Private	Verbal approval	Written approval has been requested.
18680	18720	0.34	3	1^	1^	1^	0^	6	13	DP879175	Private	Verbal approval	Written approval has been requested.
19190	19290	0.28	4	2	1	1	0	2	13	DP879175	Private	Verbal approval	Suggested offset location contains Government Creek Reserve.
20300	20370	0.48	14	6	5	2	1	1	119	DP751368	Private	Verbal approval	Suggested site contains only sparse vegetation; consider distributing boxes in the northern corner of the same Lot Plan.
20700	20830	1.23	22	9	8	3	2	18	7300	DP1144709	State Forest	Pending MoU	
22310	22450	1.19	18	8	6	3	1	17	111	DP751368	State Forest	Pending MoU	
22690	23310	6.84	23	10	8	3	2	16	111	DP751368	State Forest	Pending MoU	
23850	24110	2.22	40	16	14	6	4	14	111	DP751368	State Forest	Pending MoU	Spread boxes south.
23890	24000	0.42	4	2^	1^	1^	0	15	111	DP751368	State Forest	Pending MoU	
24090	24320	2.5	2	1	1	0	0	12#	111	DP751368	State Forest	Pending MoU	Do not place extra large box within 300 m of proposed rope bridge.
24190	24530	0.72	5	3^	1^	1^	0^	21	105	DP751380	State Forest	Pending MoU	
24320	24520	1.89	16	6^	6^	2^	2^	13#	111	DP751368	State Forest	Pending	

Chainage from	Chainage to	Vegetation to be removed (ha)	Total number of nest boxes required*	No. of small boxes required	No. of medium boxes required *	No. of large boxes required	No. of extra large boxes required	Offset site no	Proposed offset site LOT	Proposed offset site PLAN	Tenure	Approval	Notes
												MoU	
24810	26350	21.33	6	3	2	1	0	11	55	DP751358	State Forest	Pending MoU	
25400	25920	1.43	12	5	4	2	1	20	105	DP751380	State Forest	Pending MoU	
26350	26850	4.01	3	1	1	1	0	10	20	DP1123940	State Forest	Pending MoU	
26350	26850	0.86	6	3	2	1	0	19	105	DP751380	State Forest	Pending MoU	
26850	27200	3.39	12	5	4	2	1	9	20	DP1123940	State Forest	Pending MoU	
27200	27600	5.77	6	3	2	1	0	8	74	DP751380	State Forest	Pending MoU	
27600	28170	7.57	6	2	2	1	1	7	74	DP751380	State Forest	Pending MoU	Offset site split across the road. Distribute boxes across both sites.
	Cleared	42.5	2	1	1	0	0						

proposed nest box areas are adjacent to each other. Nest boxes should be placed across these two areas.

*including additional possum boxes (refer to table 6). ^ adjusted number. Refer to Table 5.

7 Nest box management and maintenance

Nest boxes require ongoing maintenance and monitoring to ensure that their ecological function is preserved.

7.1 Installation

The contractor should install 70% of the nest boxes prior to clearing to alleviate the impacts to hollow dependent fauna from clearing. It can take several months (sometimes several years) (Franks and Franks 2003) for fauna to start using nest boxes so it is recommended that the first group of nest boxes be installed at least two months before clearing begins.

The contractor should install the remaining 30% of the nest boxes after the actual number of hollows cleared has been determined. An ecologist should be on hand during clearing to count each hollow so that adjustments to the number of nest boxes can be made, if necessary. No owl boxes should be installed in proximity to fauna crossing structures, in order to avoid facilitating predation of animals using the crossings.

7.2 Monitoring and maintenance

Nest boxes should be monitored after installation to assess their use by fauna and to determine any maintenance requirements. Each nest box installed should be numbered and its location recorded with a GPS so that each box can be monitored. Monitoring reports for each box should include:

- Nest box number.
- Inspection date and time.
- Species of fauna currently occupying the box (if any).
- Species possibly using the box based on signs (scats or scratches).
- Presence of any pest species (bees, ants, mynas).
- Any maintenance issues such as cracked timber, faulty lid, tight wire etc.
- Follow up maintenance requirements.
- Any other notes about changes in environment.

The recommended timing and frequency of maintenance and monitoring is shown in Table 10.

Table 10 Monitoring and maintenance schedule for nest box management

Management action	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Responsibility	Documentation requirements
Pre-construction										
Implement nest box management plan	✓								RMS	Construction environmental management plan
Construction										
Commission Construction of nest boxes	✓								RMS	Nest Box Procurement & Site Establishment Strategy
Installation of 70% nest boxes – pre-clearing	✓								Contractor	G36 & Construction environmental management plan
Installation of the remaining 30% of nest boxes - post clearing		✓							Contractor	G36 & Construction environmental management plan
Monitoring										
Summer and winter			✓	✓		✓		✓	RMS	Yearly report
Maintenance										
Maintenance of boxes			✓	✓		✓		✓	Post construction RMS	
Pre-handover inspection								✓	RMS	Nest box final report

Maintenance should be undertaken on any dysfunctional or damaged boxes. Some factors that should be considered for maintenance include (Lewis 2013):

- Presence of exotic pests species such as common mynas, common starling and European bees. These species may need to be removed.
- Replacement of fallen, damaged or degraded nest boxes.
- Repositioning or relocation of dysfunctional nest boxes.
- Checking each box is not holding water or leaking.
- Removing excess nesting material as this may impede access over time.

7.3 Performance measures

The effectiveness of the nest box program should be assessed against the performance criteria listed in Table 11.

Table 11 Performance objectives and criteria for assessing the effectiveness of the nesting box program.

Performance objective	Performance criteria	Contingency measures
Utilization of the nest boxes by a range of native fauna species	At least 50% of the nest boxes being used by a variety of native fauna.	Investigate nest box numbers, type and locations to determine the possible cause of low uptakes.
Species-specific boxes being used by the target species e.g. boxes for glossy black-cockatoos being used by glossy black-cockatoos	At least 50% of the species-specific boxes being utilized by the target species.	Consider location of the nest boxes; consider moving species-specific boxes to other suitable habitat areas.
Minimise the number of boxes being utilized by pest species e.g. bees, common myna	Less than 5% of the boxes being utilized by pest fauna.	Consider installing deterrents to deter pests e.g. buffalo fly ear tag to discourage bees. Consider box design to discourage mynas.
Minimise maintenance costs	Less than 5% of the boxes requiring maintenance, removal or disposal.	Ensure all boxes are installed correctly and in the right location. Talk to manufacturer about maintenance issues.

References

DEC 2004, *Natural Resource Management Advisory Series Note 1: Trees with Hollows*, Department of Environment and Conservation, <http://www.environment.nsw.gov.au/resources/nature/landholderNotes01TreeHollows.pdf>

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Lewis, BD 2013. *Warrell Creek to Urunga: Nest Box Plan*. An unpublished report for Roads and Maritime Services.

OEH 2013, *List of key threatening processes*. <http://www.environment.nsw.gov.au/threatenedspecies/KeyThreateningProcessesByDoctype.htm>. Accessed 9 September 2014.

RMS 2013a. Woolgoolga to Ballina Pacific Highway Upgrade- Environmental Impact Statement Volume 1A: Biodiversity. Roads and Maritime Services. Sydney.

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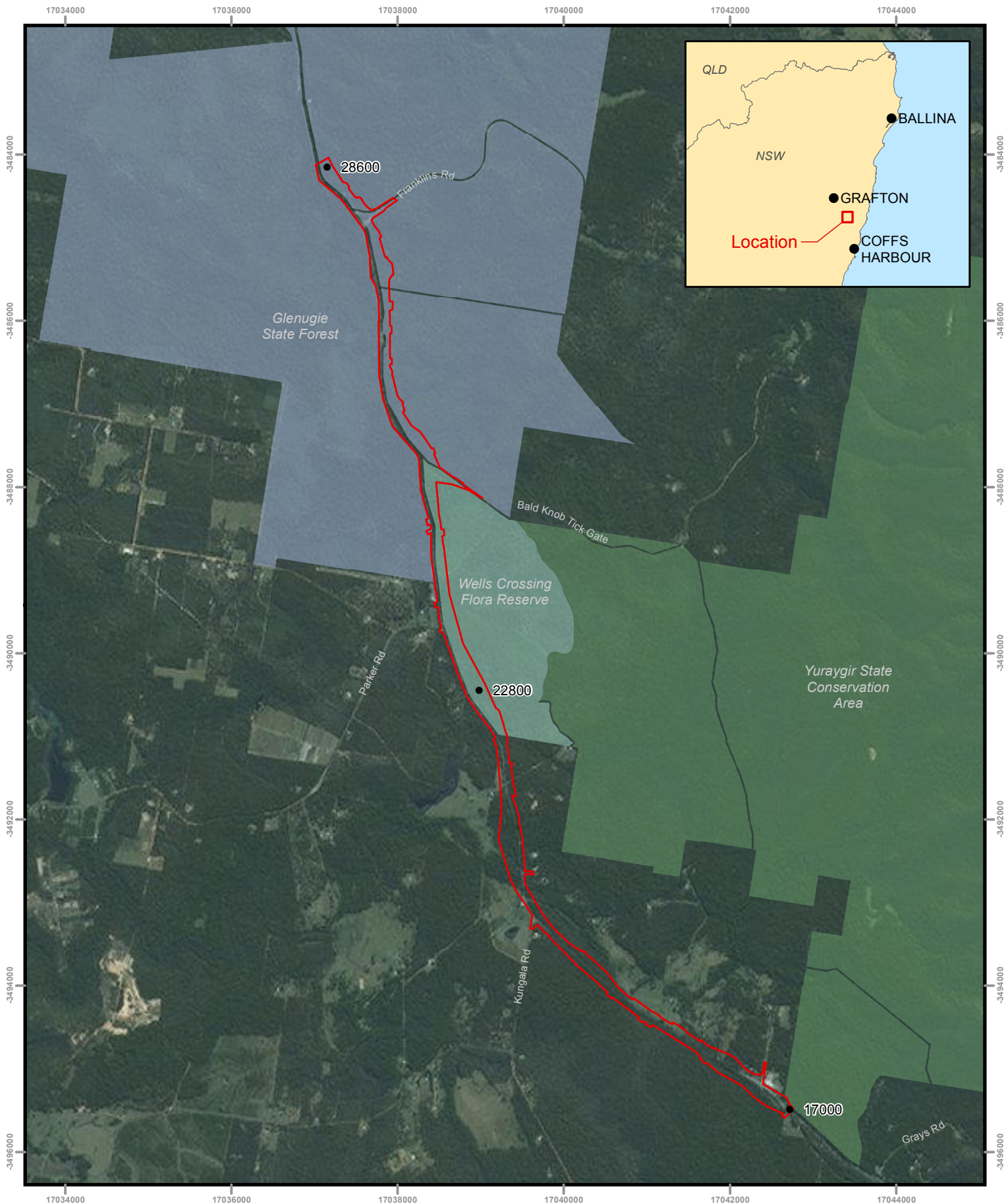
Appendix 1 Species potentially in the site which use hollows and their hollow requirements (if known)

Species name	Common name	TSC status	EPBC status	Preferred height (m)	Hollow entrance size (mm)	Depth (mm)	Other notes
AMPHIBIANS							
<i>Litoria caerulea</i>	Green tree frog						No specific requirements
REPTILES							
<i>Oedura robusta</i>	Robust velvet gecko						No specific requirements
<i>Saltuarius swaini</i>	Southern leaf-tailed gecko						No specific requirements
<i>Varanus gouldii</i>	Gould's goanna						No specific requirements
<i>Varanus varius</i>	Lace monitor						No specific requirements
<i>Morelia spilota</i>	Carpet & diamond pythons						No specific requirements
<i>Boiga irregularis</i>	Brown tree snake						No specific requirements
<i>Dendrelaphis punctulatus</i>	Common tree snake						No specific requirements
<i>Hoplocephalus stephensii</i>	Stephens' banded snake	V					No specific requirements
BIRDS							
<i>Chenonetta jubata</i>	Australian wood duck			3		400	prefers entrance hole close to base so young can climb out
<i>Aegotheles cristatus</i>	Australian owl-nightjar			0.2-30	70-250	200-3500	
<i>Cacatua galerita</i>	Sulphur-crested cockatoo			1-35	220	200-1800	
<i>Calyptorhynchus funereus</i>	Yellow-tailed black-cockatoo			5-56	460	600-2400	prefers older trees
<i>Calyptorhynchus lathami</i>	Glossy black-cockatoo	V		5-28	210	400-1200	
<i>Eolophus roseicapillus</i>	Galah			1-19	250	200-1800	
<i>Alisterus scapularis</i>	Australian king-parrot			6-25	600	50-18000	
<i>Glossopsitta concinna</i>	Musk lorikeet			3-8	40	500	
<i>Glossopsitta pusilla</i>	Little lorikeet	V		6-18	29-32	180-500	

Species name	Common name	TSC status	EPBC status	Preferred height (m)	Hollow entrance size (mm)	Depth (mm)	Other notes
<i>Lathamus discolor</i>	Swift parrot	E1	E				no measurements known, presumable similar to Rainbow Lorikeet
<i>Platycercus elegans</i>	Crimson rosella			1-30	6-410	180-2440	
<i>Platycercus eximius</i>	Eastern rosella			1-30	6-410	180-2440	
<i>Trichoglossus chlorolepidotus</i>	Scaly-breasted lorikeet			3-20	50-150	200-1980	prefers smooth bark or dead tree
<i>Trichoglossus haematodus</i>	Rainbow lorikeet			3-30	220	300-600	
<i>Ninox connivens</i>	Barking owl	V		3-30	200-300	300-2500	based on boobook numbers
<i>Ninox novaeseelandiae</i>	Southern boobook			3-30	200-300	300-2500	
<i>Ninox strenua</i>	Powerful owl	V		12-45	450-750	2000	
<i>Tyto javanica</i>	Eastern barn owl			0-20	200-250	600-2000	
<i>Tyto novaehollandiae</i>	Masked owl	V		10-30	450-550	400-5000	
<i>Tyto tenebricosa</i>	Sooty owl	V		16-30		400-3000	
<i>Dacelo novaeguineae</i>	Laughing kookaburra			2-60	80-400	200-1500	
<i>Todiramphus macleayii</i>	Forest kingfisher			0.5-35			based on sacred
<i>Todiramphus sanctus</i>	Sacred kingfisher			0.5-35			
<i>Eurystomus orientalis</i>	Dollarbird			6-35			
<i>Climacteris erythroptis</i>	Red-browed reecreeper			4-5			based on white-throated treecreeper
<i>Climacteris picumnus victoriae</i>	Brown treecreeper (eastern subspecies)	V		4-5			based on white-throated treecreeper
<i>Cormobates leucophaea</i>	White-throated treecreeper			4-5			
<i>Pardalotus punctatus</i>	Spotted pardalote						
<i>Pardalotus striatus</i>	Striated pardalote						
MAMMALS							
<i>Antechinus flavipes</i>	Yellow-footed antechinus						
<i>Dasyurus maculatus</i>	Spotted-tailed quoll	V	E				

Species name	Common name	TSC status	EPBC status	Preferred height (m)	Hollow entrance size (mm)	Depth (mm)	Other notes
<i>Phascogale tapoatafa</i>	Brush-tailed phascogale	V					
<i>Petaurus australis</i>	Yellow-bellied glider	V		44	110-140	1300	
<i>Petaurus breviceps</i>	Sugar glider			8-31	35-50	60-700	
<i>Petaurus norfolcensis</i>	Squirrel glider	V		8-31	35-50	60-700	based on sugar glider
<i>Petauroides volans</i>	Greater glider			11	180		
<i>Pseudocheirus peregrinus</i>	Common ringtail possum			4	66-80	>200	
<i>Acrobates pygmaeus</i>	Feather-tail glider			25	120	920	
<i>Trichosurus caninus</i>	Short-eared possum			6	>100	90-120	
<i>Trichosurus vulpecula</i>	Common brush-tail possum			6	>100	90-120	
<i>Mormopterus norfolkensis</i>	Eastern freetail-bat	V					No specific requirements
<i>Tadarida australis</i>	White-striped freetail-bat						No specific requirements
<i>Chalinolobus gouldii</i>	Gould's wattled bat						No specific requirements
<i>Chalinolobus morio</i>	Chocolate wattled bat						No specific requirements
<i>Chalinolobus nigrogriseus</i>	Hoary wattled bat	V					No specific requirements
<i>Falsistrellus tasmaniensis</i>	Eastern false pipistrelle	V					No specific requirements
<i>Miniopterus australis</i>	Little bentwing-bat	V					No specific requirements
<i>Nyctophilus geoffroyi</i>	Lesser long-eared bat						No specific requirements
<i>Nyctophilus gouldi</i>	Gould's long-eared bat						No specific requirements
<i>Scoteanax rueppellii</i>	Greater broad-nosed bat	V					No specific requirements
<i>Scotorepens orion</i>	Eastern broad-nosed bat						No specific requirements
<i>Vespadelus darlingtoni</i>	Large Fforest bat						No specific requirements
<i>Vespadelus pumilus</i>	Eastern forest bat						No specific requirements
<i>Vespadelus vulturnus</i>	Little forest bat						No specific requirements

Appendix 2 Maps



Project: GE311_MP_NB_001_NB_Location

Job Number: GE311

Approved	Project Manager	CF	14/07/2014
REV	BY	CHK	DESCRIPTION
R0	MD	CF	ISSUED TO CLIENT
			14/07/2014
			DATE

Scale: 1:60,000 when printed at A4

Coordinate System:
GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

Project boundary

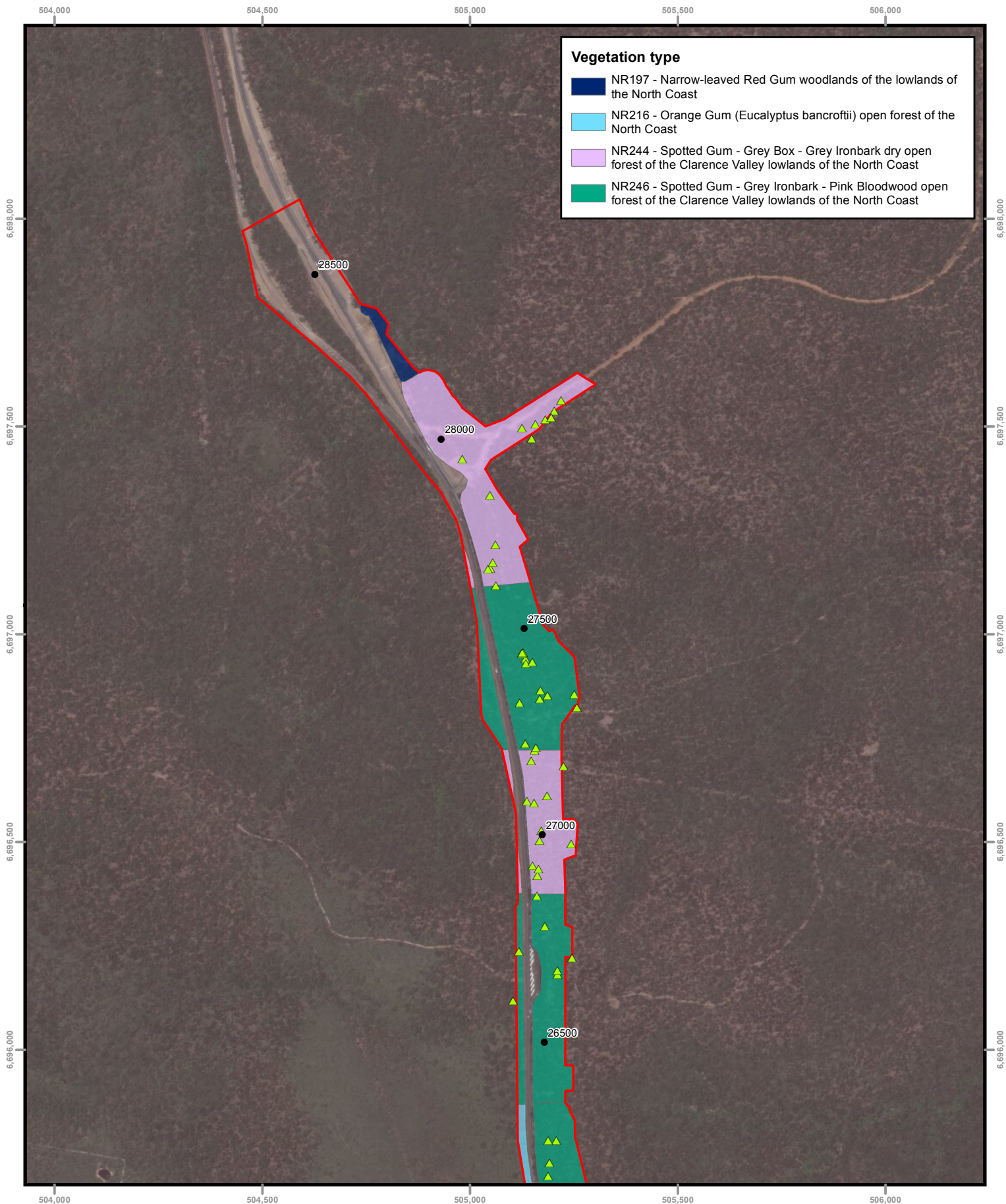
Data Sources:
- NSW Roads and Maritime Services, 2013
- NSW Parks and Wildlife Services
- Forestry Corporation of NSW
- © Copyright Commonwealth of Australia (Geoscience Australia) 2014. The Commonwealth gives no warranty regarding the accuracy, completeness, currency or suitability for any particular purpose.
- © Ecosure Pty Ltd, 2014
- Aerial image: DigitalGlobe, 2011

Map 1: Project area and location

Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Vegetation type

- NR197 - Narrow-leaved Red Gum woodlands of the lowlands of the North Coast
- NR216 - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR244 - Spotted Gum - Grey Box - Grey Ironbark dry open forest of the Clarence Valley lowlands of the North Coast
- NR246 - Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast

GE311_MP_NB_002_HollowTrees_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE

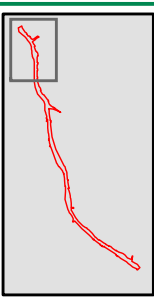
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Coordinate System:
GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

Hollow-bearing tree

Project boundary (18/10/2013)

Data Sources:
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- Aerial image: DigitalGlobe, 2011

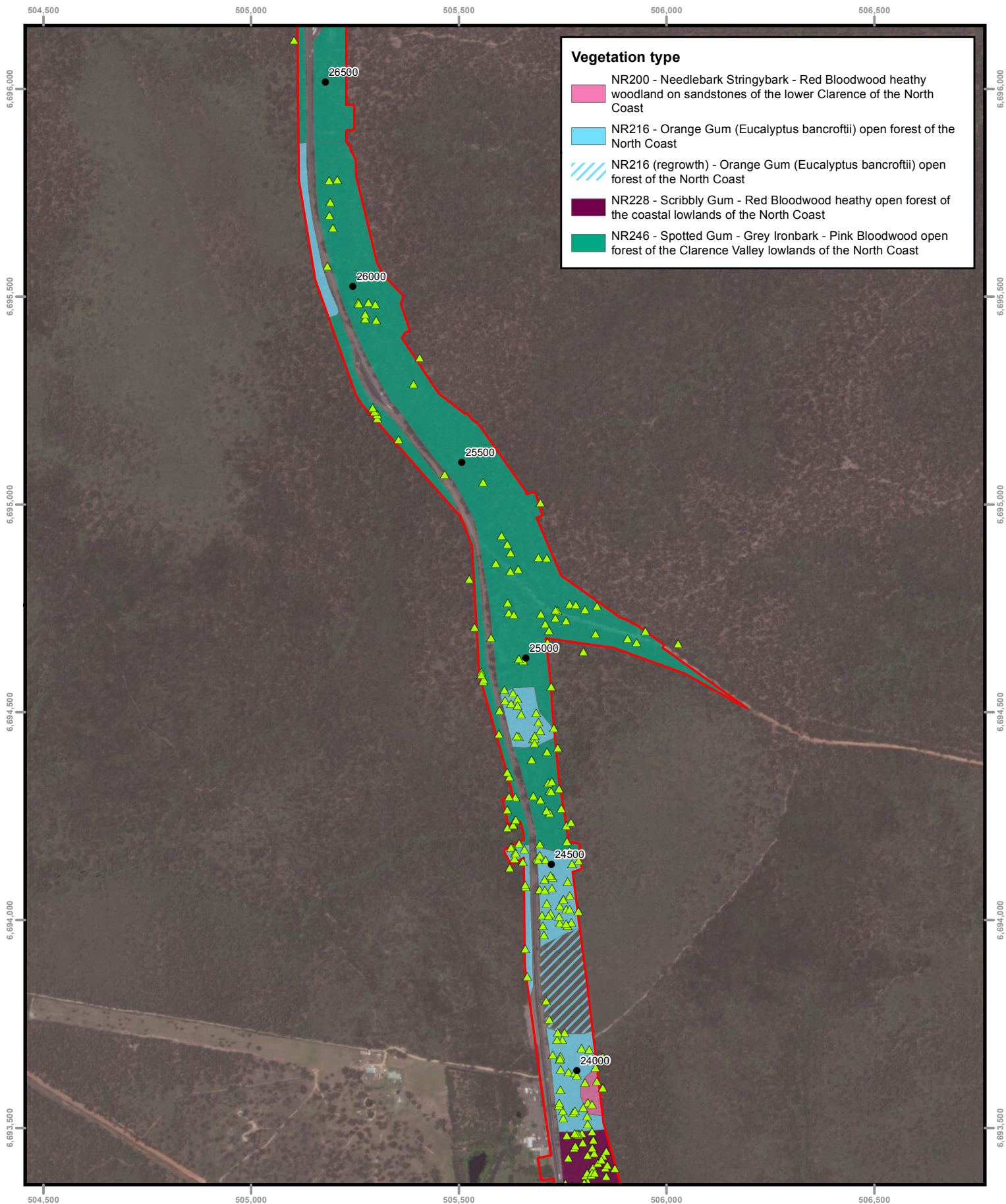


Map 2 (a): Locations of hollow-bearing trees

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Vegetation type

- NR200 - Needlebark Stringybark - Red Bloodwood heathy woodland on sandstones of the lower Clarence of the North Coast
- NR216 - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR216 (regrowth) - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR228 - Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast
- NR246 - Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast

GE311_MP_NB_002_HollowTrees_R2

Job Number: **GE311v3**

Approved Project Manager	CF	11/07/2014
R2	MD DB	ISSUED 11/07/2014
R1	MD DB	ISSUED 12/06/2014
R0	MD DB	ISSUED 29/05/2014
REV	BY	CHK DESCRIPTION DATE

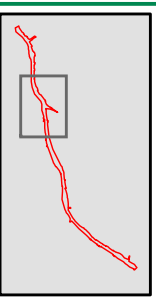
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Coordinate System:
GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

▲ Hollow-bearing tree

Project boundary (18/10/2013)

Data Sources:
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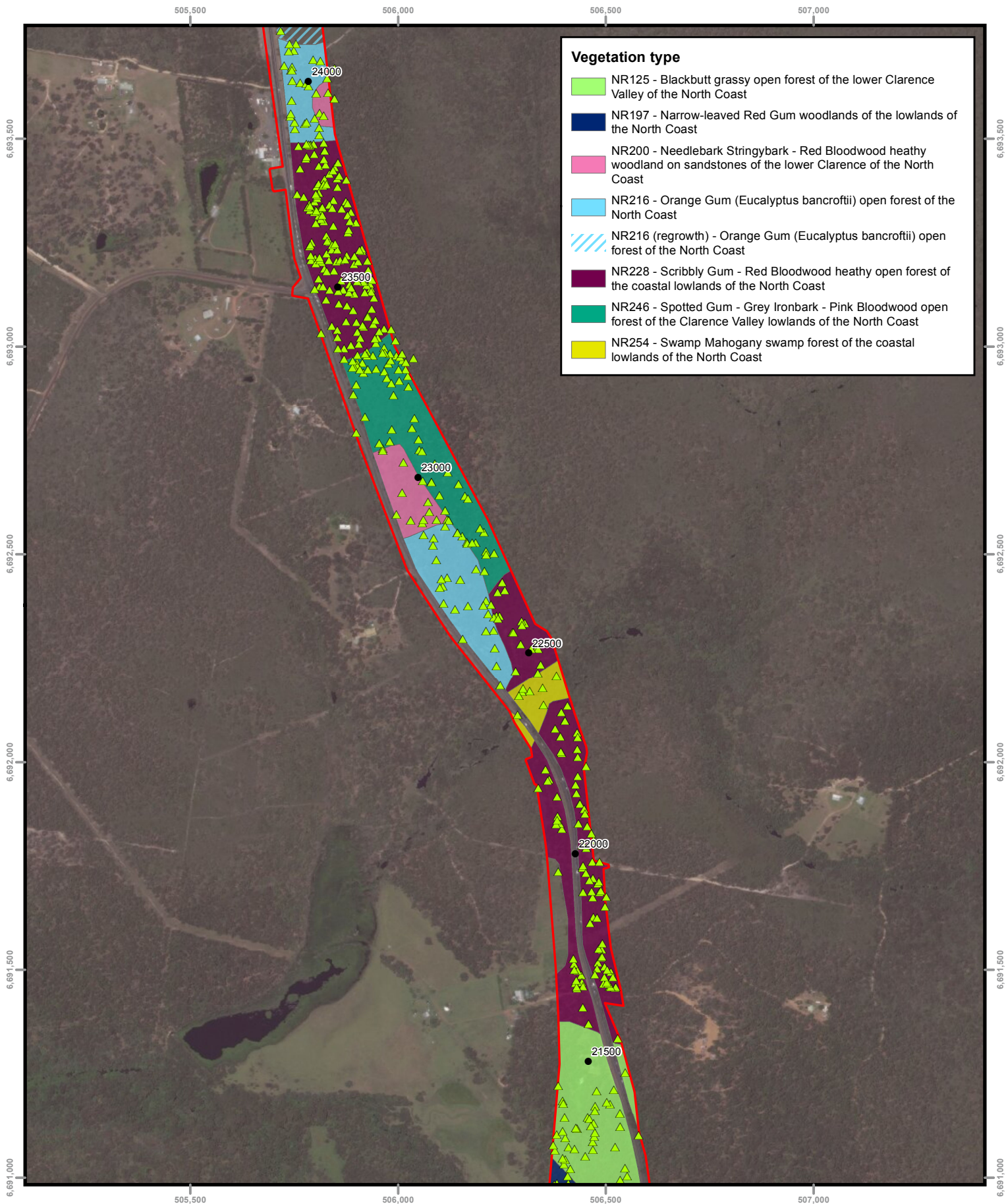


Map 2 (b): Locations of hollow-bearing trees

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Vegetation type

- NR125 - Blackbutt grassy open forest of the lower Clarence Valley of the North Coast
- NR197 - Narrow-leaved Red Gum woodlands of the lowlands of the North Coast
- NR200 - Needlebark Stringybark - Red Bloodwood heathy woodland on sandstones of the lower Clarence of the North Coast
- NR216 - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR216 (regrowth) - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR228 - Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast
- NR246 - Spotted Gum - Grey Ironbark - Pink Bloodwood open forest of the Clarence Valley lowlands of the North Coast
- NR254 - Swamp Mahogany swamp forest of the coastal lowlands of the North Coast

GE311_MP_NB_002_HollowTrees_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE

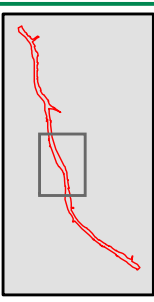
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Coordinate System:
GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

Hollow-bearing tree

Project boundary (18/10/2013)

Data Sources:
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- Aerial image: DigitalGlobe, 2011

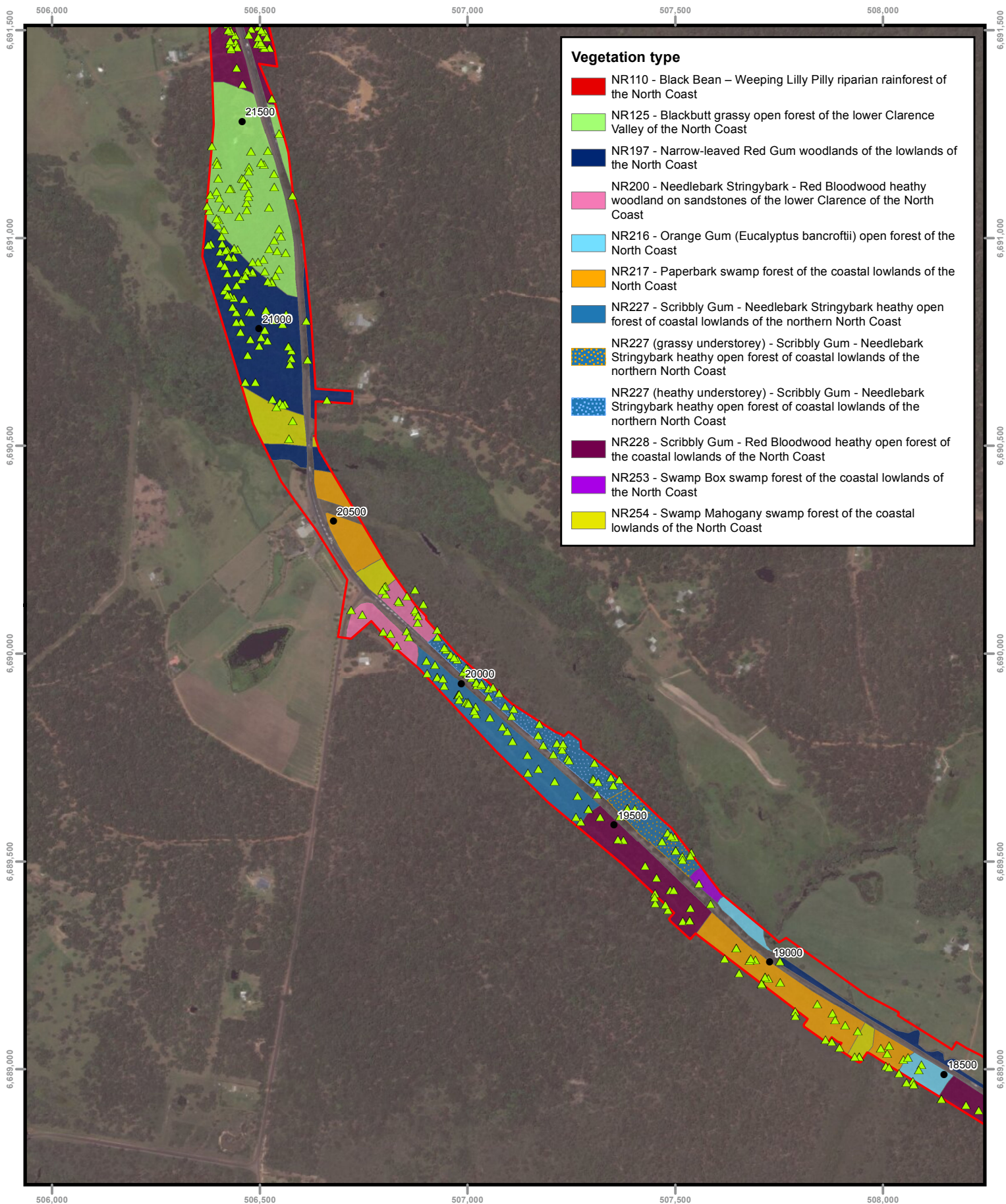


Map 2 (c): Locations of hollow-bearing trees

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



GE311_MP_NB_002_HollowTrees_R2

Job Number: **GE311v3**

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE

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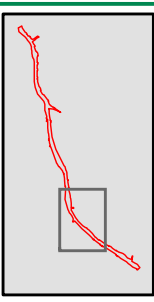
Coordinate System: GDA 1994 MGA Zone 56
 Projection: Transverse Mercator
 Datum: GDA 1994
 Units: Metre

▲ Hollow-bearing tree

▭ Project boundary (18/10/2013)

Data Sources:

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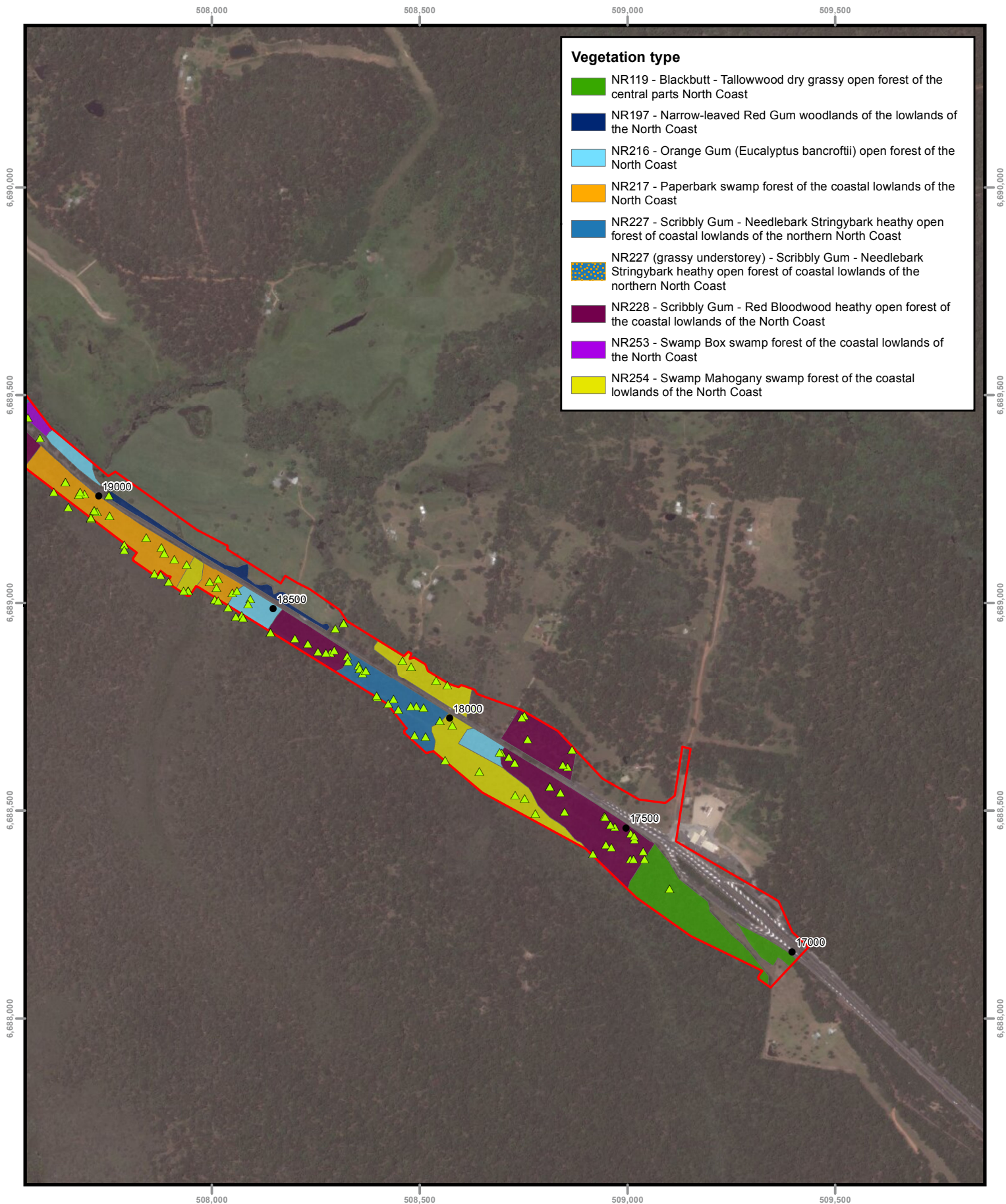


Map 2 (d): Locations of hollow-bearing trees

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Vegetation type

- NR119 - Blackbutt - Tallowood dry grassy open forest of the central parts North Coast
- NR197 - Narrow-leaved Red Gum woodlands of the lowlands of the North Coast
- NR216 - Orange Gum (Eucalyptus bancroftii) open forest of the North Coast
- NR217 - Paperbark swamp forest of the coastal lowlands of the North Coast
- NR227 - Scribbly Gum - Needlebark Stringybark heathy open forest of coastal lowlands of the northern North Coast
- NR227 (grassy understorey) - Scribbly Gum - Needlebark Stringybark heathy open forest of coastal lowlands of the northern North Coast
- NR228 - Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast
- NR253 - Swamp Box swamp forest of the coastal lowlands of the North Coast
- NR254 - Swamp Mahogany swamp forest of the coastal lowlands of the North Coast

GE311_MP_NB_002_HollowTrees_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE

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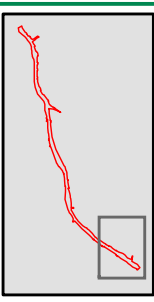
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GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

▲ Hollow-bearing tree

Project boundary (18/10/2013)

Data Sources:

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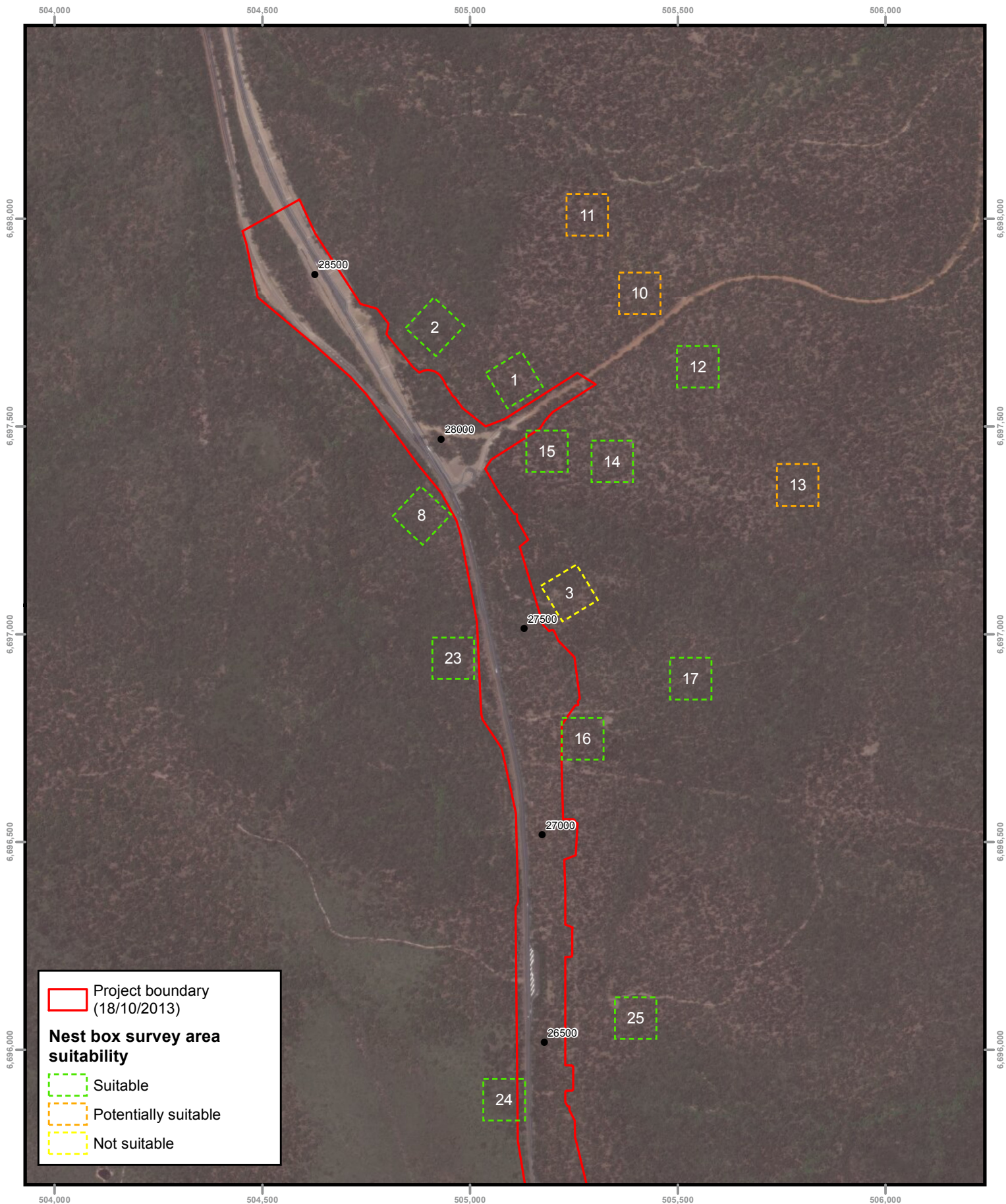


Map 2 (e): Locations of hollow-bearing trees

NSW Roads and Maritime Services

Nest box management plan


Glenugie to Halfway Creek, NSW



Project boundary
(18/10/2013)

Nest box survey area suitability


- Suitable
- Potentially suitable
- Not suitable



GE311_MP_NB_003_PotNestBoxLocations_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE



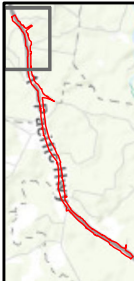
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Metres

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Coordinate System:
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Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

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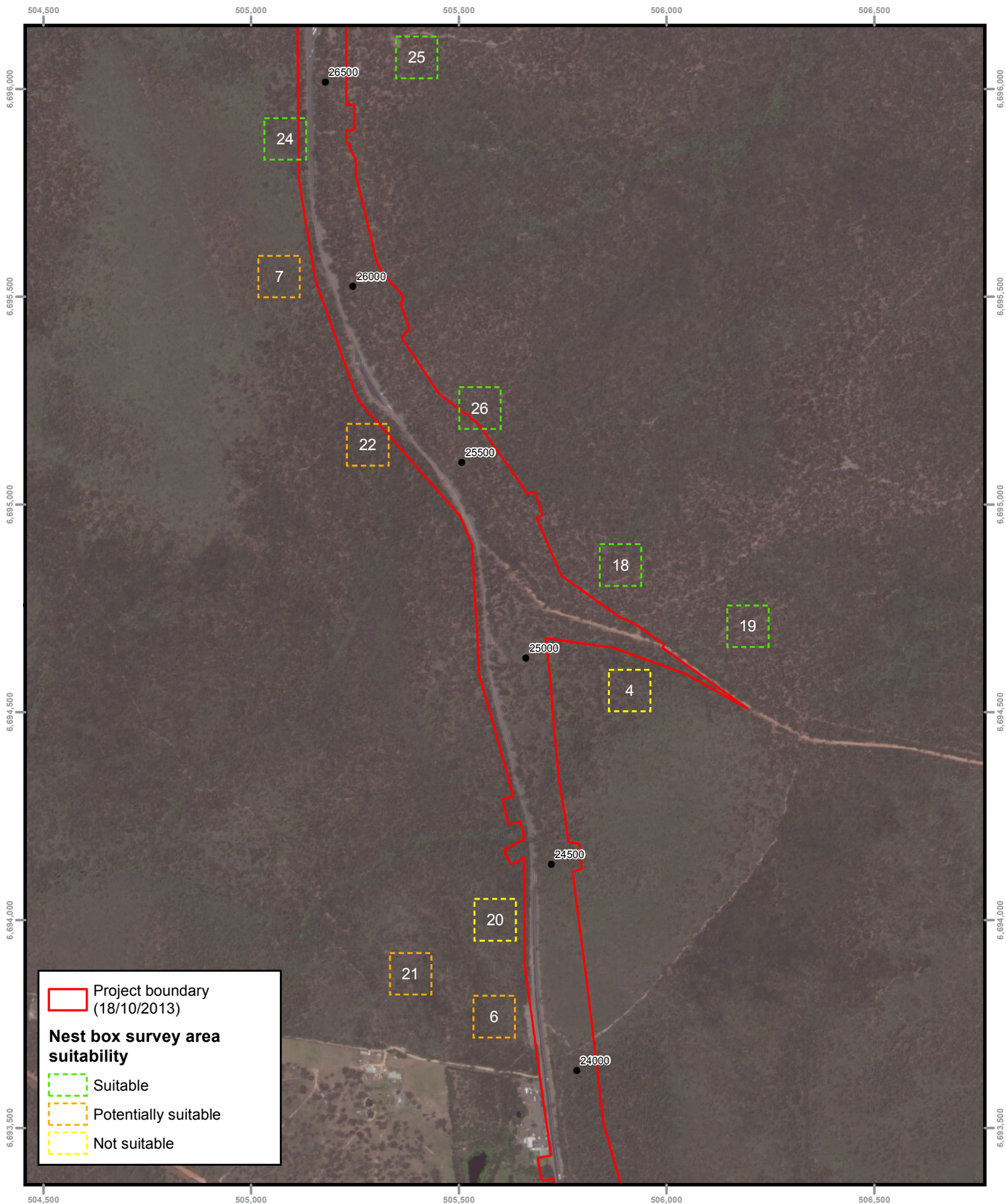


Map 3 (a): Survey locations of potential nest box areas

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Project boundary
(18/10/2013)

Nest box survey area suitability

- Suitable
- Potentially suitable
- Not suitable

GE311_MP_NB_003_PotNestBoxLocations_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014		
R2	MD DB	ISSUED 11/07/2014		
R1	MD DB	ISSUED 12/06/2014		
R0	MD DB	ISSUED 29/05/2014		
REV	BY	CHK	DESCRIPTION	DATE

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Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

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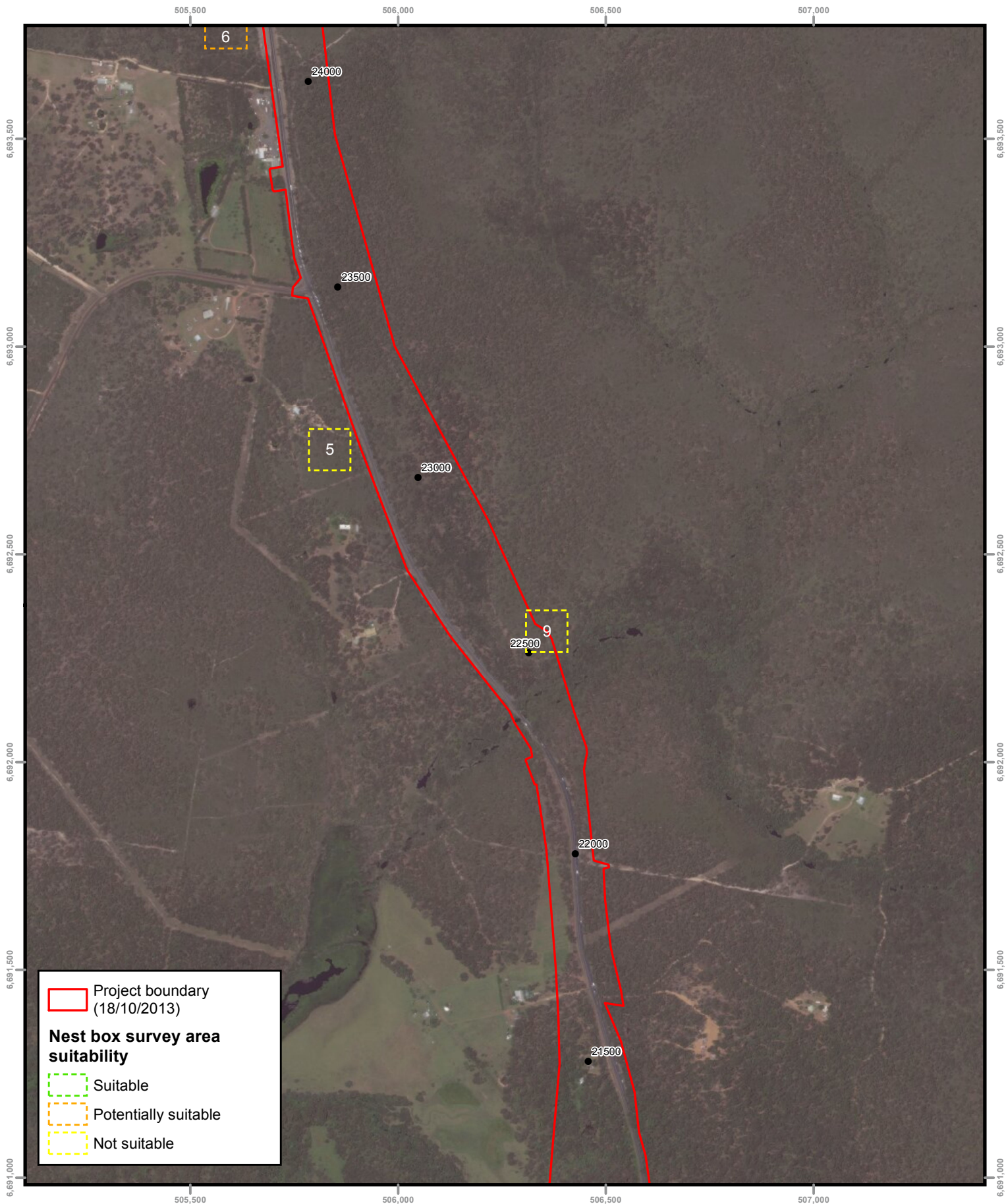
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Map 3 (b): Survey locations of potential nest box areas

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Project boundary (18/10/2013)

Nest box survey area suitability

- Suitable
- Potentially suitable
- Not suitable

Job Number: GE311v3			
Approved Project Manager	CF	11/07/2014	
R2	MD	DB	ISSUED 11/07/2014
R1	MD	DB	ISSUED 12/06/2014
R0	MD	DB	ISSUED 29/05/2014
REV	BY	CHK	DESCRIPTION DATE

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 Projection: Transverse Mercator
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 Units: Metre

Data Sources:

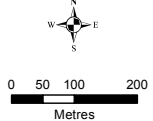
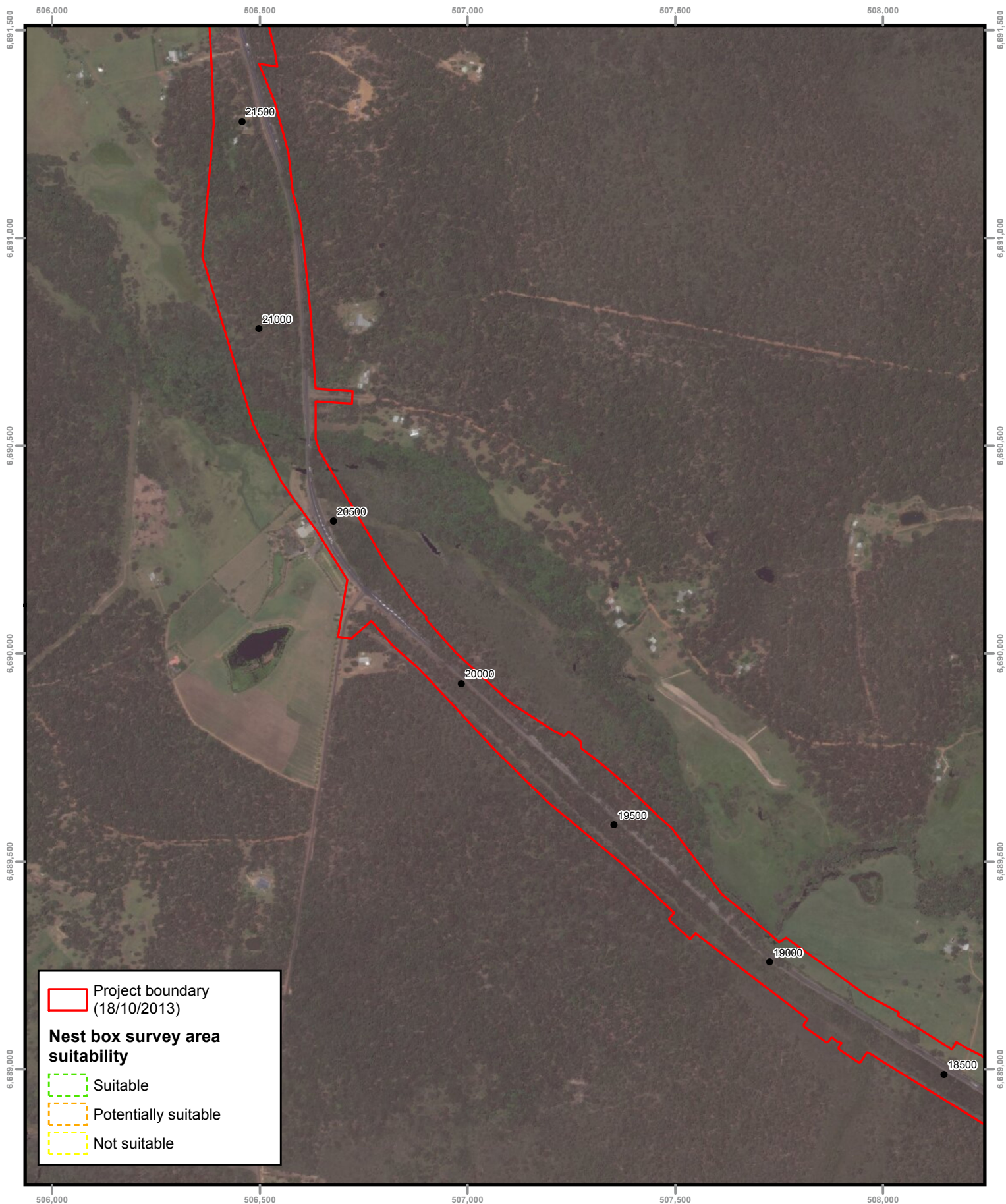
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- Aerial image: DigitalGlobe, 2011

Map 3 (c): Survey locations of potential nest box areas

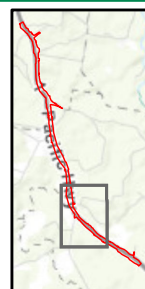
NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



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Map 3 (d): Survey locations of potential nest box areas

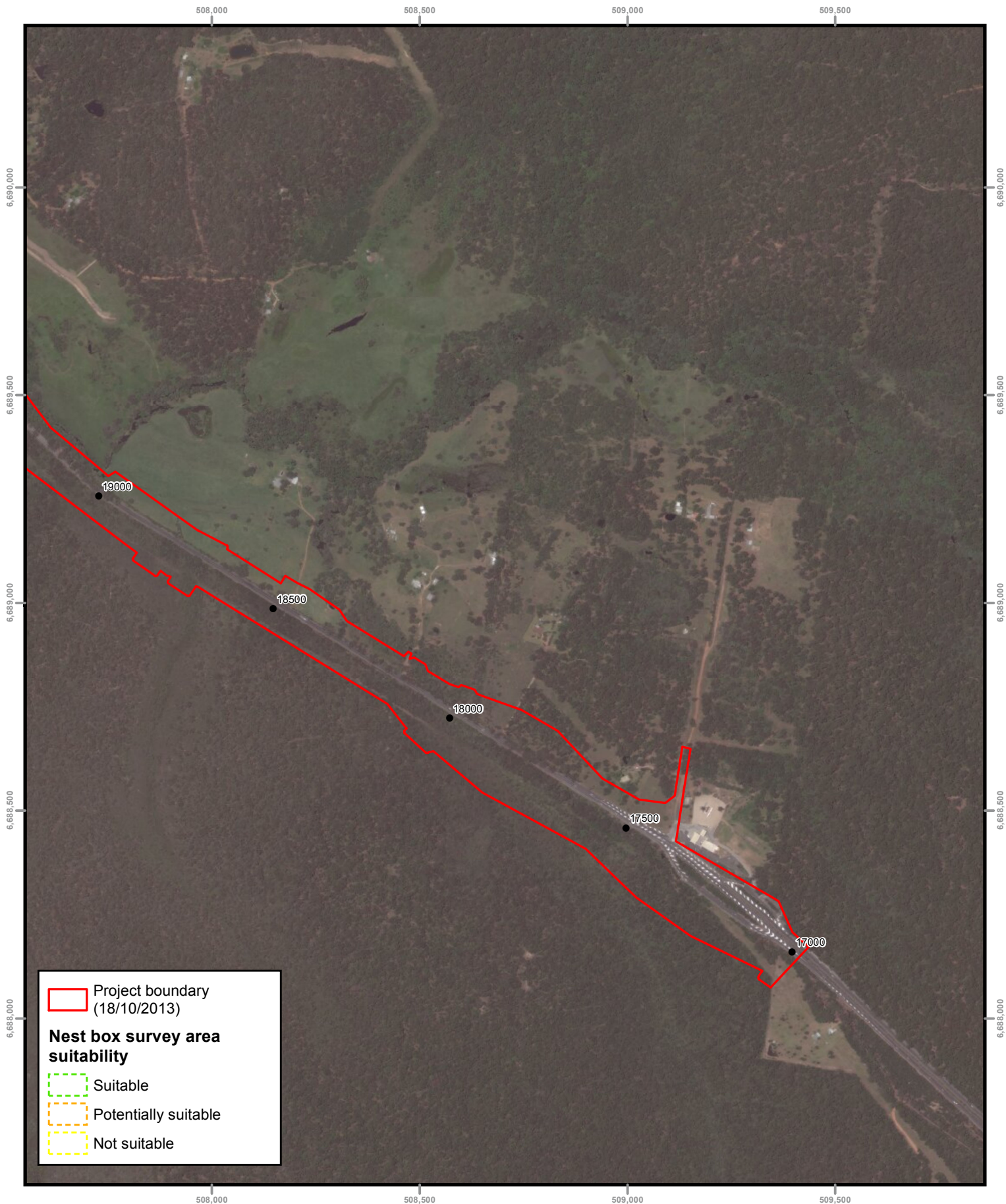
NSW Roads and Maritime Services
Nest box management plan
Glenugie to Halfway Creek, NSW

Job Number: GE311v3

REV	BY	CHK	DESCRIPTION	DATE
R2	MD	DB	ISSUED	11/07/2014
R1	MD	DB	ISSUED	12/06/2014
R0	MD	DB	ISSUED	29/05/2014

Scale: 1:12,000 when printed at A4

Coordinate System:
 GDA 1994 MGA Zone 56
 Projection: Transverse Mercator
 Datum: GDA 1994
 Units: Metre



Project boundary (18/10/2013)

Nest box survey area suitability

- Suitable
- Potentially suitable
- Not suitable

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GE311_MP_NB_003_PotNestBoxLocations_R2

Job Number: GE311v3

Approved Project Manager	CF	11/07/2014
R2	MD DB	ISSUED 11/07/2014
R1	MD DB	ISSUED 12/06/2014
R0	MD DB	ISSUED 29/05/2014
REV	BY	CHK DESCRIPTION DATE

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Projection: Transverse Mercator
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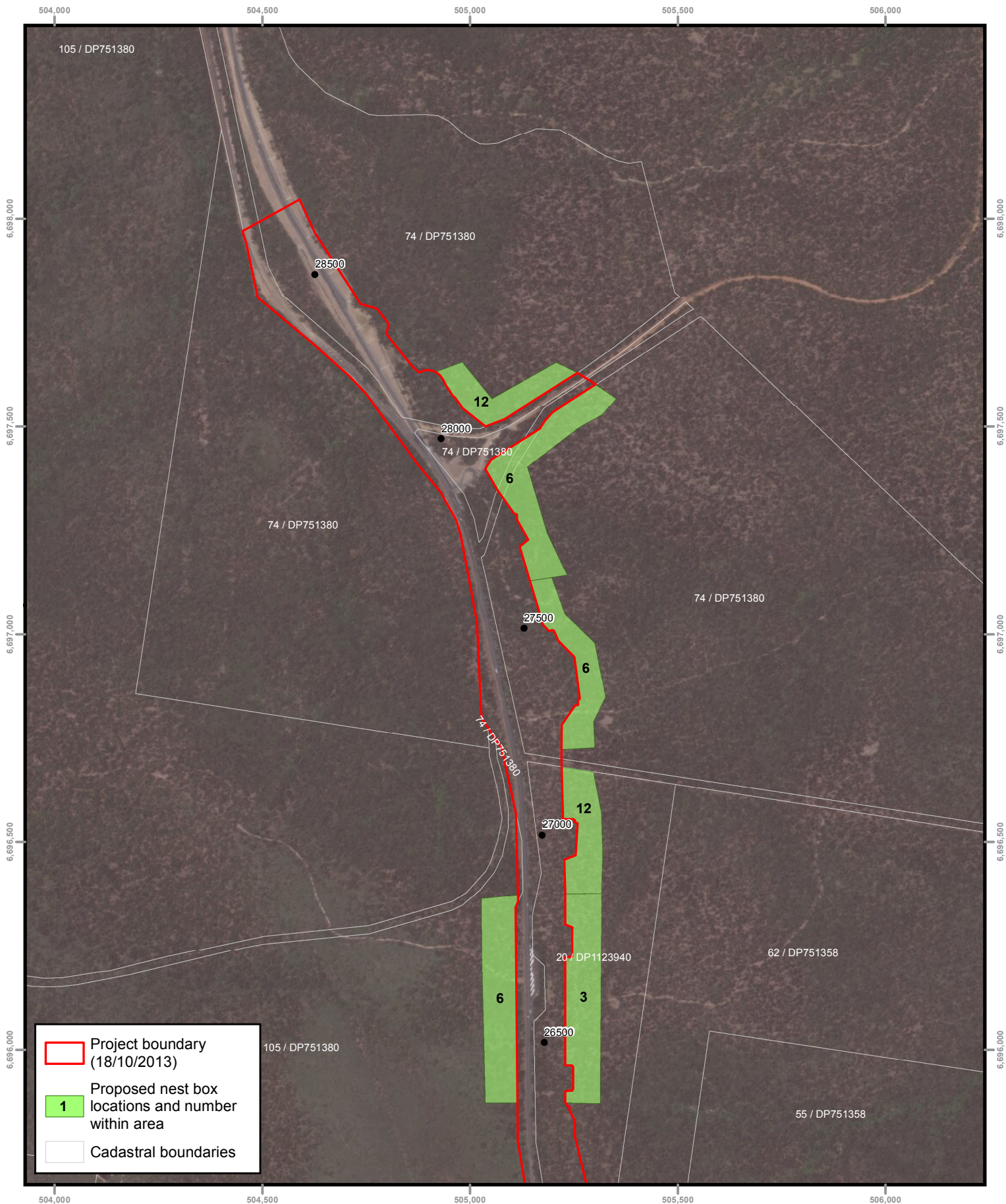
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Map 3 (e): Survey locations of potential nest box areas

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Project boundary (18/10/2013)

Proposed nest box locations and number within area

Cadastral boundaries

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GE311_MP_NB_004_ProposedNBLocations

Job Number: GE311

Approved Project Manager	EL	29/10/2014		
R1	MD	EL	COMMENTS ADDRESSED	31/10/2014
R0	MD	EL	ISSUED	29/10/2014
REV	BY	CHK	DESCRIPTION	DATE

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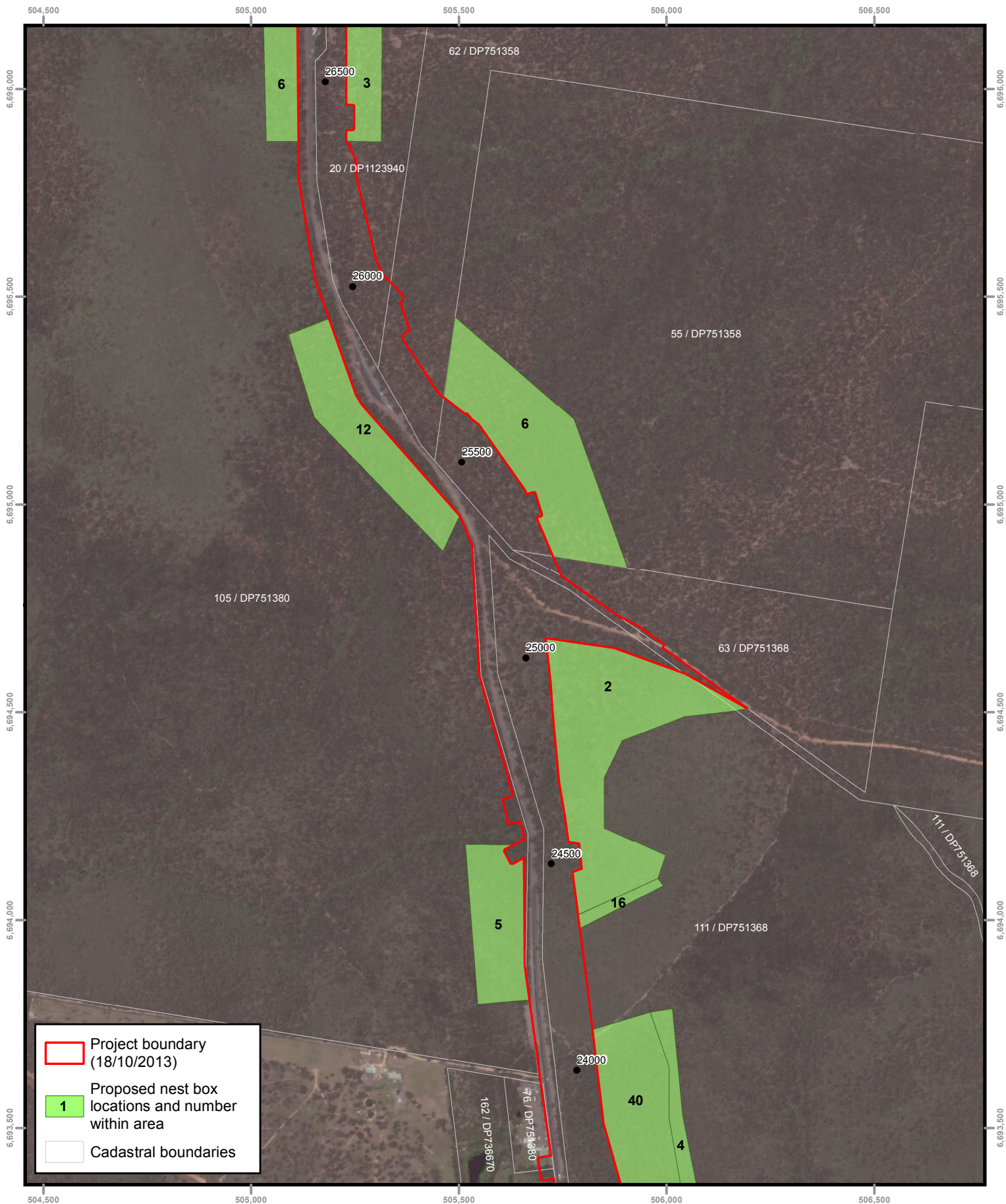
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Map 4 (a): Proposed locations of nest boxes

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Project boundary (18/10/2013)

Proposed nest box locations and number within area

Cadastral boundaries

ecosure

GE311_MP_NB_004_ProposedNBLocations

Job Number: GE311

Approved Project Manager	EL	29/10/2014		
R1	MD	EL	COMMENTS ADDRESSED	31/10/2014
R0	MD	EL	ISSUED	29/10/2014
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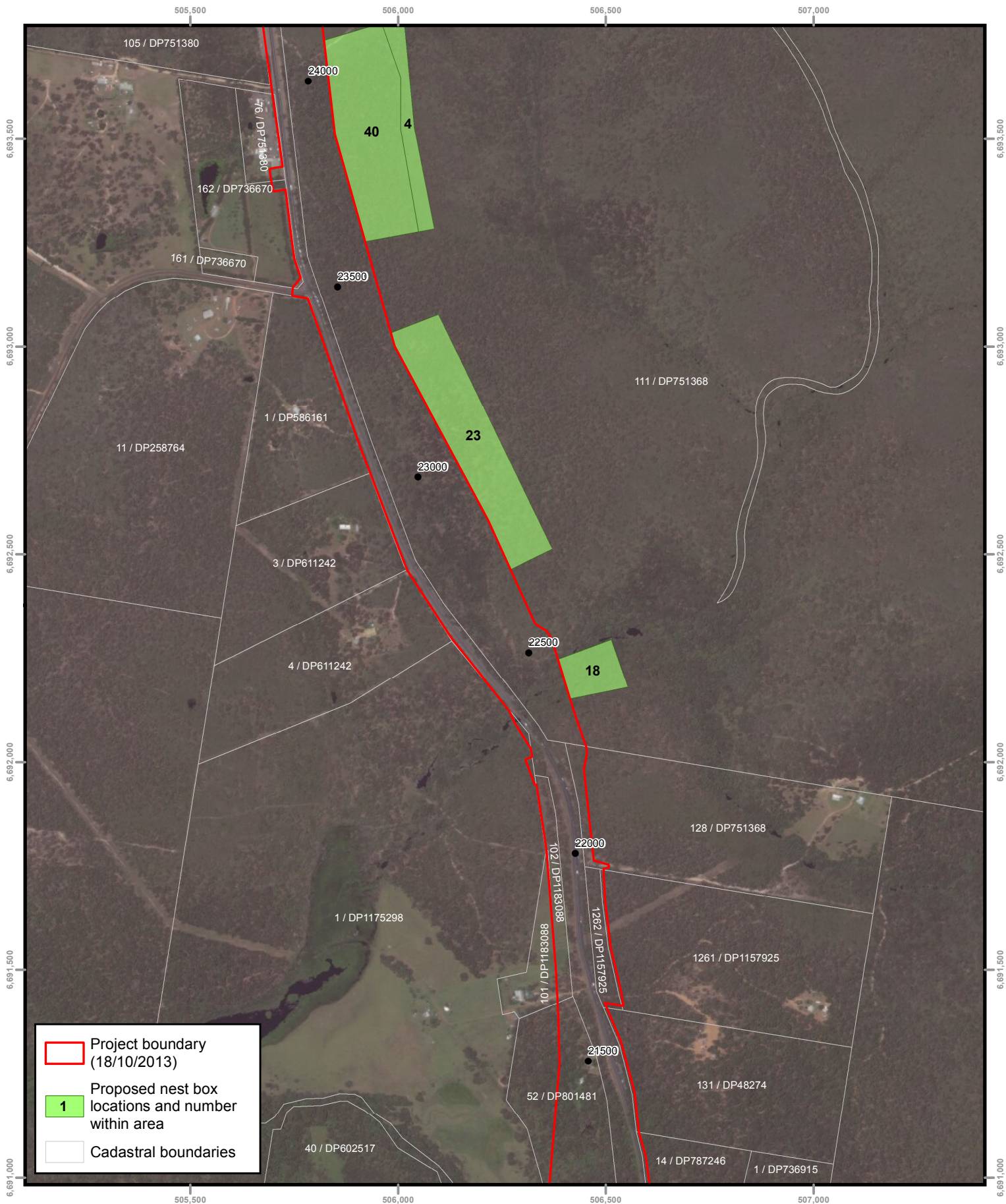
Coordinate System: GDA 1994 MGA Zone 56
 Projection: Transverse Mercator
 Datum: GDA 1994
 Units: Metre


Map 4 (b): Proposed locations of nest boxes


NSW Roads and Maritime Services


Nest box management plan


Glenugie to Halfway Creek, NSW



 Project boundary (18/10/2013)

 Proposed nest box locations and number within area


 Cadastral boundaries



Documents
GE311_MP_NB_004_ProposedNBLocations

Job Number: **GE311**

Approved Project Manager	EL	29/10/2014		
R1	MD	EL	COMMENTS ADDRESSED	31/10/2014
R0	MD	EL	ISSUED	29/10/2014
REV	BY	CHK	DESCRIPTION	DATE




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Metres

Scale: 1:12,000 when printed at A4

Coordinate System:
 GDA 1994 MGA Zone 56
 Projection: Transverse Mercator
 Datum: GDA 1994
 Units: Metre

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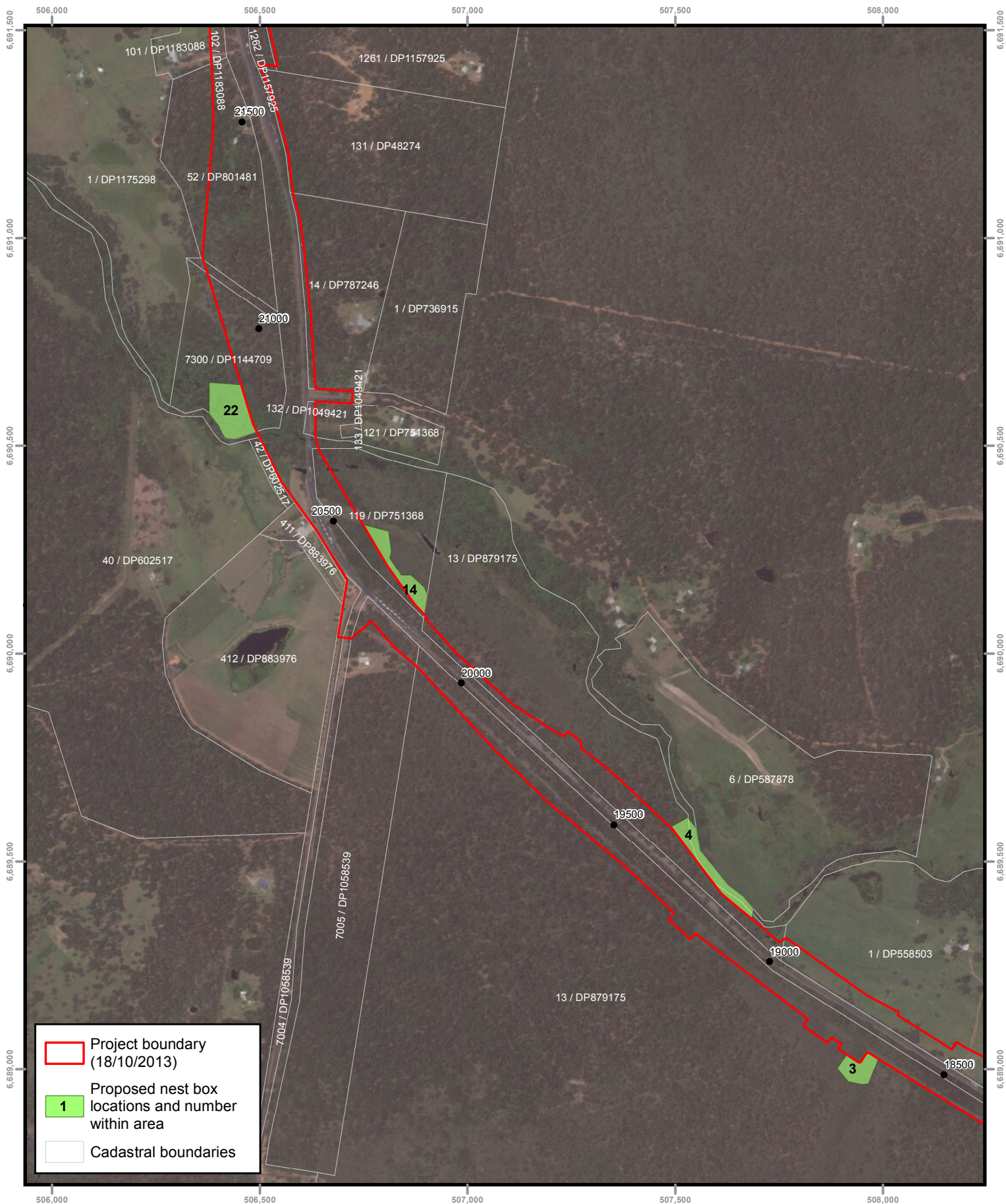


Map 4 (c): Proposed locations of nest boxes

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW



Project boundary (18/10/2013)

Proposed nest box locations and number within area

Cadastral boundaries

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GE311_MP_NB_004_ProposedNBLocations

Job Number: GE311

Approved Project Manager	EL	29/10/2014
R1	MD	EL
COMMENTS ADDRESSED		31/10/2014
R0	MD	EL
ISSUED		29/10/2014
REV	BY	CHK
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Map 4 (d): Proposed locations of nest boxes

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW

508,000 508,500 509,000 509,500

6,689,000

6,689,500

6,689,000

6,688,500

6,688,000

6,690,000

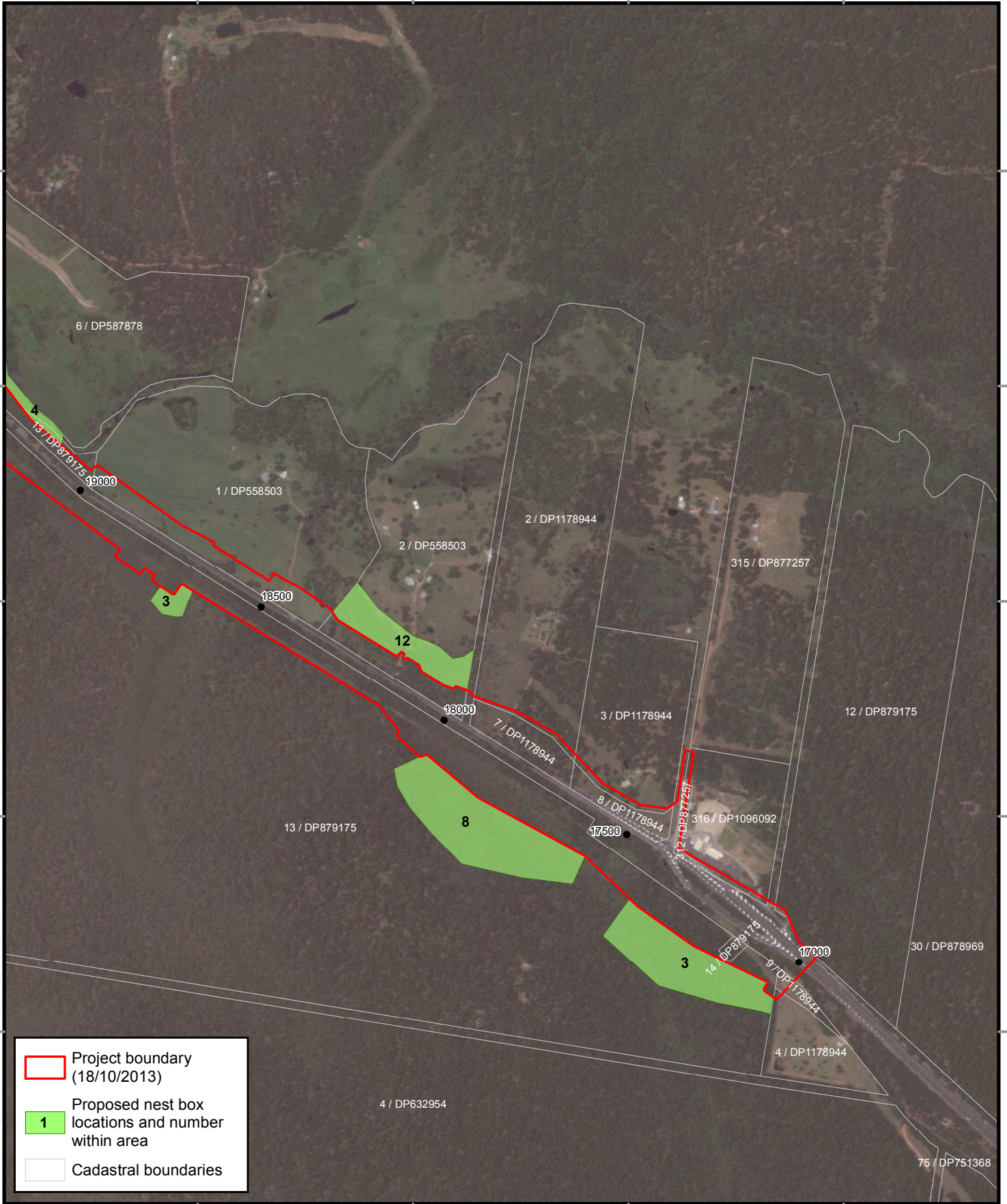
6,689,500

6,689,000

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508,000 508,500 509,000 509,500



Project boundary (18/10/2013)

Proposed nest box locations and number within area

Cadastral boundaries

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GE311_MP_NB_004_ProposedNBLocations

Job Number: GE311

Approved Project Manager	EL	29/10/2014
R1	MD	EL
COMMENTS ADDRESSED		31/10/2014
R0	MD	EL
ISSUED		29/10/2014
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 Datum: GDA 1994
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Map 4 (e): Proposed locations of nest boxes

NSW Roads and Maritime Services

Nest box management plan

Glenugie to Halfway Creek, NSW

Revision History

Revision No.	Revision date	Details	Prepared by	Reviewed by	Approved by
00	29/05/2014	Halfway Creek to Glenugie nest box management plan	Dr Carissa Free (Senior Ecologist)	Dr Elvira Lanham (Senior Ecologist)	
01	13/06/2014	Halfway Creek to Glenugie nest box management plan	Dr Carissa Free (Senior Ecologist)	Dr Elvira Lanham (Senior Ecologist)	
02	19/06/2014	Halfway Creek to Glenugie nest box management plan	Dr Carissa Free (Senior Ecologist)	Dr Elvira Lanham (Senior Ecologist)	
03	11/07/2014	Halfway Creek to Glenugie nest box management plan	Dr Carissa Free (Senior Ecologist)		
04	29/10/14	Halfway Creek to Glenugie nest box management plan – Final.R3	Dr Elvira Lanham (Senior Ecologist) and Dr Carissa Free (Senior Ecologist)	Beth Kramer (Senior Environmental Scientist)	

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GE311-RE Nest box management plan.F1.R4

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