Appendix B: Road Mortality Data, Bonville

Date	Location	Easting	Northing	Sex	Age Class	Age Years	Comments
23/02/2000	Pacific Highway, in Pine Creek						
12/05/2000	Pacific Highway, 400m south of Hunters Road	502435	6635785				
17/07/2000	60m south of corner Hunters Road/Pacific Highway, western side	502443	6635785	M	Sub-Adult	3	Middle of study site
3/08/2000	Pacific Highway, 50m north of Mailmans Track west	501957	6633943				
5/09/2000	P C State Forest	502350	6635400				Roadkill
5/09/2000	Pacific Highway, 400m south of Hunters Road	502435	6635785				
12/09/2000	Pacific Highway, opposite Mailmans Track east	501957	6633939				
13/09/2000	Pacific Highway at PC State Forest	502000	634050	F			Roadkill
23/09/2000	250m south of Hunters Road			F	Adult	< 3	Roadkill
5/10/2000	Overhead Bridge Road, South Pine Creek	502000	6633950	M			
7/10/2000	P C State Forest	502100	6634175	M			
11/10/2000	Pacific Highway, adjacent to P C State Forest, 700m north of Overhead Bridge Road intersection	502345	6635314	M	Sub-Adult	3	
12/10/2000	Pacific Highway, Pine Creek						
22/03/2001	Pacific Highway, Pine Creek	502800	6636350		Juv-enile		Roadkill
24/03/2001	Pacific Highway north of Coffs Harbour, 70m north of Old Coast Road turnoff at Sapphire Motel						
21/08/2001	Pacific Highway, P C State Forest, 30m south of Mailmans track	501949	6633947	F	Juv-enile	1	Road-kill. Good body condition. Fractured mandible and haemorrhage left ear canal
21/09/2001	Pacific Highway, Mailmans Track	501950	6633975	M			Road-kill. Specimen labelled 1
7/10/2001	Pacific Highway, Pine Creek	502325	6635500				
19/10/2001	Pacific Highway, opposite Hunters Road	502450	6635775	M	Adult		Road-kill. Specimen labelled 7
20/10/2001	North of Reedys Creek	502875	6637550	M	Sub-adult		Road-kill. Specimen labelled 9
22/10/200	Pacific Highway, Overhead	502350	6634600	F			Road-kill.

1	Bridge Road						Specimen labelled 10, Jalena 561
22/11/2001	Pacific Highway, 30km(assumed m) south of Overhead Bridge Road	502353	6634541				
20/02/2002	Pine Creek, Pacific Highway, 50m north of Overhead Bridge Road	502337	6634652	F	Adult		
21/08/2002	Pine Creek, south of Hunters Road						
1/09/2003	Pacific Highway, P C State Forest, Sid Burke Area?	502755	6636211	M	Adult		
10/2003	Pacific Highway, Mailmans East	502225	6634250				
16/10/2003	Pacific Highway, at Sid Burke Park	502750	6636200	M	Adult		
22/12/2003	Pacific Highway, south of Mailmans	501892	6633747	F			
1/09/2004	Sid Burke Park	502716	6636170	M	Adult		
7/09/2004	Pacific Highway, at Darkes Road, near truck stop	502500	6635925		Adult		
8/09/2004	North of Sid Burke Park	502775	6636350		Adult		
8/09/2004	Pacific Highway, Darkes Road near truck stop	502000	6634050		Adult		
15/09/2004	400m south of Sid Burke Park	502455	6635833				
16/09/2004	450m north of turnoff to Sid Burke Park	502689	6636128				
21/09/2004	Pacific Highway, at Hunters Road	502439	6635797				
4/10/2004	Pacific Highway, at East Mailmans Track	502250	6634250	F	Adult		
8/10/2004	Pacific Highway, at Sid Burke Park	502750	6636200		Adult		
22/10/2004	Pacific Highway, Overhead Bridge Road	502356	6634603	M			
29/07/2005	50m south of Hunters Road and Pacific Highway intersection	502400	6635775				
4/08/2005	Pacific Highway/Mailmans Track intersection	501925	6633930	F	Sub-Adult	2	
3/11/2005	400m north of Overhead Bridge Road, northbound lane	502289	6635007	M	Sub-Adult		
13/11/2005	50m south of Sid Burke Rest Area	502851	6635948				
5/09/2006	100m south of Sid Burke Forest Park	502580	6636050	M			
3/10/2006	100m south of intersection of Overhead Bridge Road and Pacific Hwy			M			DNA sample
9/10/2006	Opposite Overhead Bridge Road turnoff			M	Adult	3-5	DNA sample; Healthy young adult male; Body intact.
28/10/2006	Speed camera, Pacific Hwy, Bongil Bongil NP						x

15/11/2006	100m south of overhead bridge road						not sure if killed after being sighted
22/11/2006	Mailmans Track moving south towards Repton						Live but presumed
29/11/2006	200m south of Hunters Road						x
20/12/2006	Pacific Hwy, Pine Creek, approx. 20m north of intersection with Overhead Bridge Rd, eastern turning lane	502360	6634570				Roadkill; too damaged to determine sex.
2/08/2007	on old existing hwy at Sid burke rest area (chainage 95100)	502635	6636178	F	Adult		DNA sample
8/08/2007	western side of hwy, 500 m south of Hunters Rd,	502396	6635471	M			DNA sample; directly underneath the newly installed fauna fence
11/08/2007	Next to Koala Fence. East edge of existing H' way.	502494	6635665	F	Sub-Adult		DNA sample; came from west side of H' way. Trapped by fence
14/08/2007	Chainage 92650, 40 - 50m south of new Koala tunnel. On new service road	501983	6633826	F	Adult	4	DNA sample; got trapped by concrete barriers
19/08/2007	Opposite Hunters road, east side of existing H' way next to fence	502557	6635977	F	Sub-Adult		DNA sample
12/09/2007	50m S of Hunters rd, N bound lane of existing Hwy,	502491	6635913	F	Sub-Adult		DNA sample; accessed the Hwy via hunters forest Rd
4/10/2007	100m N of Sid Bourke. S bound lane of existing Hwy			F			
5/10/2007	pine Ck bridge, N bound lane South bank on existing hwy			F			
11/10/2007	40 m north of Overhead Bridge rd on highway			M			DNA sample
22/09/2008	50m north of Mailmans track on new highway, southbound lane.	502051	6634180				Road-kill. Probably walked through gate on Mailmans track when left open for logging trucks, would have crossed both northbound lanes. 1st noticed at 11:30 are, workings say it was not there at 6:30am when work commenced.
25/08/2009	south bound lane, just south of extent of fauna fencing south of Raleigh underpass			M	sub-adult	very young	

	(100m south of private property boundary)						
11/09/2009	almost same location as 25/08.						
20/09/2009	on bridge over Infra 2 underpass.			M	sub-adult		
9/10/2009	almost same location as 25/08 - 3rd roadkill in this area.						
23/10/2009	North bound lane in gutter, just north of Twelve Mile Road. Chainage 94400	502450	6635490	F	adult		

Appendix C: Monitoring of Fauna Movement Structures at Bonville

Raleigh underpass 1999

The underpass was used on at least three and possibly four occasions by Koalas (AMBS 2001c). Three of the traverses were made by two animals which were captured and tagged during the 2000 capture trip. Another unknown animal may have made a crossing but it was unconfirmed as only one series of tracks were observed in a sand tray on the western entry.

Other mammal species identified using this structure include the Brush-tailed Phascogale, wallaby, bandicoot, rat and the introduced predators, cat, dog and fox.

Remote Surveillance Monitoring, Bonville 2008-2011

Koalas were recorded 26 times using movement structures during the monitoring period (Table E1). Interpretations indicate that complete passages probably occurred on nine occasions (see below).

From 6 December 2008 to 14 April 2011 the cameras obtained 2,521 records covering 38 different species, including species of mammal, bird, reptile and frog (Table E2).

Table E1.Koala records from the remote surveillance monitoring

Record number	Date	Infra 2 south	Infra 2 north	Raleigh east	Raleigh west	Complete passage?
1	01/05/2009, 03:14	✓				**Yes**
2	21/09/2009, 03:14			✓		Unlikely
3	21/09/2009, 03:20			✓		Unlikely
4	21/09/2009, 03:23			✓		Unclear, but likely
5	22/09/2009, 23:57	✓				**Yes**
6	26/09/2009, 21:56			✓		Unlikely
7	27/09/2009, 02:37	✓				**Yes**
8	16/10/2009, 20:53/54				✓	No (returned)
9	16/10/2009, 21:33/36				✓	No (returned)
10	16/10/2009, 22:28/29				✓	No (returned)
11	17/10/2009, 03:21				✓	Unlikely
12	17/10/2009, 03:36				✓	Unclear, but likely
13	24/10/2009, 20:15		✓			**Yes**
14	10/09/2010, 00:49		✓			**Yes**
15	10/09/2010, 00:55	✓				**Yes**, same as record number 14
16	18/09/2010, 00:20				✓	See record number 17
17	18/09/2010, 00:26			✓		**Yes**, enter and exit on pole
18	18/09/2010, 00:31				✓	Unlikely, exit on pole
19	18/09/2010, 00:32				✓	Unlikely, enter on pole
20	18/09/2010, 00:40				✓	Unlikely, exit on pole
21	18/09/2010, 01:03				✓	See record number 22
22	18/09/2010, 01:06			✓		**Yes**, enter and exit on ground
23	18/09/2010, 04:17			✓		See record number 24
24	18/09/2010, 04:21				✓	**Yes**, enter and exit on ground

25	24/09/2010, 19:20				✓	See record number 26
26	24/09/2010, 19:24			✓		Yes, enter and exit on ground

Record number 1
One Koala was recorded in the centre of the Infra 2 underpass on 5 January 2009 at 03:14 (Plate E1). The Koala did not have a radio-collar or ear tag. The Koala appears to have been moving from the eastern side of the highway to the western side.

Plate E1.Koala photographed on 01/05/2009 at the Infra 2 underpass

Record number 2, 3 and 4
Three series of Koala photographs were recorded at Raleigh east on 21 September 2009. The first was taken at 03:14 in which the Koala pauses at the second furniture pole for two photographs (Plate E2). The Koala was not photographed exiting the box culvert (it is likely that the Koala exited during the delay between photographs). At 03:20 a Koala is photographed again in a series of three photographs (Plate E3), in which the Koala is seen at the third furniture pole. Once again the Koala is not seen exiting the box culvert, but a second series of three photographs immediately following the Koala photographs suggests that the individual triggered the camera again while exiting. At 03:23 a Koala is photographed again entering the box culvert in a series of three photographs (Plate E4). Another series of three photographs continues which faintly shows the Koala passed the third furniture pole, the furthest it had been photographed. No photographs were taken after this series on this date.

Interpretation of this photographic series suggests it is likely it was the same Koala being photographed entering and exiting the underpass, mainly due to the short time between each photographic series. It is unclear if the Koala made a complete passage through the underpass, but considered likely due to the fact there were no more photographs on 21 September after the third photographic series.

Record number 5
One Koala was recorded in the centre of the Infra 2 underpass on 22 September 2009 at 23:57. No ear tags or radio-collars were visible from the photograph. The Koala appears to have been moving from the western side of the study area to the east.

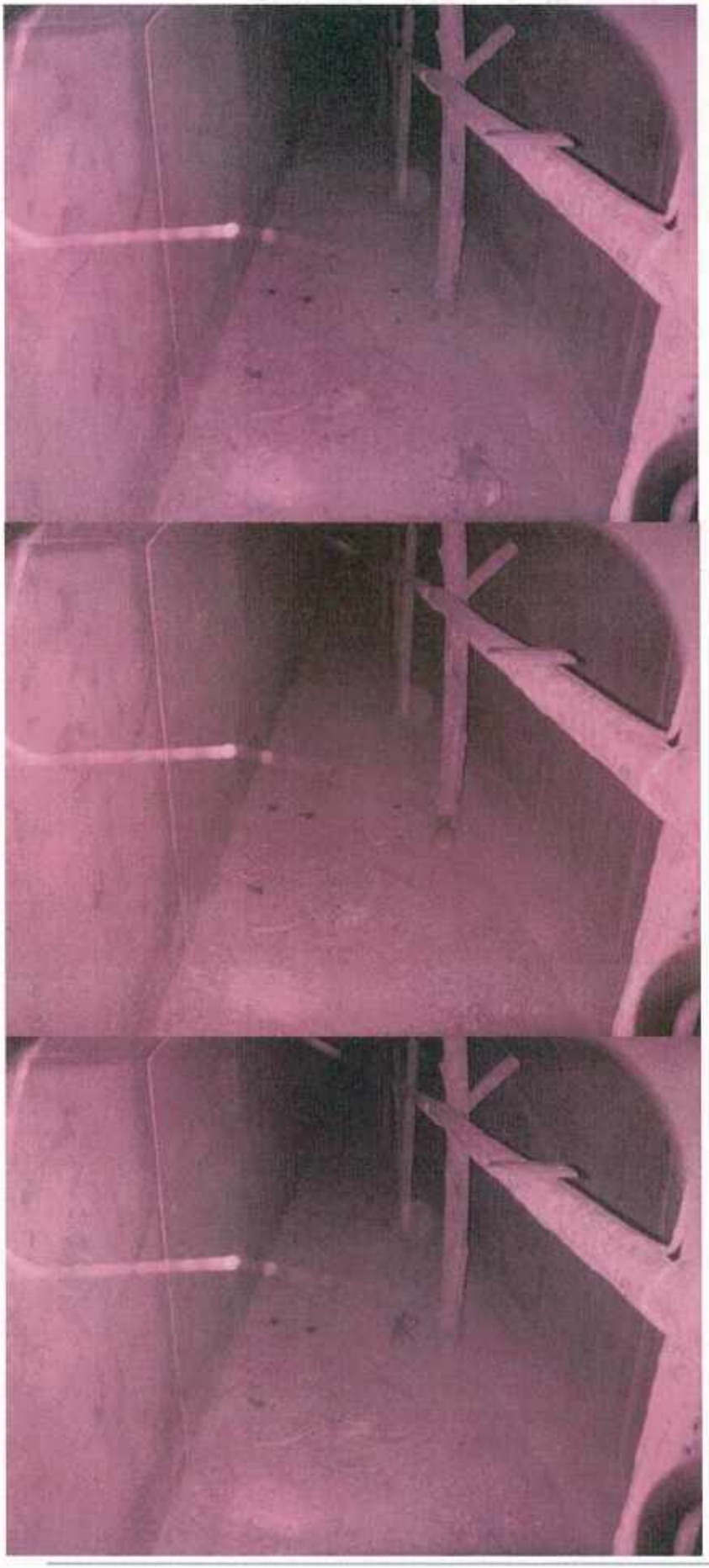


Plate E2. Koala photographed at 03:14 on 21/09/2009, entering Raleigh east

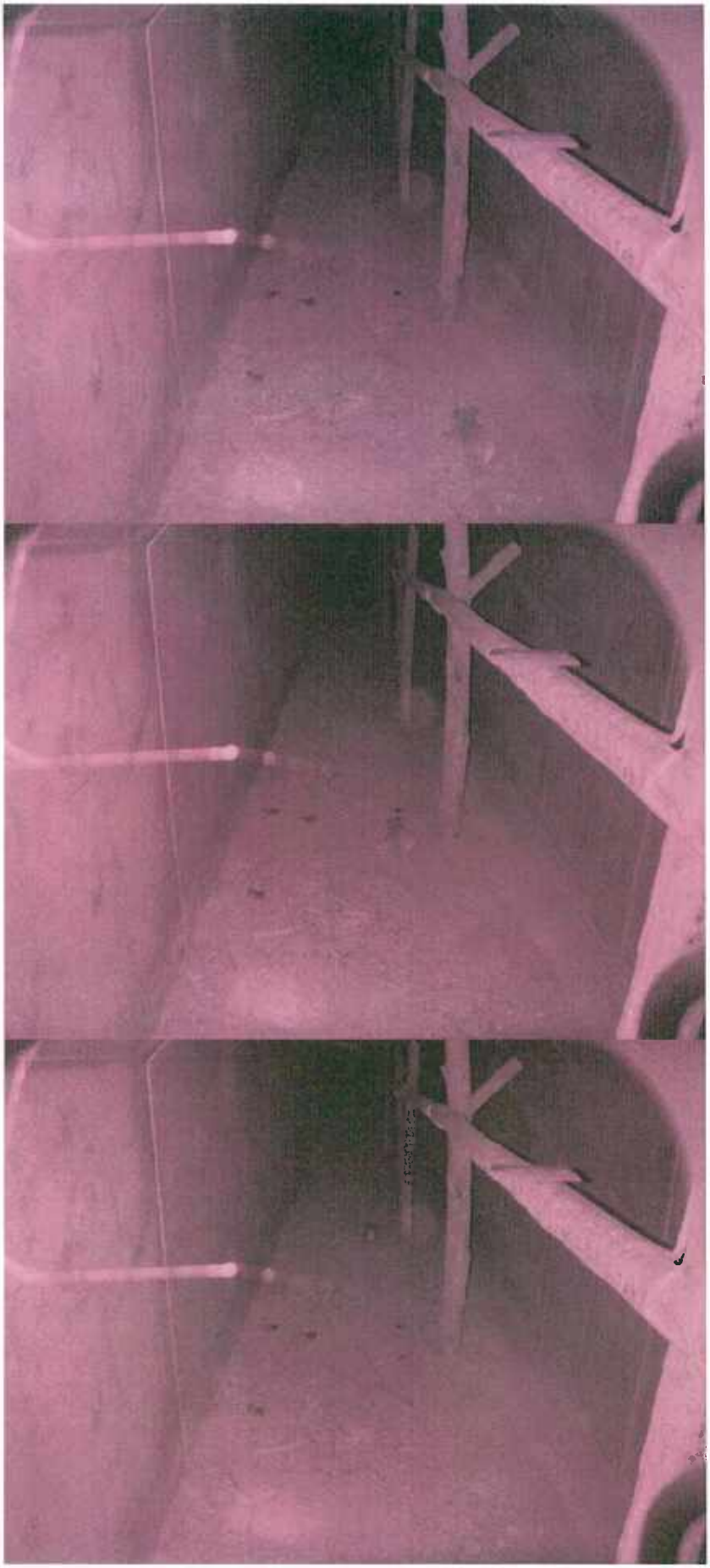


Plate E3. Koala photographed at 03:20 on 21/09/2009, entering Raleigh east

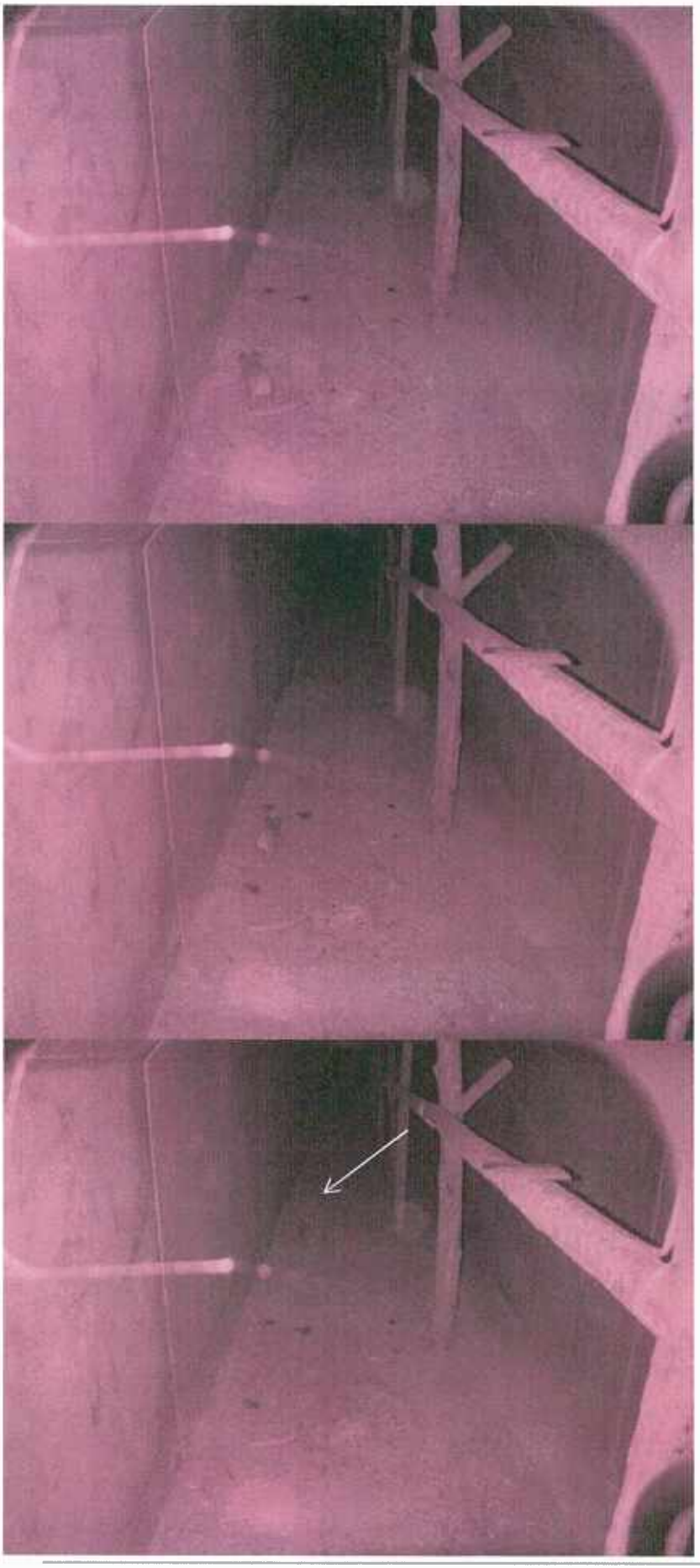


Plate E4. Koala photographed at 03:23 on 21/09/2009, entering Raleigh East

Record number 6
One Koala was photographed in a series of three photographs at Raleigh east on 26 September 2006. At 21:56 the Koala can be seen entering the underpass, and adjacent to the third furniture pole for two photographs (Plate E6). The Koala was not photographed again and there are no photographs occurring soon after that could be interpreted as the Koala exiting. Since each photograph has an approximately 10 second delay, it is possible the individual exiting the box culvert at Raleigh east during this lag time. If the Koala continued through the underpass to Raleigh West it is likely that it would have been photographed.

Record number 7
The second was photographed on 27 September 2009 at 02:37, and was travelling from the eastern side of the study area to the west (Plate E5). No ear tags or radio-collars were visible from the photographs.

Plate E5.Koala photographed on 27/09/2009 at the Infra 2 underpass.

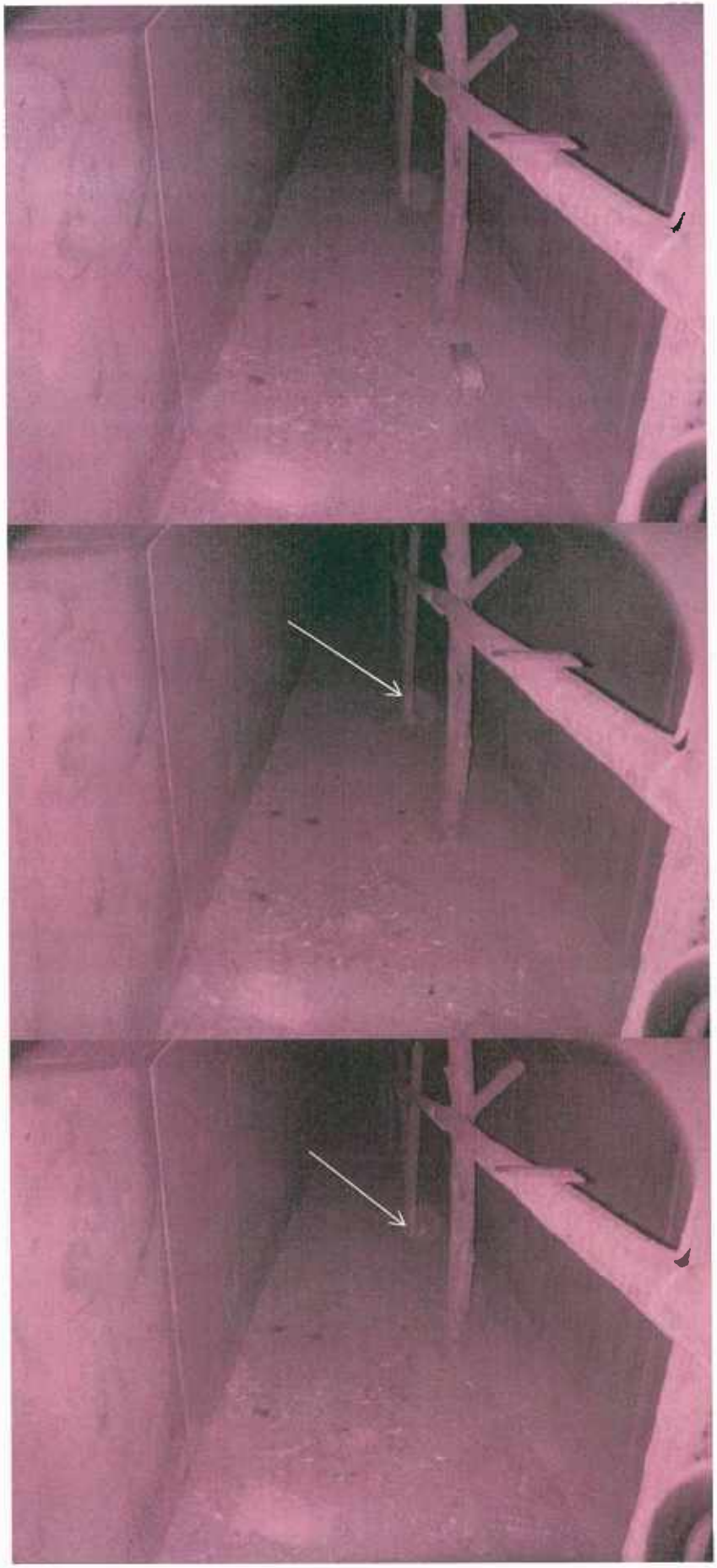


Plate E6. Koala photographed at 21:56 on 26 September 2009, entering Raleigh East

Record number 8, 9, 10, 11 and 12
Five series of Koala photographs were recorded at Raleigh west on 16 October 2009. The first series was taken at 20:53 which show the Koala entering the box culvert and exiting at 20:54 (Plates D8, D9). At 21:33 a Koala is photographed entering the box culvert (Plate E10), and possibly exiting at 21:36 although the photograph is inconclusive. At 22:28 a Koala is photographed entering the box culvert again and is clearly photographed exiting at approximately 22:29 (Plate E11). At 3:21am on 17 October a Koala is photographed entering again (Plate E12) but is not photographed exiting in the following five photographs (it is likely that the Koala triggered the camera but exited during the delay between photographs). At 03:36 a Koala is photographed entering the box culvert and is possibly photographed exiting at although the photograph is inconclusive.

Interpretation of this photographic series suggests it is likely it was the same Koala being photographed entering and exiting the underpass, mainly due to the short time between each photographic series. No photographs were taken at Raleigh east close to this time that could be interpreted as the Koala exiting. It is likely that the Koala did not make a complete passage through the box culvert.

Record number 13
One Koala was photographed in the centre of the Infra 2 underpass on 24 October 2009 at 20:15 (Plate E7). It was photographed on the northern camera moving from the eastern side of the study area to the west, on 24 October 2009 at 18:15. No ear tags or radio-collars were visible from the photographs.

Plate E1.Koala photographed on 24/10/2009 at the Infra 2 underpass.

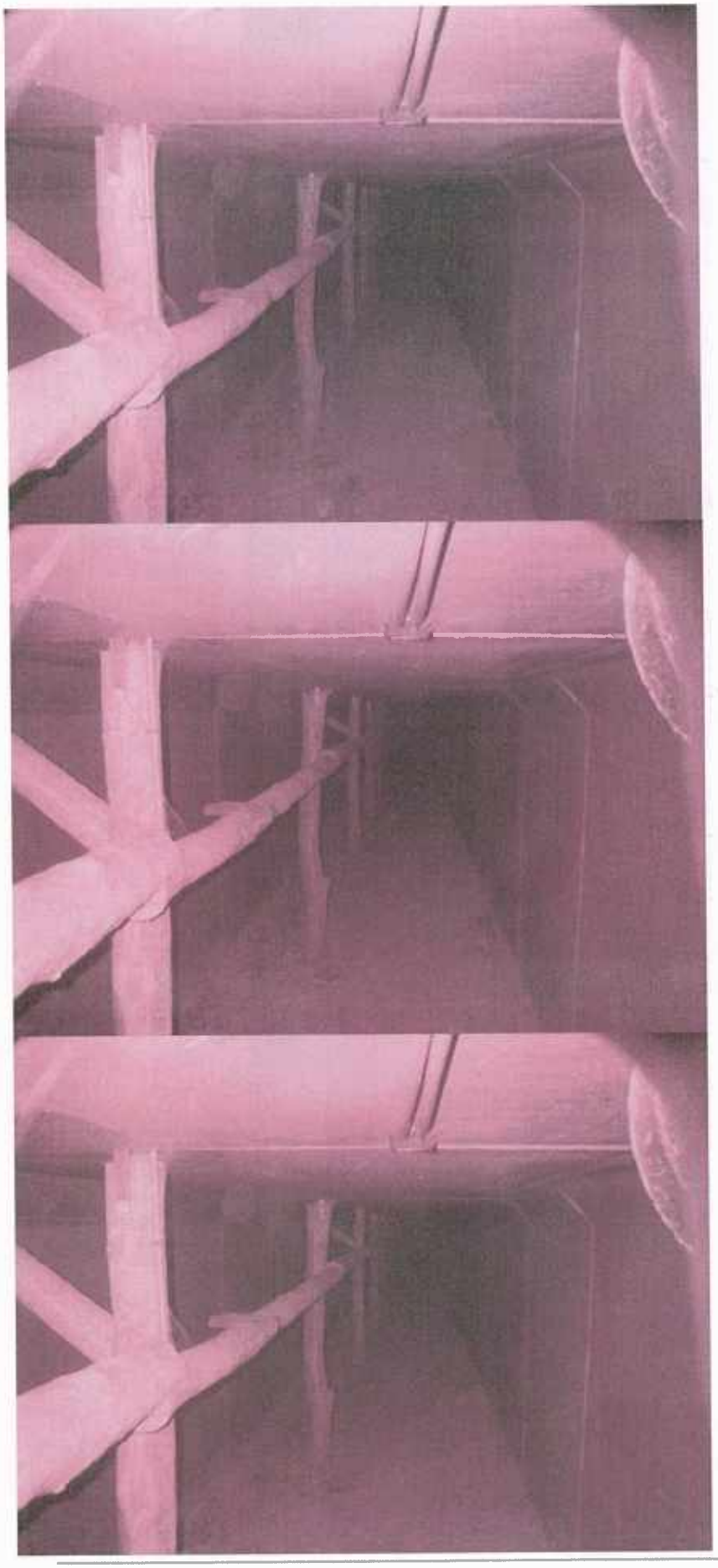


Plate E 2. Koala photographed at 20:53 on 16/10/2009, entering Raleigh west

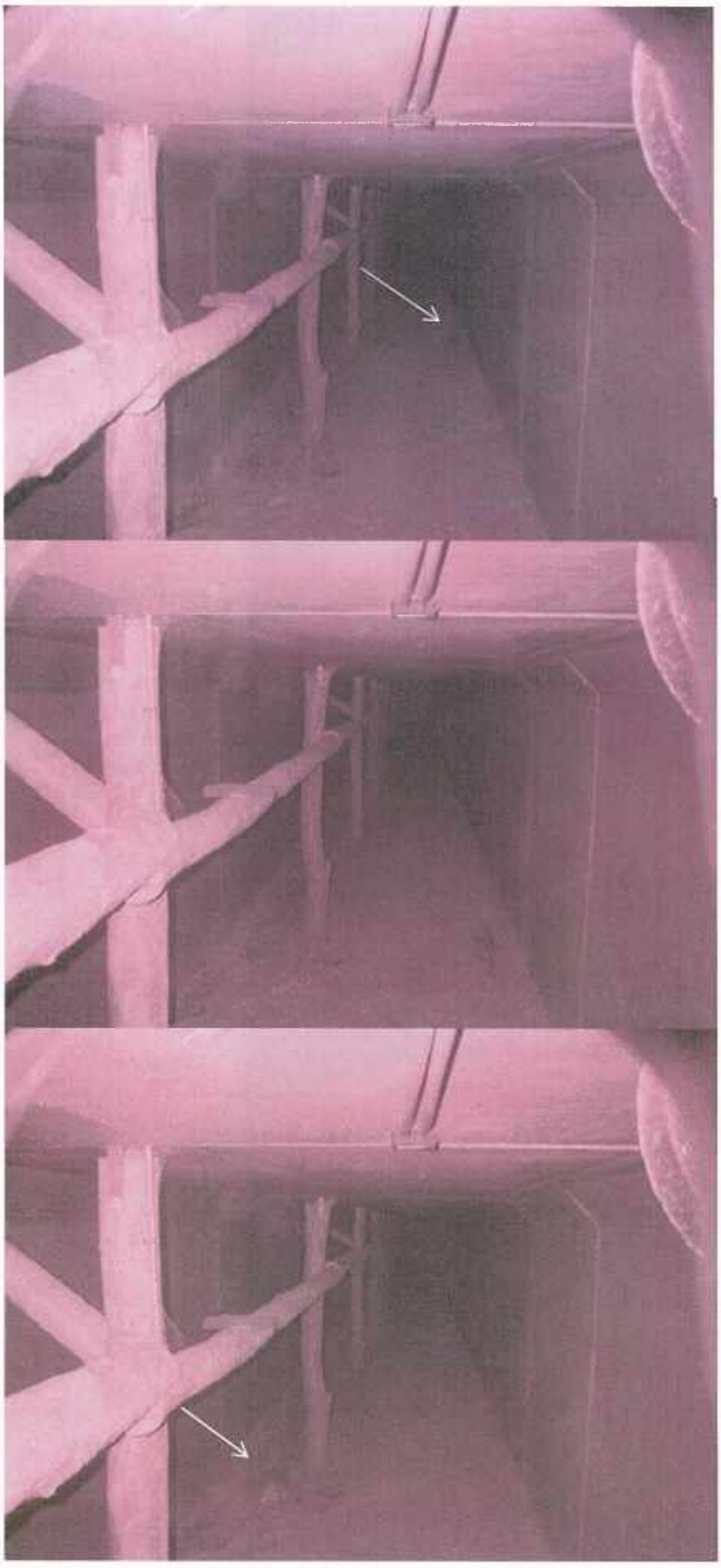


Plate E3. Koala photographed at 20:53 on 16/10/2009, exiting Raleigh west

Plate E4. Koala photographed at 21:23 on 16/10/2009, entering Raleigh west

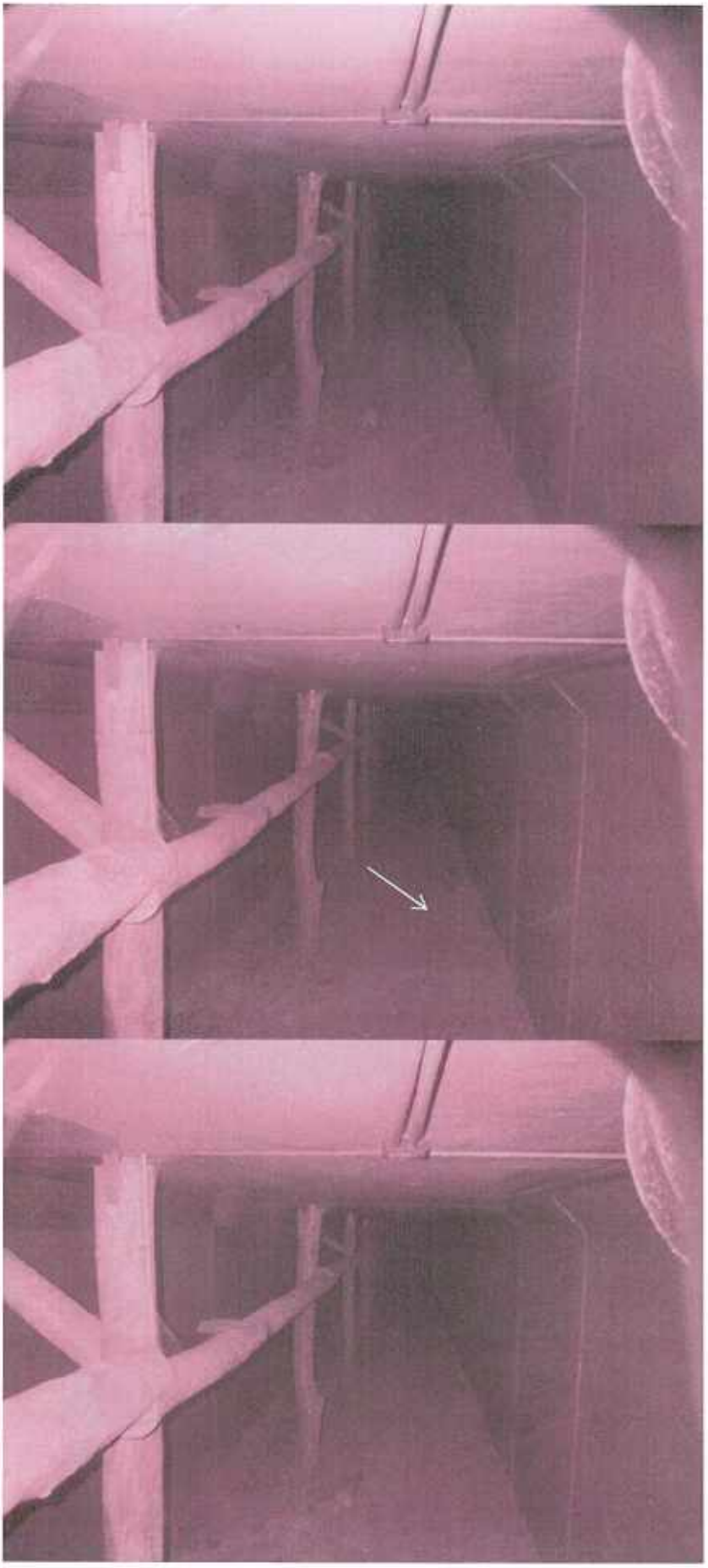


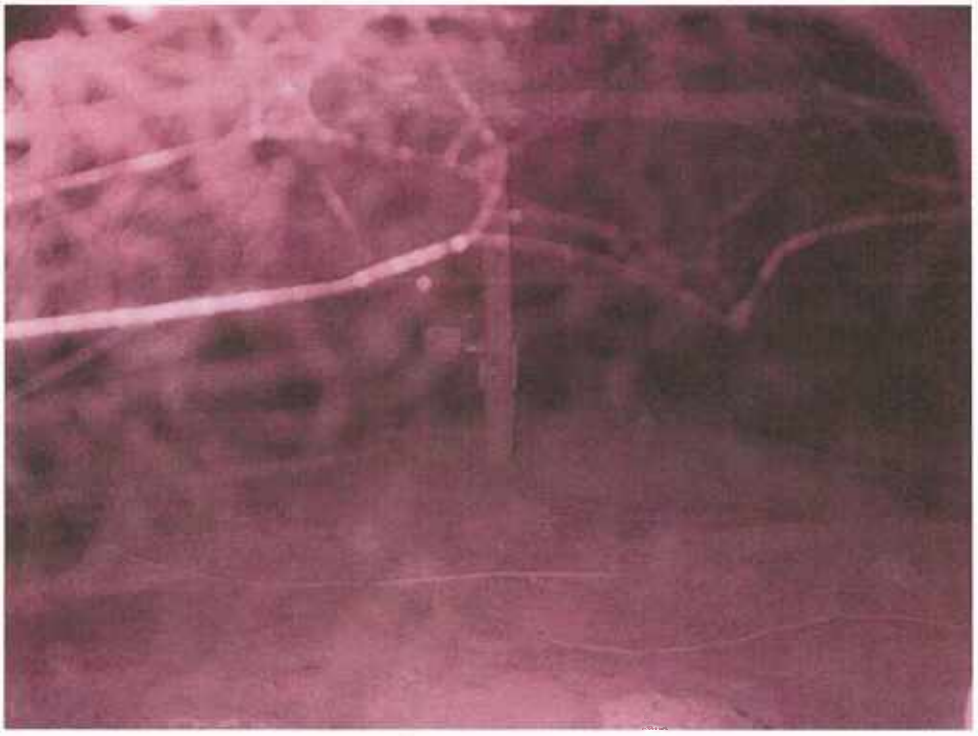
Plate E 5. Koala photographed at 22:28 on 16/10/2009, entering and exiting Raleigh west

Plate E6. Koala photographed at 03:21 on 17/10/2009, entering Raleigh west

Record number 14 and 15

One Koala was photographed in the centre of the Infra 2 underpass at 00:49 on 10 September 2010 (Plate E13, D14). It was initially photographed in a series of four photographs in which the Koala appears to be moving from the eastern side of the highway to the western side. The Koala moves toward the wooden furniture and pauses for three of these photographs near the Infra 2 south camera. There is one photograph of the Koala walking away from the Infra 2 south camera. The Koala did not appear to have a radio-collar or ear tag.

Plate E7. Koala photographed in the Infra 2 underpass on 10/09/2010 (above and below)



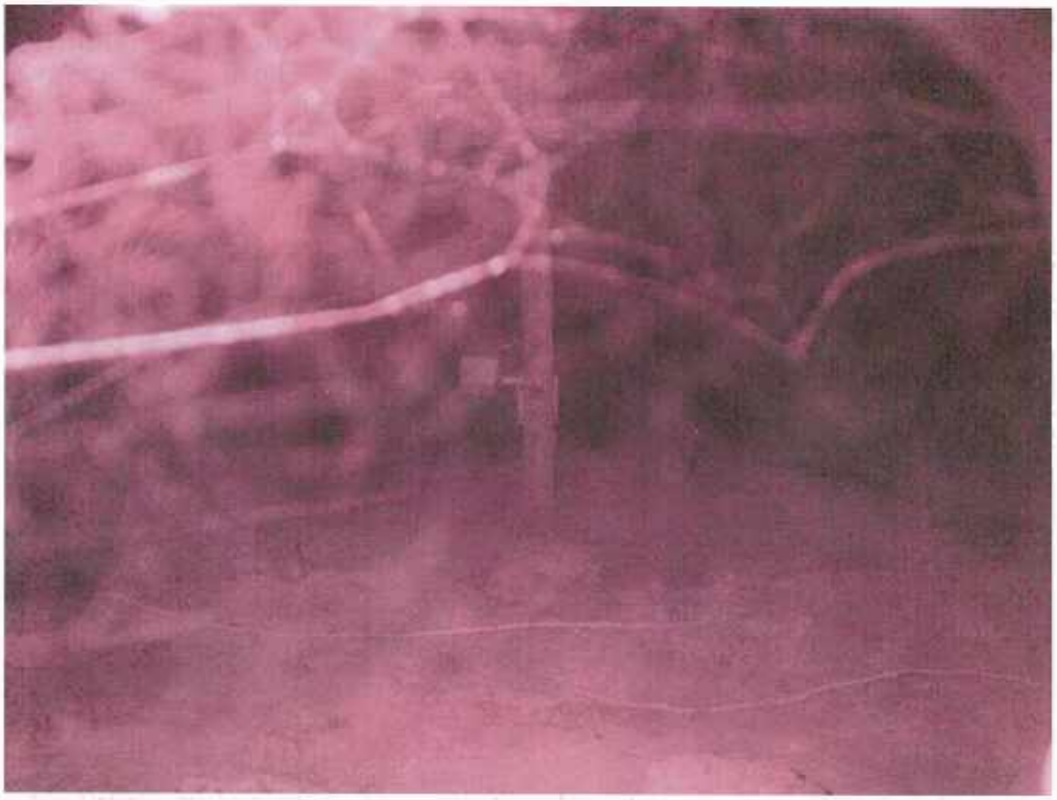


Plate E8.Koala photographed in the Infra 2 underpass on 10/09/2010 (above and below)

Record number 16 and 17

One Koala was photographed at Raleigh west on 18 September 2010 at 00:20 (Plate E15). It was entering the underpass on the wooden furniture. At 00:26 a Koala was photographed at Raleigh east, exiting the underpass on the wooden furniture. Interpretation of this photographic series suggests it is likely it was the same Koala photographed on each occasion, and therefore made a complete passage through the underpass. No ear tag or radio-collar was visible from the photographs.

Plate E9.Koala photographed on 18/09/2010 entering and exiting the Raleigh underpass

Record number 18, 19, 20, 21 and 22
Five series of Koala photographs were recorded at the Raleigh underpass on 18 September 2010.

The first was taken at 00:31 at Raleigh west, in which the Koala appears to be exiting the underpass on the wooden furniture (Plate E16). There was no photo of a Koala entering the underpass at Raleigh east, so it is likely this individual entered at Raleigh west, triggered the sensor and quickly turned, and was subsequently photographed during exit.

Plate E10.Koala photographed on 18/09/2010 at Raleigh west

At 00:32 on 18 September 2010, a Koala was photographed at Raleigh west entering the underpass on the wooden furniture, and eight minutes later (at 00:40) a Koala was photographed exiting at Raleigh west on the wooden furniture (Plate E17). There was no photo of a Koala entering the underpass at Raleigh east so it is likely it is the same individual that was photographed entering and exiting.

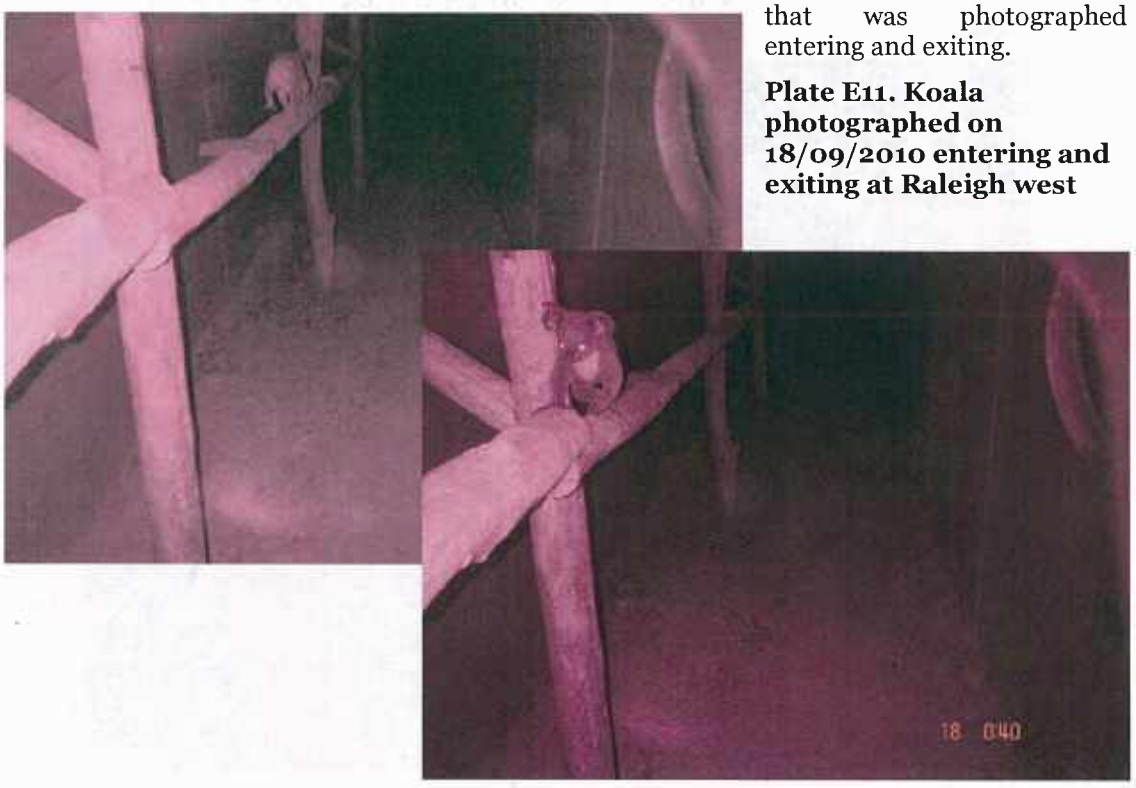


Plate E11. Koala photographed on 18/09/2010 entering and exiting at Raleigh west

At 01:03 a Koala was photographed at Raleigh west entering the underpass on the ground, and three minutes later a Koala was photographed at Raleigh east exiting the underpass on the ground (Plate E18).

Interpretation of this photographic series suggests it is likely it was the same Koala in all photographs, mainly due to the short time frame between each photographic series. It appears the Koala entered and exited the Raleigh underpass twice, and on the third occasion made a complete passage as it was photographed at both ends.

Plate E12.Koala photographed on 18/09/2010 entering and exiting the Raleigh underpass

Record number 23 and 24

One Koala was photographed at Raleigh east on 18 September 2010 at 04:17. It was entering the underpass on the ground. Three minutes later (at 04:21) a Koala was photographed at Raleigh west, exiting the underpass. Interpretation of this photographic series suggests it is likely it was the same Koala photographed on each occasion, and therefore made a complete passage through the underpass (Plate E19). No ear tag or radio-collar was visible from the photographs.

Plate E13.Koala photographed on 18/09/2010 entering and exiting the Raleigh underpass

Record number 25 and 26

One Koala was photographed at Raleigh west on 24 September 2010 at 19:20 (Plate E20). It was entering the underpass on the ground. Four minutes later (at 19:24) a Koala was photographed at Raleigh east, exiting the underpass. Interpretation of this photographic series suggests it is likely it was the same Koala photographed on each occasion, and therefore made a complete passage through the underpass. No ear tag or radio-collar was visible from the photographs.

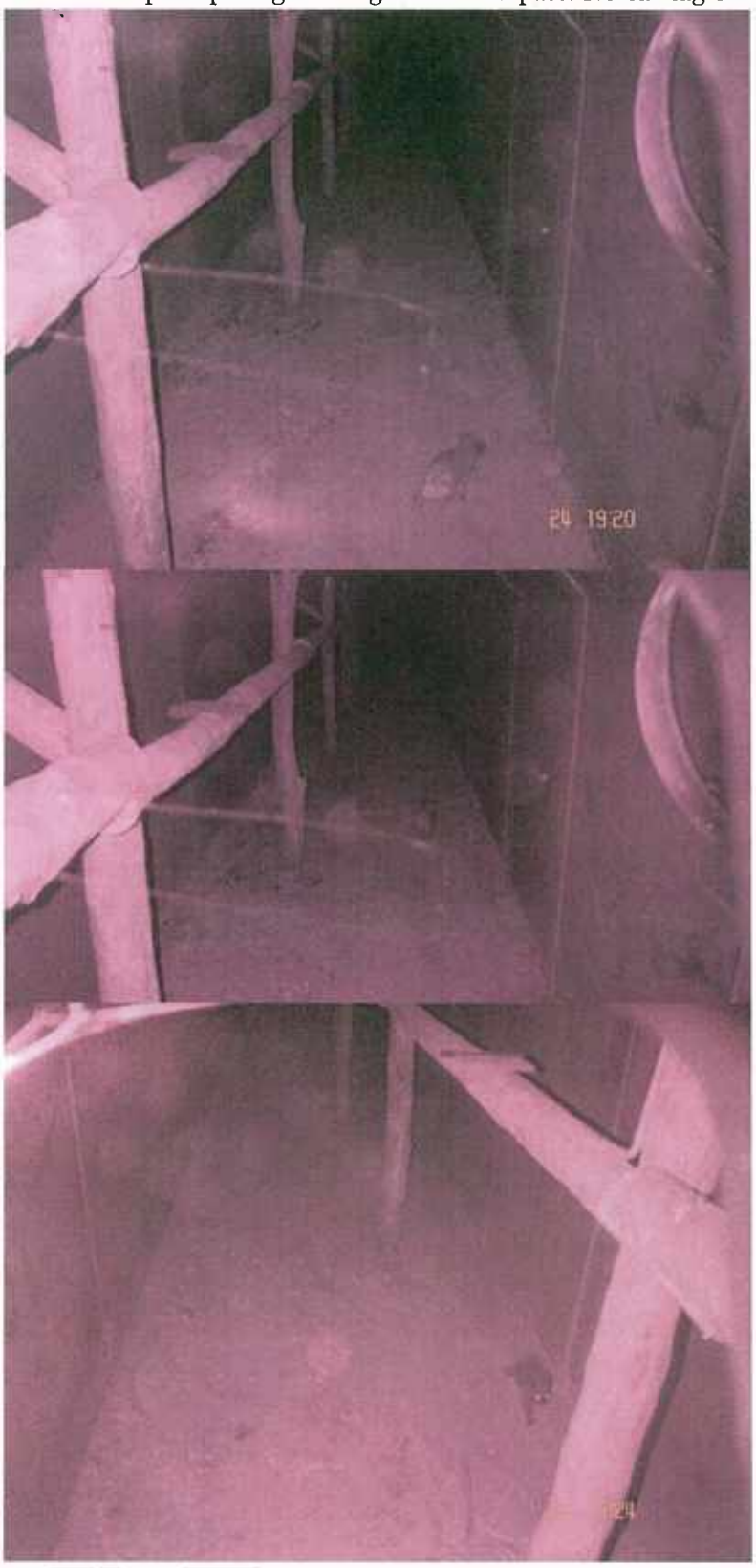


Plate E14. Koala photographed on 24/09/2010 entering and exiting the Raleigh underpass

Other species which were commonly recorded utilising the fauna movement structures were Swamp Wallabies (*Wallabia bicolor*; 206 records), Lace Monitors (*Varanus varius*; 293 records), Red Foxes (*Vulpes vulpes*; 105 records) and small mammals (550 records). The small mammals appear to be a combination of species from the genera *Antechinus*, *Rattus* and *Melomys*. Confirmed species within these genera include the Bush Rat (*Rattus fuscipes*) and the introduced Black Rat (*Rattus rattus*). Two species of bandicoot have been recorded; the Long-nosed Bandicoot (*Perameles nasuta*) and the Northern Brown Bandicoot (*Isoodon macrourus*).

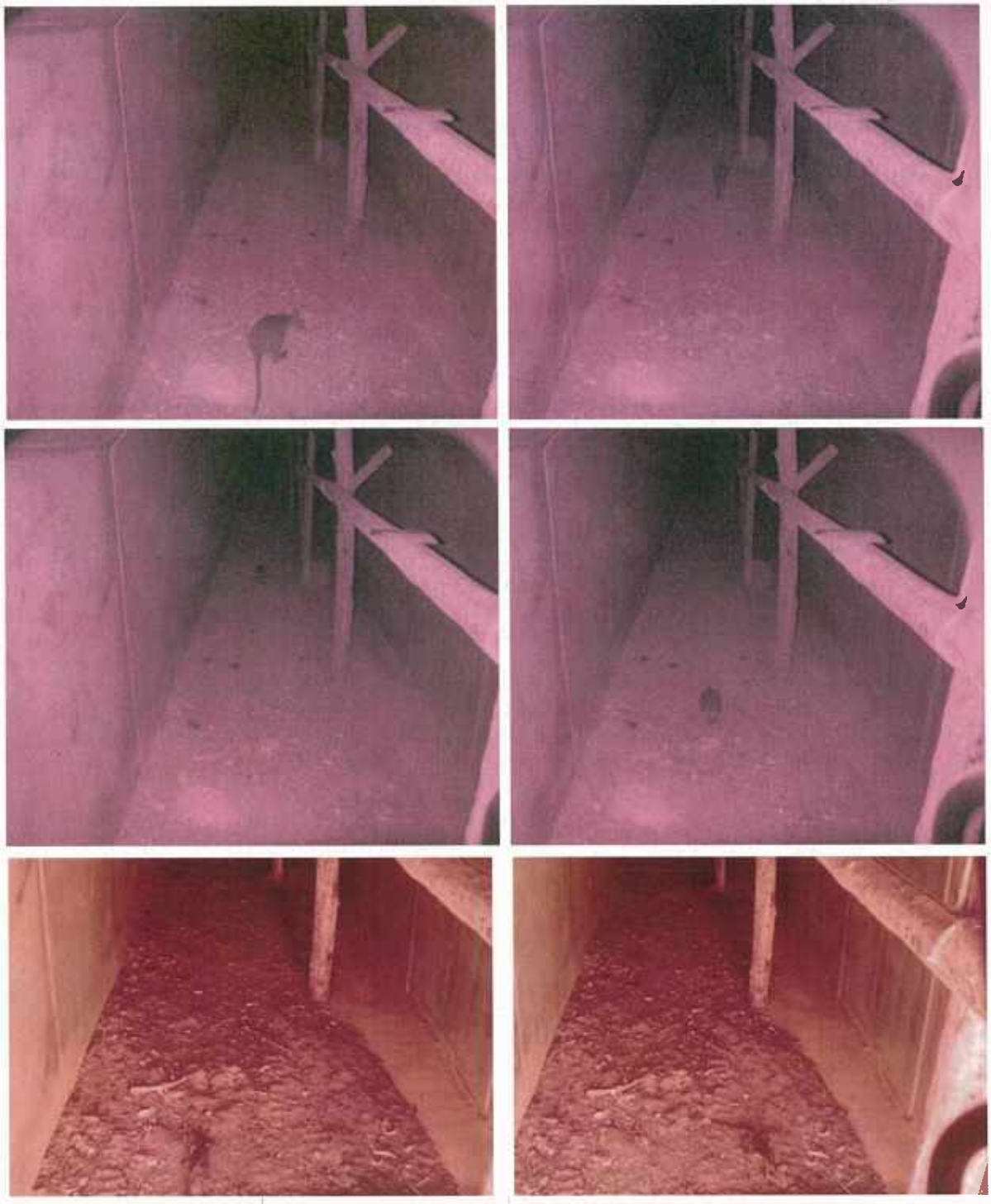
Table E2. Species recorded during the remote surveillance monitoring (RE = Raleigh East; RW = Raleigh West; OP = Overpass).

Common Name	Scientific Name	Infra 2 South	Infra 2 North	RE	RW	OP5	OP6	OP7	OP8
Swamp Wallaby	*Wallabia bicolor*	151	40	5	5	0	1	2	2
Unidentified Macropod	-	23	9	1	2	0	0	1	1
Red Fox	*Vulpes vulpes*	57(5*)	7(2*)	9	5(1*)	6(1*)	6	5(1*)	10 (1*)
Cat	*Felis catus*	29	14	8	14	7	2	5	8
Dingo/Dog	*Canis lupis dingo / familiaris*	14(2*)	9(1*)	0	1	0	5	4	26
Domestic dog	-	0	0	0	0	2	0	0	0
Cow	-	0	0	0	0	0	0	0	1
Koala	*Phascolarctos cinereus*	5	1	8	12	0	0	0	0
Ringtail Possum	*Pseudocheirus peregrinus*	1	0	0	0	0	0	0	0
Brushtail Possum	*Trichosurus vulpecula*	0	0	0	1	0	0	0	0
Mountain Brushtail Possum	*Trichosurus caninus*	0	0	2	1	0	0	0	0
Brushtail Possum species	*Trichosurus sp.*	0	1	8	20	0	0	0	0
Short-beaked Echidna	*Tachyglossus aculeatus*	3	16	4	13	1	1	2	9
Northern Brown Bandicoot	*Isoodon macrourus*	22(1*)	14	0	0	0	0	0	0
Long-nosed Bandicoot	*Perameles nasuta*	0	1	0	1	3	0	1	0
Bandicoot sp.	*Isoodon / Perameles sp.*	9	12	1	0	1	2	1*	0
Medium-sized mammal	-	2	10	7	0	0	0	2	2
Large mammal	-	2	0	0	0	0	1	0	2
Bush Rat	*Rattus fuscipes*	2(2*)	0	0	0	0	0	0	0
Black Rat	*Rattus rattus*	6	3	2	2	0	0	0	1
Swamp Rat	*Rattus lutreolus*	0	0	1*	0	0	0	0	0
Rat	*Rattus sp.*	2	7	3	1	0	0	2(1*)	0
Melomys	*Melomys sp.*	0	0	1*	0	0	0	0	0
Rodent	-	2	0	0	2	0	0	0	0
Antechinus species	*Antechinus sp.*	1	0	1(1*)	1	0	0	0	0
Unidentified Small	-	21	132	220	98	6	20	8	8

Common Name	Scientific Name	Infra 2 South	Infra 2 North	RE	RW	OP5	OP6	OP7	OP8
mammal									
Long-eared Bat	*Nyctophilus sp.*	1	0	4	0	0	0	0	0
Unidentified micro-bat	-	1	2	25	33	0	0	0	0
Unidentified flying species	-	0	2	0	0	0	0	0	0
Magpie-lark	*Grallina cyanoleuca*	0	0	0	0	2	1	5	3
Australian Magpie	*Gymnorhina tibicen*	1	0	0	0	73	110	85	59
Pied Currawong	*Strepera graculina*	0	0	0	0	1	4	3	4
Pied Butcherbird	*Cracticus nigrogularis*	0	0	0	0	1	0	2	0
Torresian crow	*Corvus orru*	0	0	0	0	14	27	50	31
Butcherbird	*Cracticus sp.*	0	0	0	1	2	1	1	1
Laughing Kookaburra	*Dacelo novaeguineae*	0	2	0	0	0	0	2	1
Australian Brush Turkey	*Alectura lathami*	3	2	0	0	3	3	0	0
Superb Lyrebird	*Menura novaehollandiae*	0	0	0	0	0	0	0	1
Southern Boobook	*Ninox novaeseelandiae*	0	9(2*)	0	0	0	0	0	0
Eastern Yellow Robin	*Eopsaltria australis*	0	0	0	0	0	0	1	0
Robin species	-	0	0	1	0	0	0	0	1
Willie Wagtail	*Rhipidura leucophrys*	0	0	2	0	1	1	0	0
Quail / Button-quail	-	0	4	0	0	0	0	0	0
Fairy-wren	-	0	0	0	0	0	0	6	20
Unidentified Bird	-	0	2	0	1	3	9	0	4
Easter Blue tongue	*Tiliqua scincoides*	0	0	7	6	0	0	0	0
Unidentified Skink	-	14	2	0	0	0	0	0	0
Eastern Water Dragon	*Physignathus lesueurii*	2	0	7	4	0	0	0	0
Unidentified Dragon	-	0	1	3	0	0	0	0	0
Lace Monitor	*Varanus varius*	70	64	79	55	1	9	8	1
Unidentified lizard	-	1	0	0	1	0	0	0	0
Common Tree Snake	*Dendrelaphis punctulata*	1*	0	0	2	0	0	0	0
Unidentified snake	-	1	0	2	5	0	0	0	1
Unidentified frog	-	0	1	2	0	1	1*	2	1*
Reptile	-	8	5	7	8	0	0	0	0
Unknown eyeshine	-	33	52	7	18	18	13	15	32
Unknown shape	-	8	15	11	14	2	6	2	6

Table E3. Confirmed complete crossings of fauna at the Raleigh underpass.

Common Name	Scientific Name	No.
Lace Monitor	Varanus varius	50



Possum	Trichosurus sp.	7
Red Fox	Vulpes vulpes	6
Cat	Felis catus	6
Koala	Phascolarctos cinereus	4
Echidna	Tachyglossus aculeatus	4
Eastern Water Dragon	Physignathus lesueurii	3
Eastern Blue Tongue	Tiliqua scincoides	2

Plate E21: Examples of fauna entering the Raleigh underpass and returning without making a crossing.

Limitations

A summary of the operational performance of for each camera is outlined in Table E3. A variety of technical difficulties or environmental issues were responsible for the majority of days in which data were not collected.

Environmental events such as extreme rainfall were responsible for a number of lost data collection days. For example, during late March and early April 2009, heavy rainfall flooded the Raleigh underpass. Both sensors attached to the concrete wall were inundated by the floods. This affected the Raleigh East sensor, with no photos being recorded during the period 04/04/09 to 09/05/09. The floods also resulted in the solar panel cord being disconnected from the Raleigh East battery box, which was later repaired.

Technical problems occurred with two cameras (Overpass 5 and Infra 2 North), resulting in some weeks when these cameras were non-operational. The technical problem was a component of the camera system called the 'regulator', which is a device that supplies a constant voltage to key system components, regardless of the voltage input. For example, the solar panels can output up to 23 volts, but the microprocessor runs on just 5 volts, active IR sensors and the illuminators use 12 volts, and the passive sensors 5 or 6 volts. If the regulator is not functioning properly, the camera system stops taking photographs. Once the problem was diagnosed the regulator was replaced.

Other problems experienced were mainly associated with too many photographs being taken before the download date resulting in the memory card being filled to capacity. This occurred several times at the Raleigh West and Infra 2 North cameras. The land bridge cameras were also susceptible to this problem during heavy rain. From 9 to 13 August 2010 overpass cameras 6, 7, and 8 were removed for a system upgrade.

The comparatively lower operational performance of the Raleigh cameras is primarily due to the fact both camera systems were stolen during January 2010. Both cameras were taken, as well as the batteries, sensors and solar panel. The Raleigh camera systems were reinstalled prior to the Koala breeding season, and were operation by 12 August 2010.

During the later stages of the monitoring the reaction time of the overpass cameras was slowing compared with when the cameras were initially installed. Further technical difficulties were experienced during late October / early November 2010 with the Infra 2 South and overpass 5 cameras, and no more photos were recorded from these cameras.

Table E2. Data collection days for all monitoring cameras

Camera	Data collection period	Dates data not collected	No. days data not collected	% operational
Raleigh West	3/12/2009 – 18/03/2011	9-20/12/08, 7-8/1/09, 15/1/09, 9-11/2/09, 16-21/05/09, 23-29/05/09, 19-22/09/09, 20-29/10/09, 22/11/09, 29/11-3/12/09, 6-7/12/09, 15-21/01/10, 31/01-10/08/10, 28-29/10/10, 26-27/11/10, 19/12/10, 6-12/02/11	182	61
Raleigh East	5/12/2009 – 14/04/2011	04/04/09-09/05/09, 20-21/01/10, 31/01-12/08/10, 21/08-26/08/10	237	52
Infra 2 North	6/12/2009 – 14/03/2011	8/01/09, 14-15/01/09, 14-17/03/09, 11-24/05/09, 28-30/06/09, 12-21/01/10, 9-10/07/10, 28/08-8/09/10, 01/01/11, 4-14/01/11	60	87
Infra 2 South	5/12/2009 – 31/10/2010	26-30/06/09, 20-30/01/10, 31/0410, 1/05/10, 23/08-8/09/10, 18/09-01/10/10	47	86
Overpass 5	11/01/2010 –	15-20/02/09, 22/02/09-19/04/09, 29/05/09, 7-9/11/10, 15-21/01/10, 09-19/02/10, 11-	142	53

	12/11/2010	19/03/10, 1-2/04/10, 15-16/04/10, 10-12/07/10, 23-24/07/10, 18-22/08/10, 17/10-11/11/10		
Overpass 6	11/01/2010 - 5/03/2011	17-20/02/09, 01-03/04/09, 23-29/05/09, 20-29/06/09, 18-22/01/10, 27-29/04/10, 11-12/07/10, 23-24/07/10, 5-15/10/10, 28/12/10-14/01/11, 16-17/01/11, 26-29/01/11	69	83
Overpass 7	11/01/2010 - 13/02/2011	18-20/02/09, 01-03/04/09, 29/05/09, 22-29/06/09, 23/09-2/10/09, 29/11-23/12/09, 25-26/06/10, 10-11/07/10, 23-24/07/10, 15-19/08/10, 30/08-4/09/10, 17-29/10/10, 13/11/10, 1-2/01/11, 7-17/01/11	92	77
Overpass 8	11/01/2010 - 22/02/201	17-19/02/09, 31/03/09-03/04/09, 30/04-01/05/09, 29/05/09, 20-26/12/09, 15-19/02/10, 24/06/10, 9/07/10, 22-24/07/10, 11-23/08/10, 30/08-4/09/10, 14/10/10, 29/10-3/11/10, 11-14/11/10, 29/11-13/12/10, 10-13/01/11, 19-27/01/11, 3-13/02/11	96	76

Effectiveness of Remote Cameras

Generally, the cameras provided excellent data, although minor technical difficulties and environmental issues (e.g., weather events) led to data losses on some occasions (see above).

No Koalas were recorded by cameras on the Bonville fauna overpass; however, subsequent to this study scats were found in the centre of the overpass (J. Pile, pers. comm.) and there is an anecdotal report of a Koala crossing the structure late in 2011 (M. Smith, pers. comm.). This suggests that Koalas and other wildlife may need time to become accustomed to this structure and/or that vegetation cover needs to be provided in order for the structure to be more effective (NB Koalas were detected in the underpasses shortly after construction). Habituation periods of wildlife adjusting to large-scale landscape change and the presence of movement structures can be up to several years, depending on the species and the location (Clevenger and Waltho 2004; Hunt *et al.* 1987; Mata *et al.* 2005).

Camera surveillance systems are designed to be continuously active and are capable of detecting most species of fauna at any given moment. At Bonville this included Lace Monitor, Swamp Wallaby, Red Fox, Dingo and/or Wild Dog, Feral Cat, small reptiles and small mammals (e.g., rodents and dasyurids). This is valuable information and such systems are highly recommended for any future monitoring. However, it needs to be recognised that they are vulnerable to theft, vandalism, flood and water damage, component failures and other limitations. Such limitations should be considered in any future monitoring and are described as follows.

- ***Security***: remote cameras may be subject to theft.
- ***Data Capacity***: if large numbers of 'blank' images are created by environmental conditions triggering the sensors, the memory card can fill before the download date. When this occurs the cameras cannot store any images and stop taking photographs.
- ***Species Detected***: the passive infra-red sensors are capable of detecting most, but not all, fauna passing through the movement structure. This type of sensor detects differences in the heat differential between the animal and the ambient air temperature. Larger species such as wallabies and lace monitors are more easily detected than smaller species such as rodents, though small mammals are regularly detected and photographed. However, identification of individual species is often very difficult due to the resolution of the images retrieved. Nocturnally-active mammals such as Koalas are expected to be readily detected due to their body temperature being well above the ambient air temperature. Nocturnally-active reptiles such as geckos are

difficult to detect because body temperature is often similar to the ambient air temperature.

The active infra-red sensors consist of an infra-red beam, which triggers the camera when the beam is broken. These sensors are used on the Infra-3 land bridge where the infra-red beam is approximately 1 cm above the ground (diameter approximately 20-25 mm). The infra-red beam will be broken by most animal species passing through, except for species such as macropods which could easily jump over it. It is expected that the target species in this study (the Koala) will almost always trigger the beam.

- ***Camera Charge Cycle***: the camera system is designed to conserve battery power by operating in a continuous cycle which periodically charges the illuminator. Each time the sensor is triggered there is a short delay while the illuminator is charged before the photo is taken. This delay is also influenced by the available light at the time (i.e. the illuminator is often not needed during the day and the delay is therefore reduced). If the illuminator is in the 'low charge' phase of the cycle, the time taken for the photo to be taken will be longer than if it was in the 'high charge' phase of the cycle. In the 'low charge' phase the time lag before the photo is taken may be 1-2 seconds longer than the 'high charge' phase. The speed at which the animal is travelling at the time it is detected by the sensor could result in it not being photographed. It is expected that Koalas are unlikely to pass the sensor at such a speed that they would not be photographed.

- ***View of Camera***: the design within the Raleigh underpass is such that most species that trigger the sensor should be captured by the camera, particularly as there are few locations within this system where 'blind-spots' would allow for an animal to pass through the structure undetected (i.e. except in the rare case an animal was positioned behind the wooden furniture when the photograph is taken). There are two 'blind-spots' associated with the Infra 2 underpass design due to the placement of the sensors. The sensors will detect fauna species moving along the ground or the furniture but they are unlikely to detected animals moving along the rocky batters that form a slope towards the base of the bridge. The system was designed for Koalas which would be unlikely to move along the batters. There are two 'blind-spots' associated with the Infra 3 land bridge, due to the security fencing which was constructed around the perimeter of each camera pole. The security fencing is square in shape and comprises steel poles and chicken wire. Small animals would be able to pass through the chicken wire but Koalas would not.

- ***Battery Charge***: technical difficulties sometimes result in the batteries not recharging sufficiently from the solar panel to maintain power for camera operation.

Plot Monitoring

During plot monitoring in 20010, no Koalas were recorded during the plot monitoring at Infra 4 and Infra 13 in either sand trays or soot-track plates. However, a range of other species or faunal groups were recorded (Table E3), and these included wallabies, bandicoots, possums, rodents, dogs, foxes, lizards, snakes and small birds.

Table E3. Fauna recorded during the sand tray and soot-track plate monitoring at Infra 4 and Infra 13 underpasses.

Species group	Notes
Wallaby / Macropod	Probable Swamp Wallaby (*Wallabia bicolor*)
Bandicoot	Long-nosed Bandicoot (*Perameles nasuta*) or Northern Brown Bandicoot (*Isoodon macrourus*)
Possum	Possible Sugar Glider (*Petaurus breviceps*), possible Common Brushtail Possum (*Trichosurus vulpecula*)
Small mammal	Definite House Mouse, definite *Rattus* sp., possible *Melomys* sp., definite

	Antechinus spp.
Larger Mammal	Definite Dog / Dingo, Red Fox (*Vulpes vulpes*), Cat (*Felis catus*), possible Echidna (*Tachyglossus aculeatus*)
Large Lizard	Probable Eastern Blue Tongue (*Tiliqua scincoides*), Dragon spp., possible Land Mullet (*Bellatorias major*), possible Lace Monitor (*Varanus varius*)
Small Lizard	Skink spp., Gecko spp.
Snake	Common Tree Snake (*Dendrelaphis punctulata*) was lying on sand when approached,
Bird	Small passerine, non-passerine, parrot, probable Brown Quail (*Coturnix ypsilophora*). Possible Fairy-wren spp.

Appendix D: Koala Home-ranges, Bonville

The home-ranges of Koalas that were tracked in the study area from 2000 to 2010 are shown in Figures H1 to H9. In these figures, dots indicate the location of the animal each time it was tracked and sighted. The predicted movement pattern is shown as mathematically derived concentric circles. The outer contour of each home-range is the predicted 95% confidence limit (i.e. there is a 95% chance that the Koala will be found within that contour). These home-ranges are not exclusive areas, and often overlap with the home-ranges of other Koalas. In some cases, the home-ranges that are indicated include either the highway or the powerline easement, but these areas do not constitute Koala habitat and should not be considered as part of any animal's home-range.

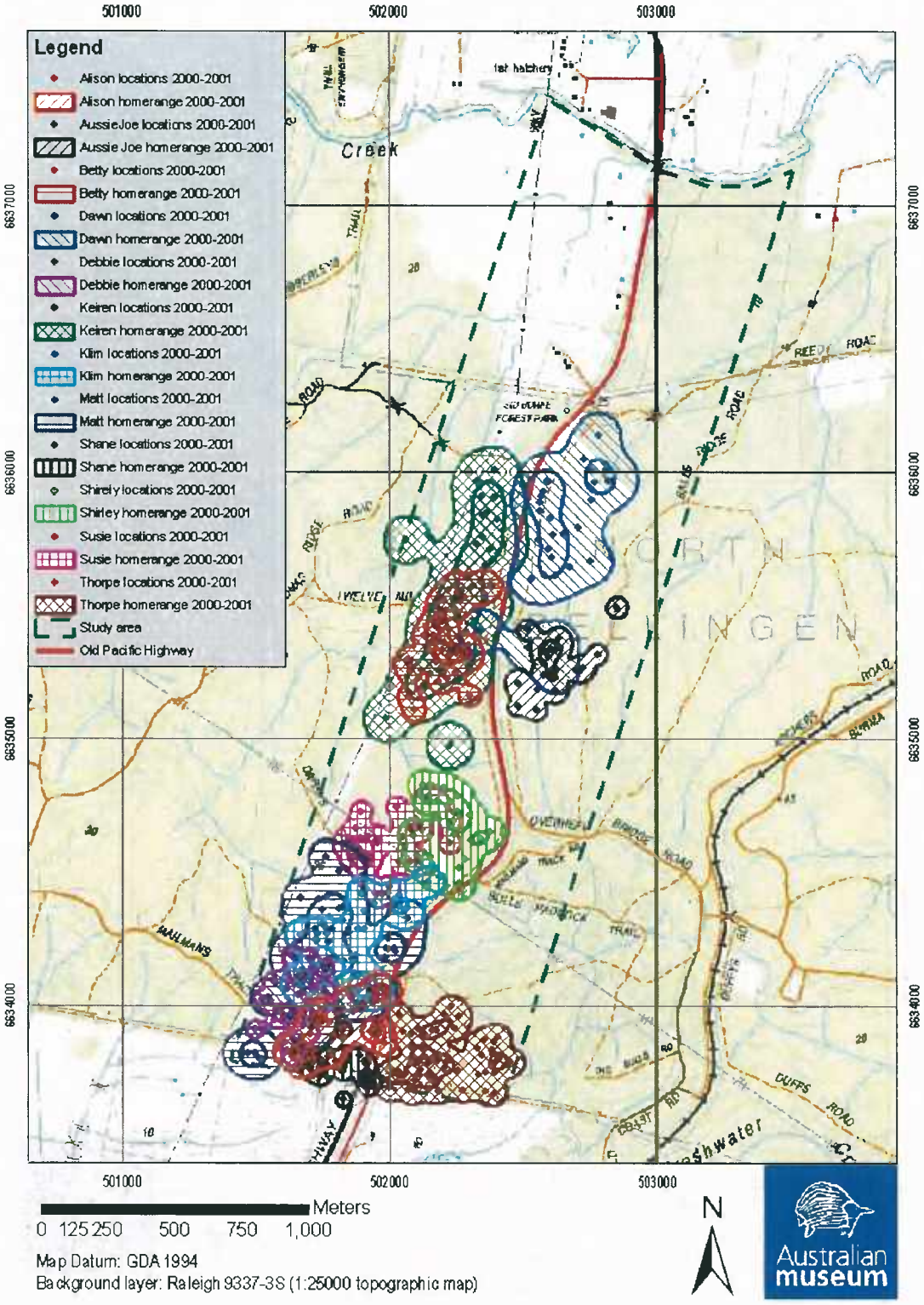


Figure F1: Koala home-range estimations during 2000 to 2001

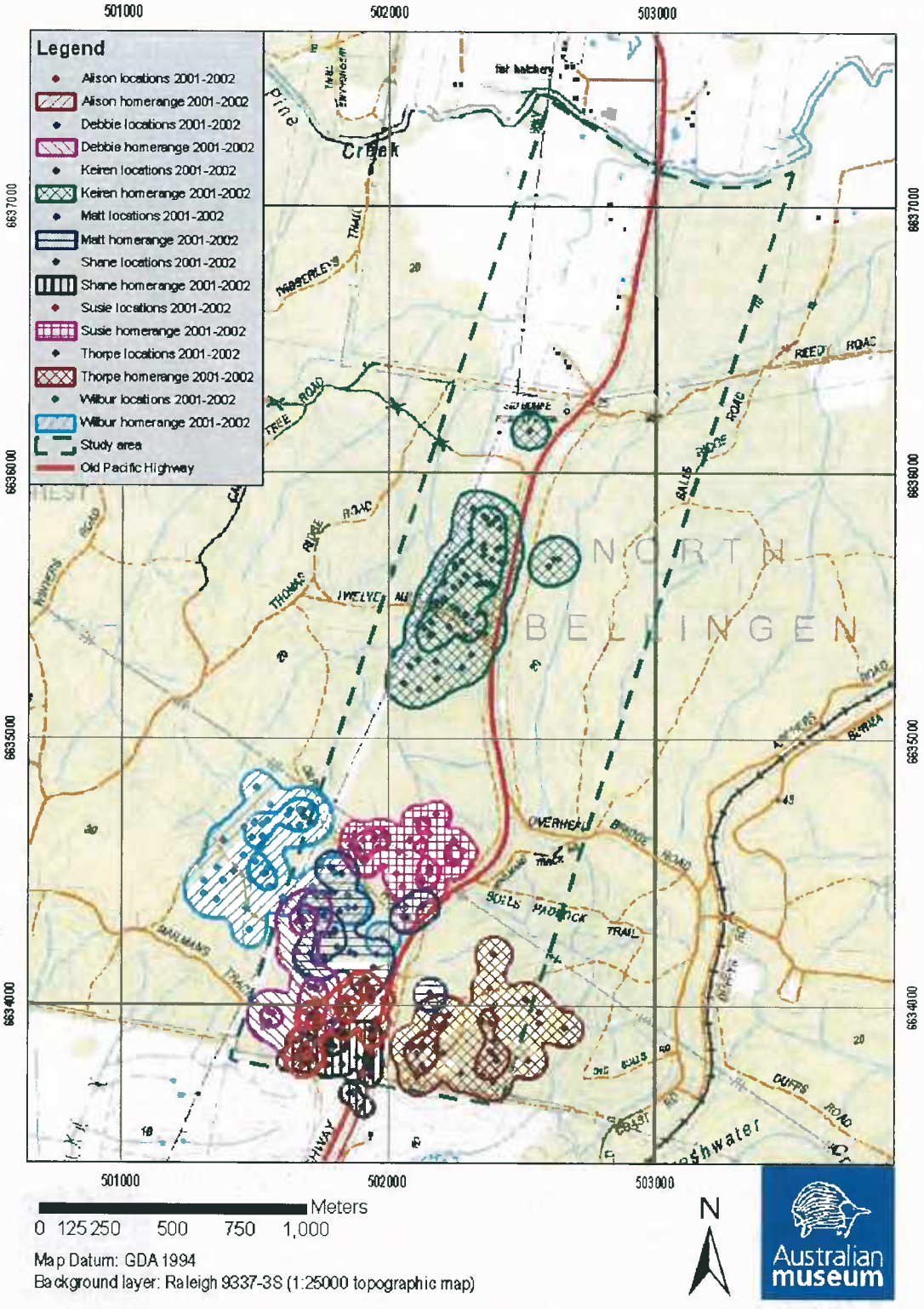


Figure F2: Koala home-range estimations during 2001 to 2002

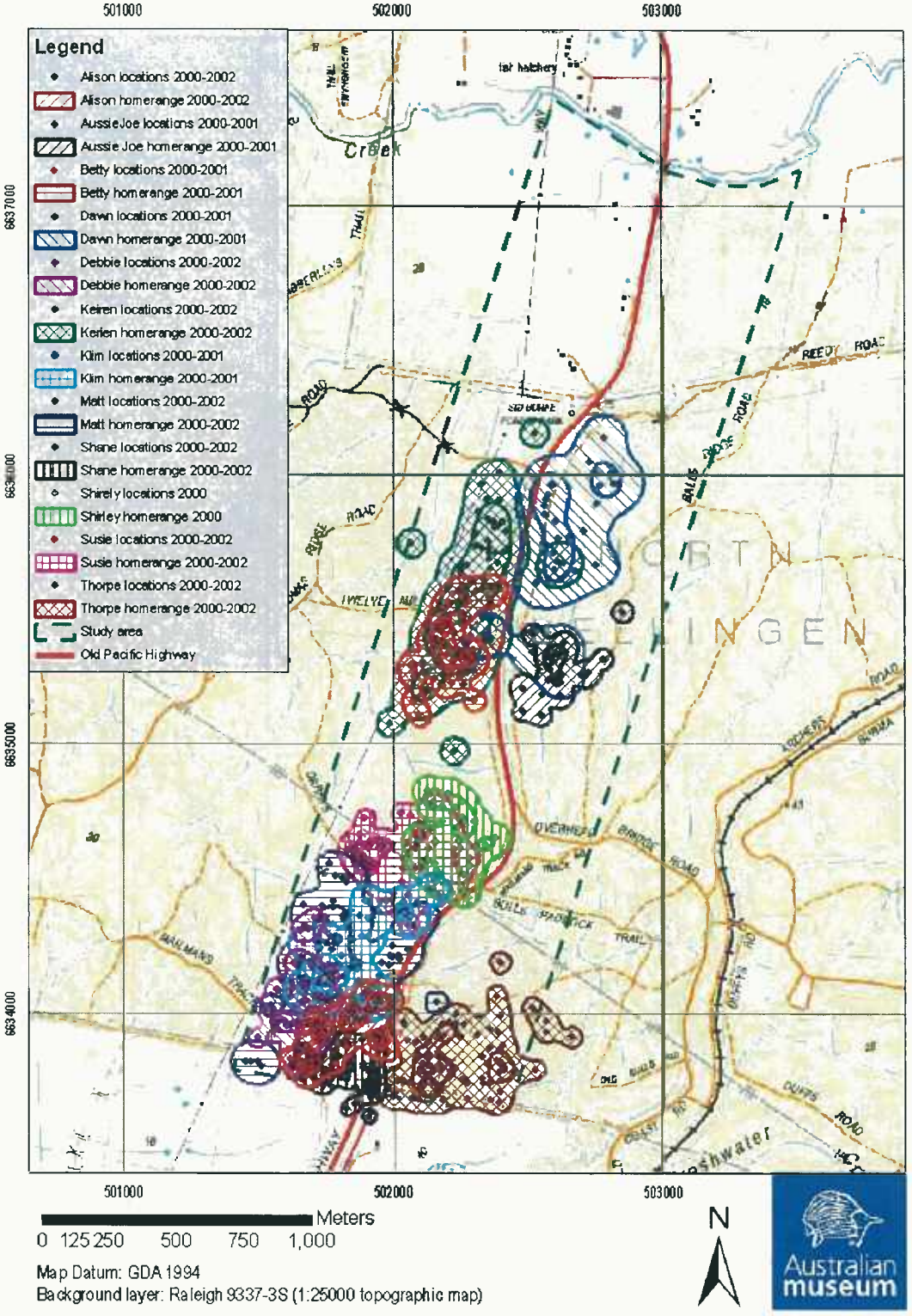


Figure F3: Koala home-range estimations during Phase 1 (2000-2002)

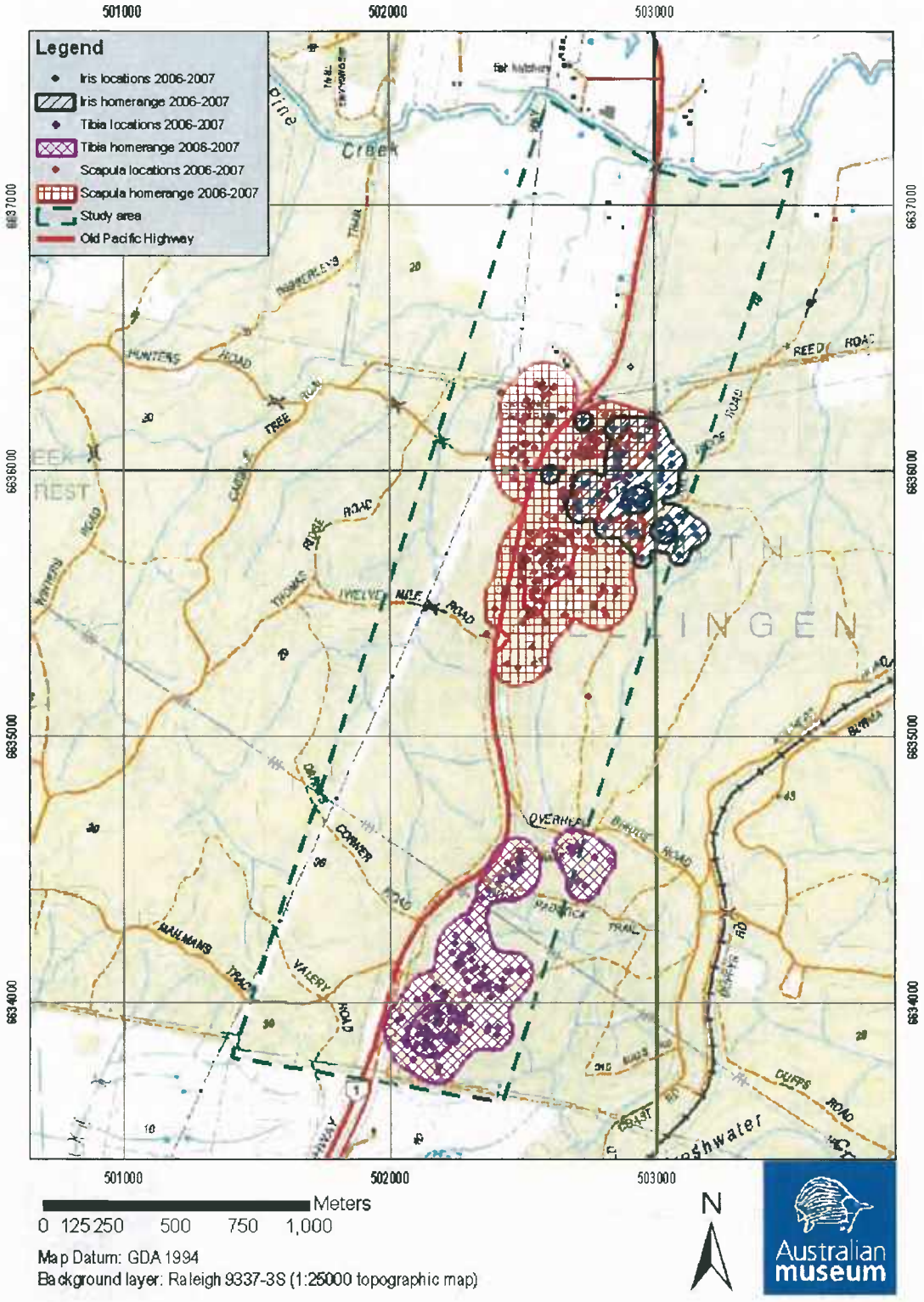


Figure F4: Koala home-range estimations during 2006 to 2007

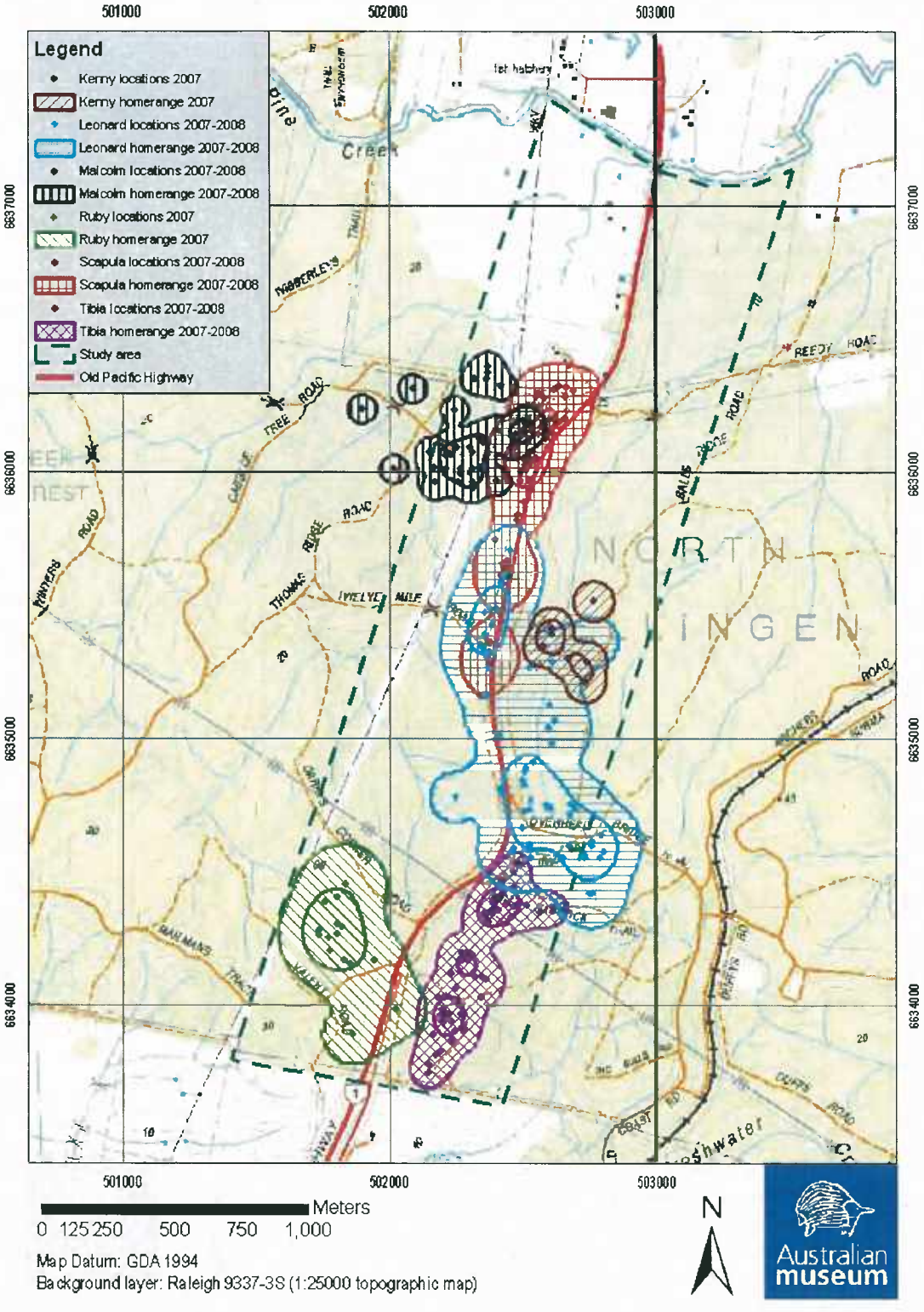


Figure F5: Koala home-range estimations during 2007 to 2008

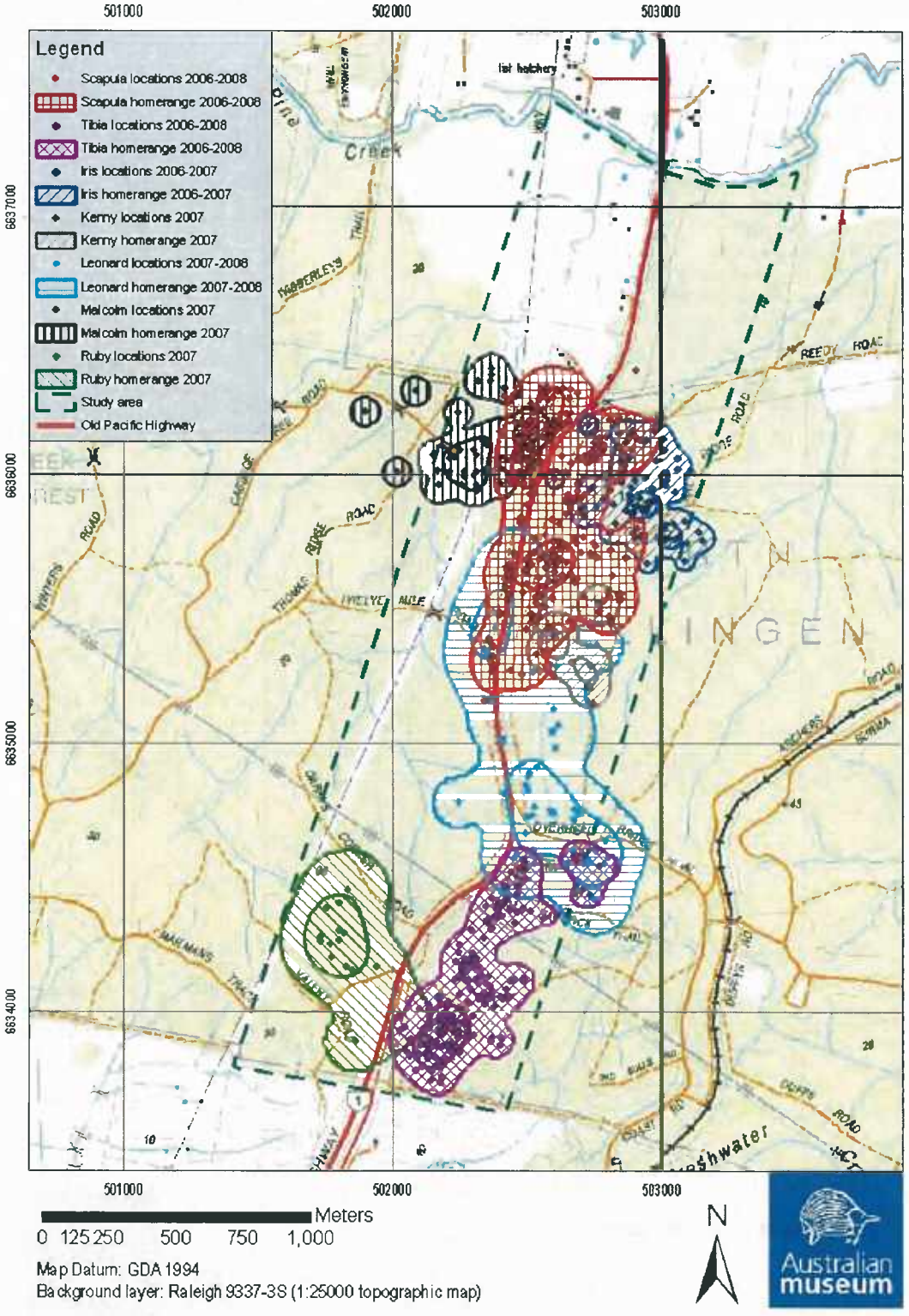


Figure F6: Koala home-range estimations during Phase 2 (2006-2008)

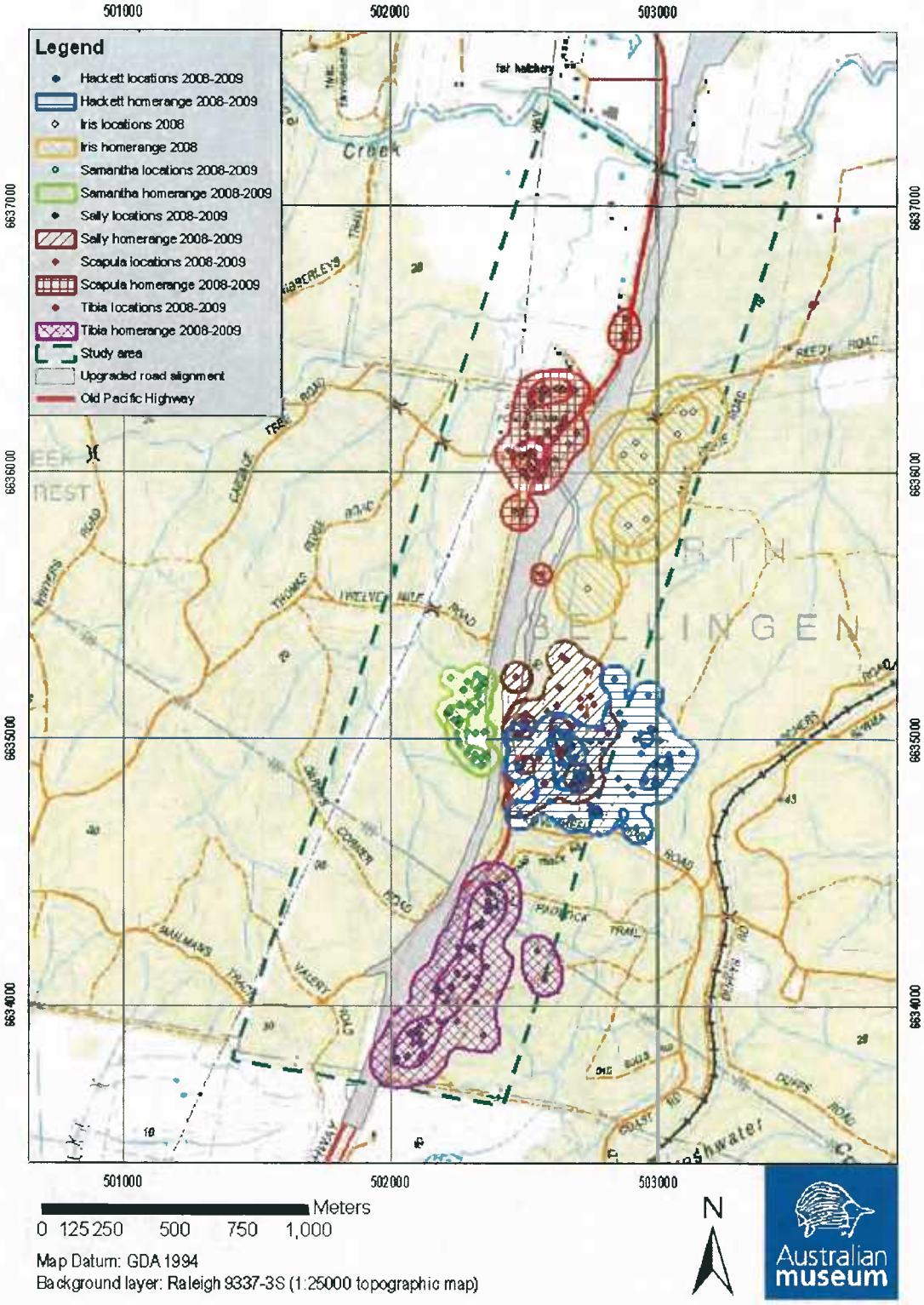


Figure F7: Koala home-range estimations during 2008 tom 2009

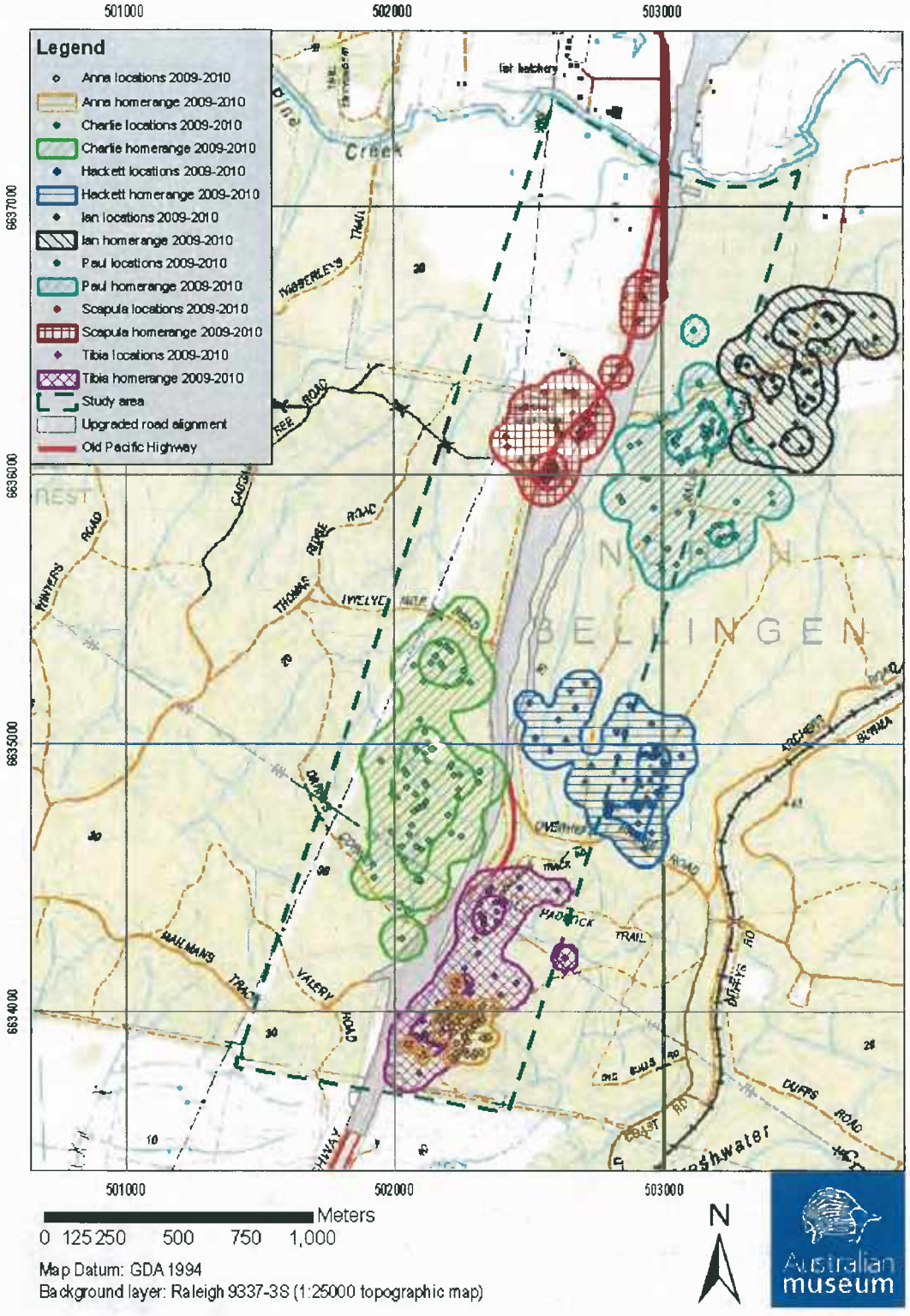


Figure F8: Koala home-range estimations during 2009 to 2010

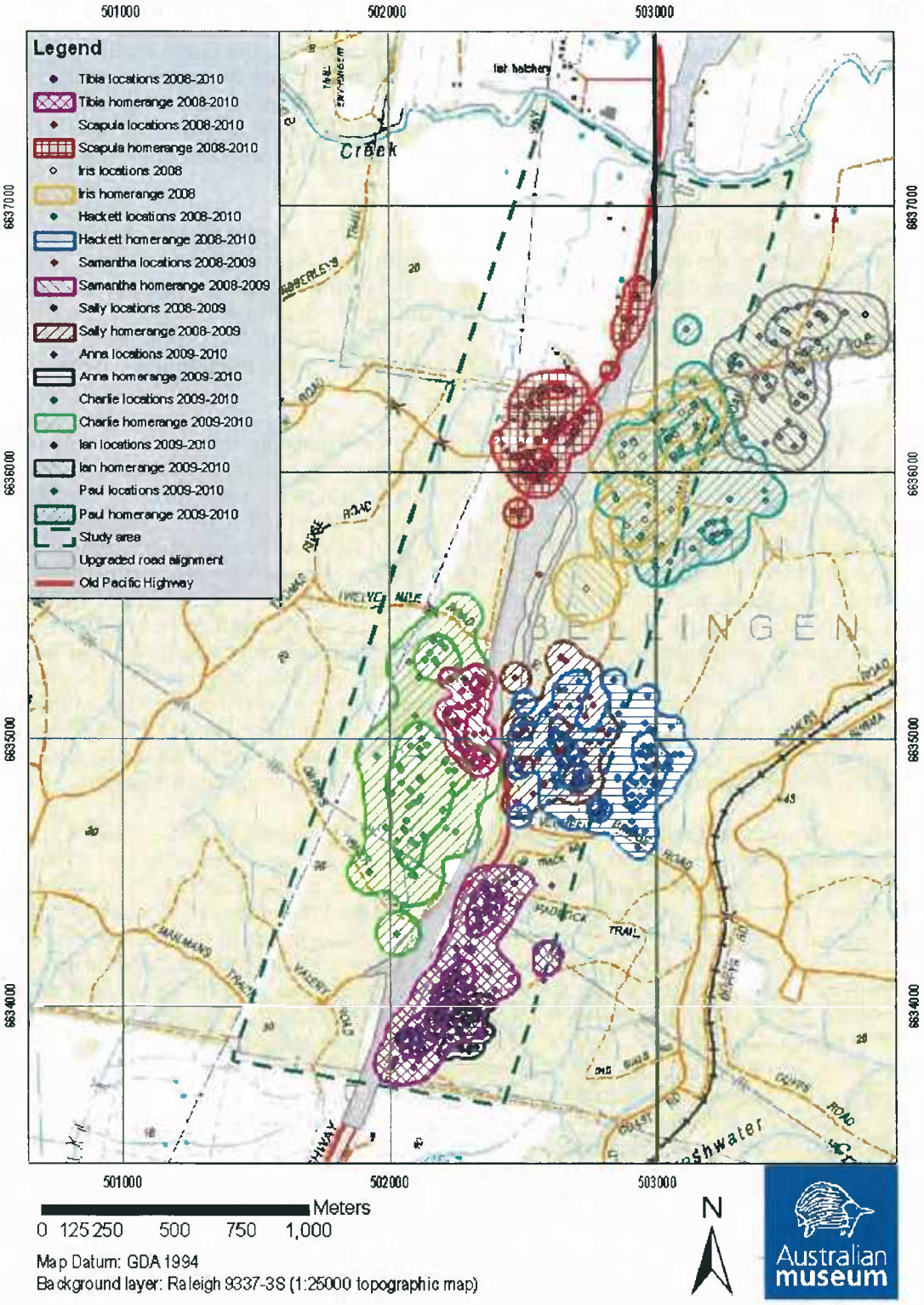


Figure F9: Koala home-range estimations during Phase 3 (2008-2010)

Appendix E: Notes on Fauna Exclusion Fencing

The data obtained throughout the course of the project suggests the fauna exclusion fencing has been successful in reducing Koala mortalities. Despite the fact that road mortalities were still recorded during the first year after the permanent fauna fencing was installed, revision of the design and identification of potential weaknesses, has allowed improvements to be made which at this stage appear to have been effective; no Koalas were recorded dead on the highway during 2010.

There are several examples from radio-collared Koalas which suggest that the fauna exclusion fencing prevents some individuals from moving onto the highway. Some of these are from resident animals recorded adjacent to the fauna fencing and on some occasions on branches overhanging the fence. For resident animals it is difficult to determine whether the individual would move onto the highway or remain in the bushland, but it is clear that the fauna exclusion fencing represents a boundary to individuals with home-ranges close to the upgraded alignment.

The best examples of the effectiveness of the fauna exclusion fencing have come from dispersing radio-collared Koalas. A young Koala (Bob) was captured and radio-collared 22 September 2009 on the western side of the Pacific Highway, very close to the Raleigh underpass. He was a sub-adult male estimated to be 2 years old. Upon release Bob began moving north (Figure G1). By 1 October 2009 he had reached Twelve Mile Road, and by 5 October he had reached Sid-Burke Forest Park. Bob continued moving north leaving Sid-Burke on 9 October, moving adjacent to the fauna fence on the eastern side of the service road. He continued north within this narrow strip of vegetation until he reached Pine Creek when he turned west, moving approximately 450 m west of the bridge. On 16 October Bob was recorded on the north side of Pine Creek. It was determined Bob was unlikely to establish a stable home-range within the study area. Consequently, he was trapped, his radio-collar removed, and subsequently released near the corner of Hunters Road / Flying Fox trail. During this period Bob was recorded on several occasions in trees adjacent to the fence. It is likely the fence has greatly reduced the risk of Bob moving onto upgraded alignment.

Another example is a Koala (Brown) who was captured and collared on 27 September 2009 on the eastern side of the highway adjacent to the service road, approximately 100 m south of Reedy Road. After release Brown's movements were erratic, he did not display normal ranging behaviour (Figure G2). On 29 September 2009 Brown had moved north close to the edge of the National Park near Pine Creek. On 30 September he was recorded on the northern side of Pine Creek; it is likely that he swam across. On 2 October 2009 he was recorded further north adjacent to Archville Station Road. It was decided to attempt to trap Brown and possibly remove his collar. However, Brown evaded capture and was the following day adjacent to the Pacific Highway and Pine Creek. On 4 October 2009 he was recorded on the southern side of Pine Creek, and it is likely he swam the creek again. On 7 October he was recorded closer to the centre of the bushland referred to as Woods', north of Reedy Road. On 8 October Brown's radio-collar signal failed and has not been received since. Despite the obvious risk exposed to Brown at Archville Station Road (there are no fauna fences here), his movements back into the study area brought him very close to the fauna fencing, which likely prevented him from moving onto the upgraded alignment.

Matilda, a young Koala captured and collared on 16 September 2008, demonstrated the limitations of the fauna exclusion fencing. In the first 7 days after collaring, Matilda moved approximately 2.75 km in a southerly direction, at which point she was located outside the study area in a small patch of trees between the Pacific Highway and the Old Pacific Highway (Figure G3). Because the animal was less than 10 m from the Pacific Highway in an area with no fauna fence, she was recaptured on 24 September 2008 and released in the original capture tree. Matilda then moved in a south-easterly direction approximately 5.4 km in 10 days, to a location well outside of the study area near Mylestom (Figure G3). She was then recaptured and her collar removed. After discussing the matter with DECC, Matilda was

released inside the National Park well away from the highway. While the fauna exclusion fencing has been effective in preventing animals from moving onto the highway within the study area, locations where the fauna fencing stops become an immediate risk to any Koalas near the road.

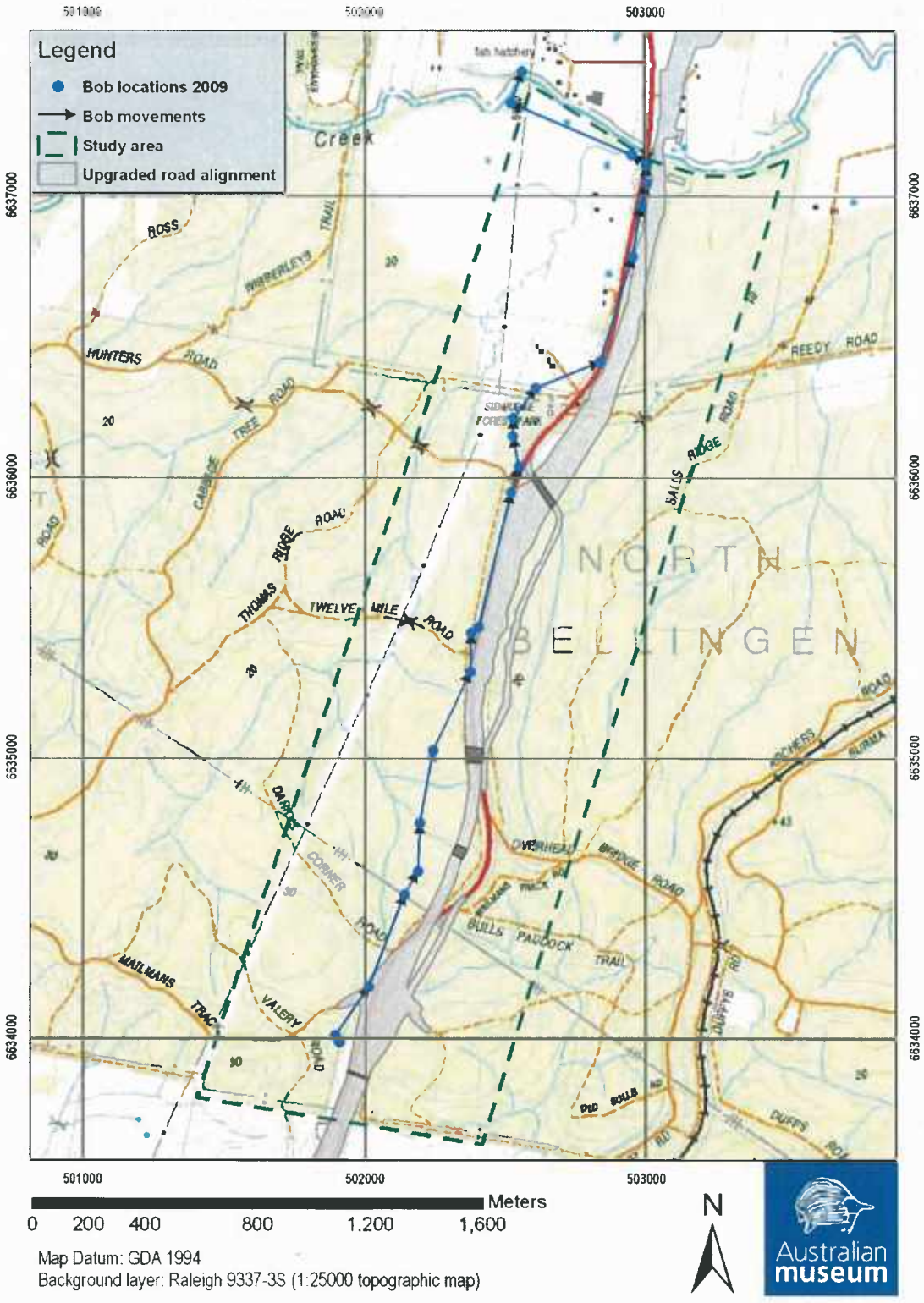


Figure G1: Movements for Bob from 22 September to 16 October 2009

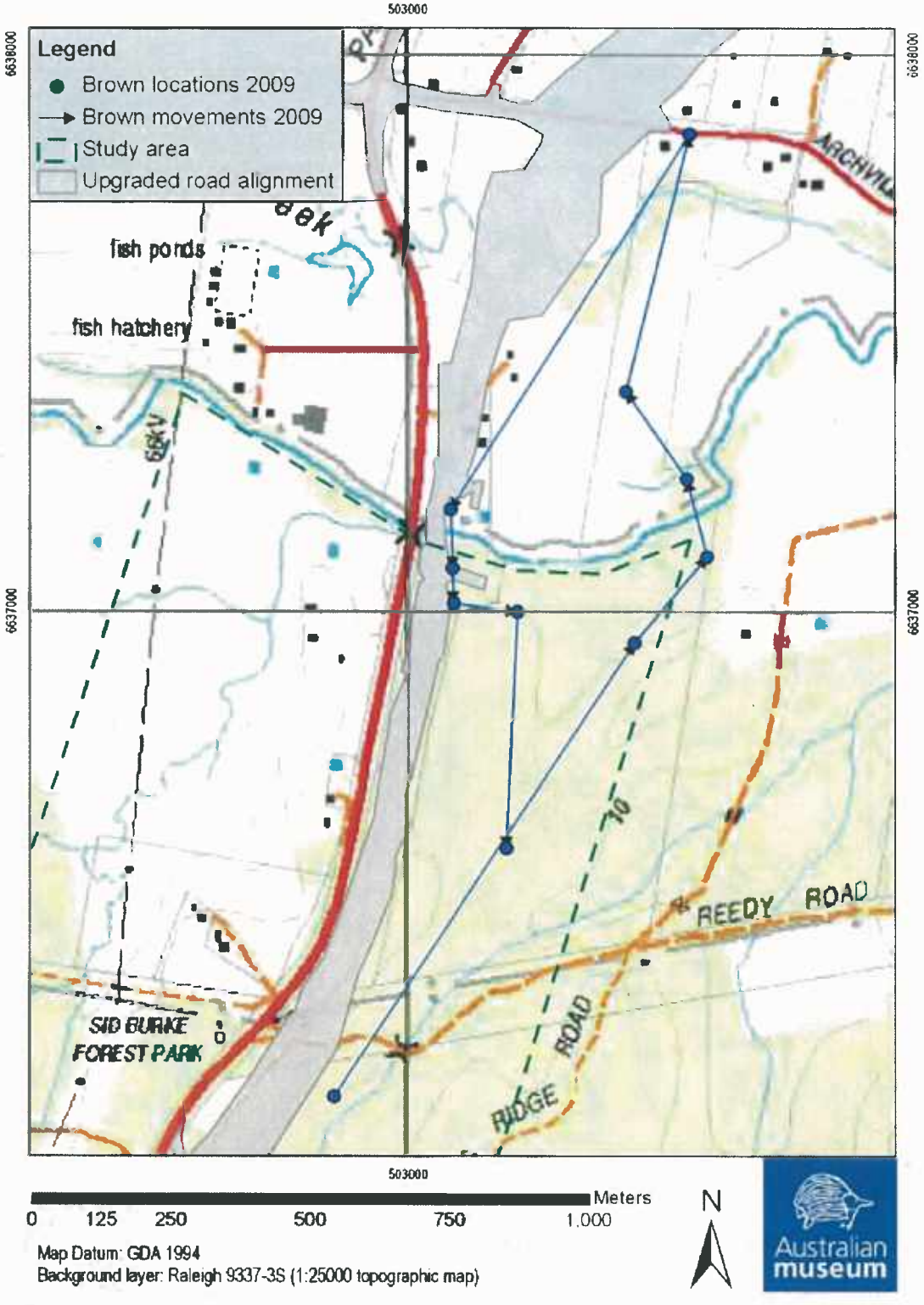


Figure G2: Movements for Brown from 27 September to 7 October 2009

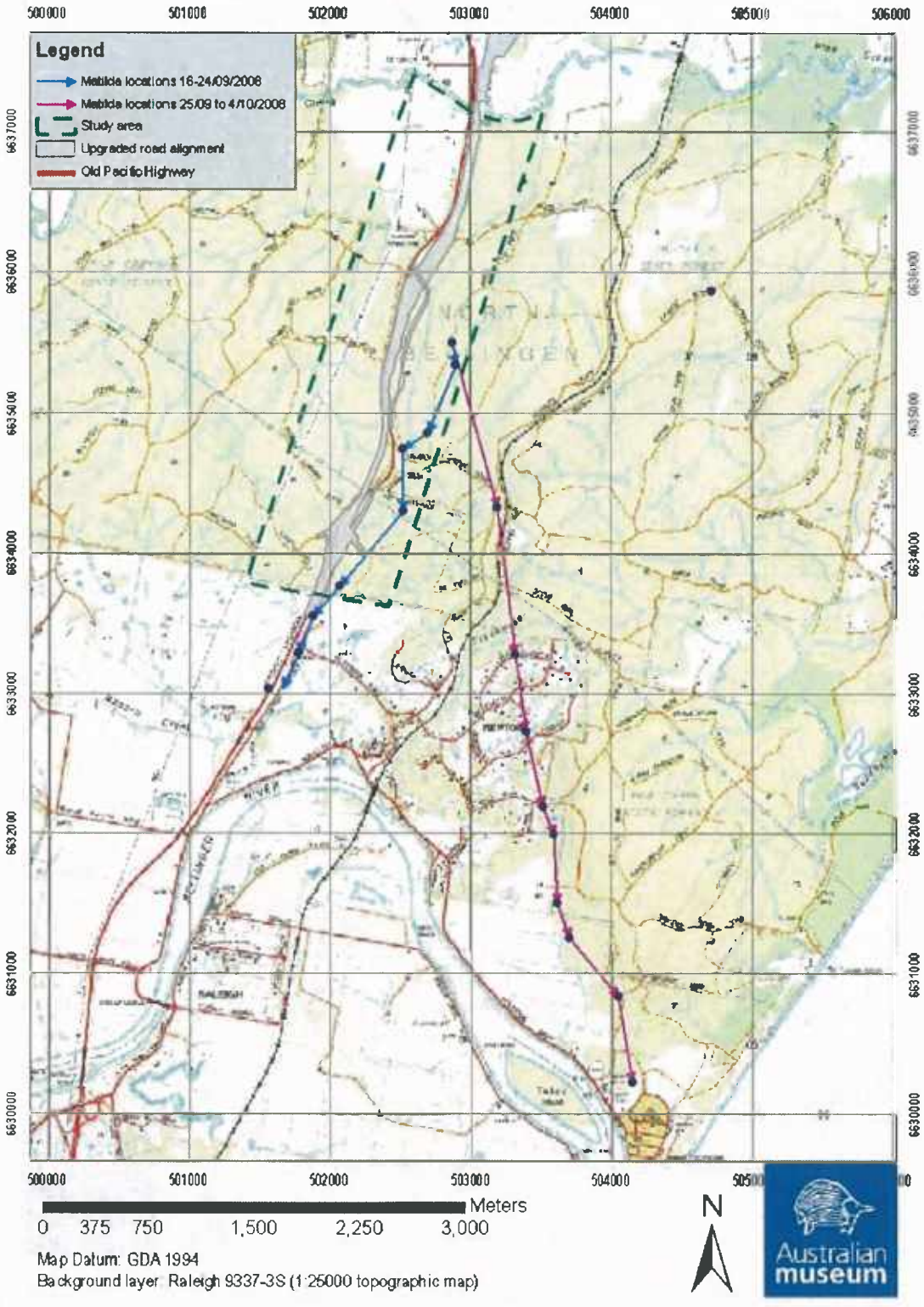


Figure G 3: Movements for Matilda from 16 September to 4 October 2008

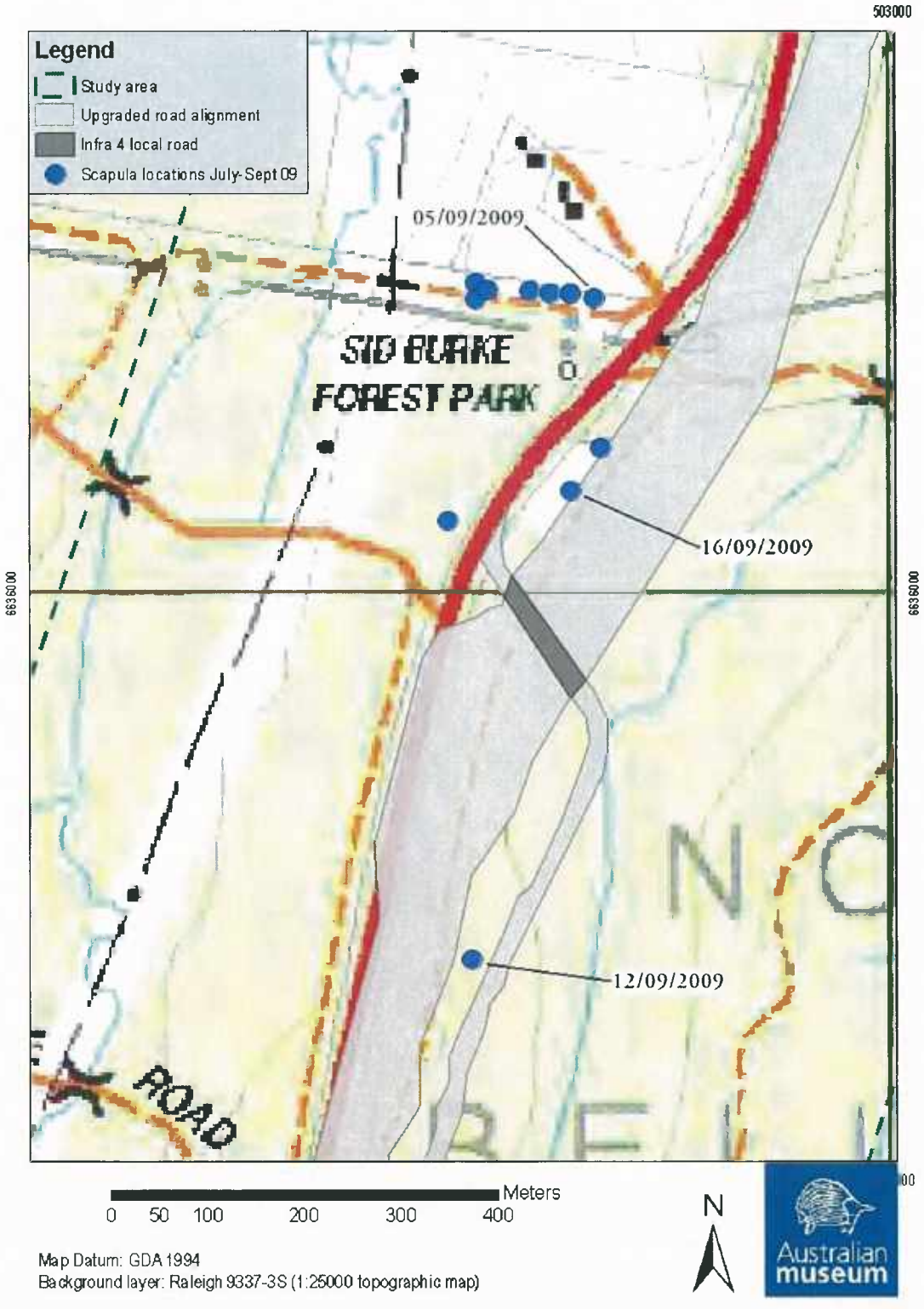


Figure G4: Scapula locations July to September 2009