



Northern Beaches Hospital Connectivity and
Network Enhancement Project:
Ecological Monitoring Program Implementation
2018/19

FINAL REPORT

Prepared for Ferrovial York Joint Venture

27 March 2020

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1 Introduction

Biosis Pty Ltd was commissioned by Ferrovial York Joint Venture (FYJV) to implement the 2018/19 Ecological Monitoring Program (EMP) for the Northern Beaches Hospital Connectivity and Network Enhancement (NBHCaNE) Project (the Project). The NBHCaNE EMP (Biosis Pty Ltd 2016a) outlines specific monitoring requirements developed to measure the effectiveness of the mitigation actions prescribed in the Project's Flora and Fauna Management Plan (FFMP) (FYJV 2016). The FFMP forms part of the Construction Environmental Management Plan (CEMP) and applies to the Project footprint and any additional areas likely to be directly or indirectly impacted by the construction of the Project.

This report addresses the monitoring works undertaken by Biosis during the 2018/2019 monitoring year (July 2018 to June 2019), including the biannual Red-crowned Toadlet *Pseudophryne australis* monitoring surveys and autumn 2019 nest box monitoring surveys. This report also includes assessment of the effectiveness of the Project's ecological mitigation measures based on the listed assessment criteria detailed in Table 3.3 (Monitoring Actions) of the NBHCNE EMP (Biosis Pty Ltd 2016a), provided in Appendix 1.

1.1 Project background

The Project has been assessed under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) and has been classified as State Significant Infrastructure (SSI). Infrastructure approval for Stage 1 of the Project was issued on 29 June 2015 (SSI-6434), and 25 February 2015 (SSI-6622) for Stage 2. Both of these approvals are subject to formal Conditions of Approval (CoA). The *NBHCaNE EMP* was prepared in accordance with these conditions and outlines the required monitoring actions and responsibilities for the Project.

The monitoring actions and reporting requirements outlined by the NBHCNE EMP that are applicable for the 2018/19 monitoring year are listed below in Table 1. The full list of monitoring actions as listed under Table 3.3 (Monitoring Actions) of the NBHCNE EMP (Biosis Pty Ltd 2016a) are attached in Appendix 1. A brief summary of progress against each of these items, as provided by FYJV, is attached in Appendix 2.

Table 1 Summary of NBHCaNE 2018/2019 EMP implementation tasks

Action	Monitoring events over reporting period July 2018 to June 2019	Survey effort	Reporting requirements
1. Pre-clearing	Inspection of hollow-bearing trees in clearing areas. Monitoring of vegetation clearance in areas adjacent to ecologically sensitive areas.	Monitoring undertaken by FYJV with Biosis assistance	Annual report
2. Nest boxes	Monitoring of nest boxes during construction. Maintenance inspection undertaken during nest box monitoring. Maintenance activities undertaken annually.	Biosis monitoring inspection	Annual report
3. Red-crowned Toadlet monitoring	Bi-annual monitoring of impact and control sites during construction in optimum conditions (during or soon after rainfall periods) as per the <i>NBHCaNE: Red-crowned Toadlet Management Plan</i> (Biosis Pty Ltd 2016b). Late winter/early spring season Late summer/early autumn season	Survey of 200 m transects at each of the 5 monitoring site undertaken twice by Biosis	Annual report
4. Weeds and pathogens	Monitor and manage weeds and pathogens during construction	Weed removal as required by FYJV	Nil
5. Unexpected threatened species	Specialist inspections as required.	As required	Nil
6. Powerful Owl habitat	Two potential Powerful Owl habitat trees have been previously identified in bushland areas (Biosis Pty Ltd 2015). No impacts to these trees are expected by the current scope of works.	As required	Nil
7. Revegetation	Revegetation efforts to be monitored annually after the initial revegetation works. Revegetation documented in Urban Design and Landscape Plan (AECOME Australia Pty Ltd 2016).	Annually after initial revegetation	Nil
8. Road kill	Roadkill monitoring monthly	Monthly inspections by FYJV	Annual report
9. Microbat habitat	Inspection of large diameter culverts and man-made structures pre-impact.	As required	Nil

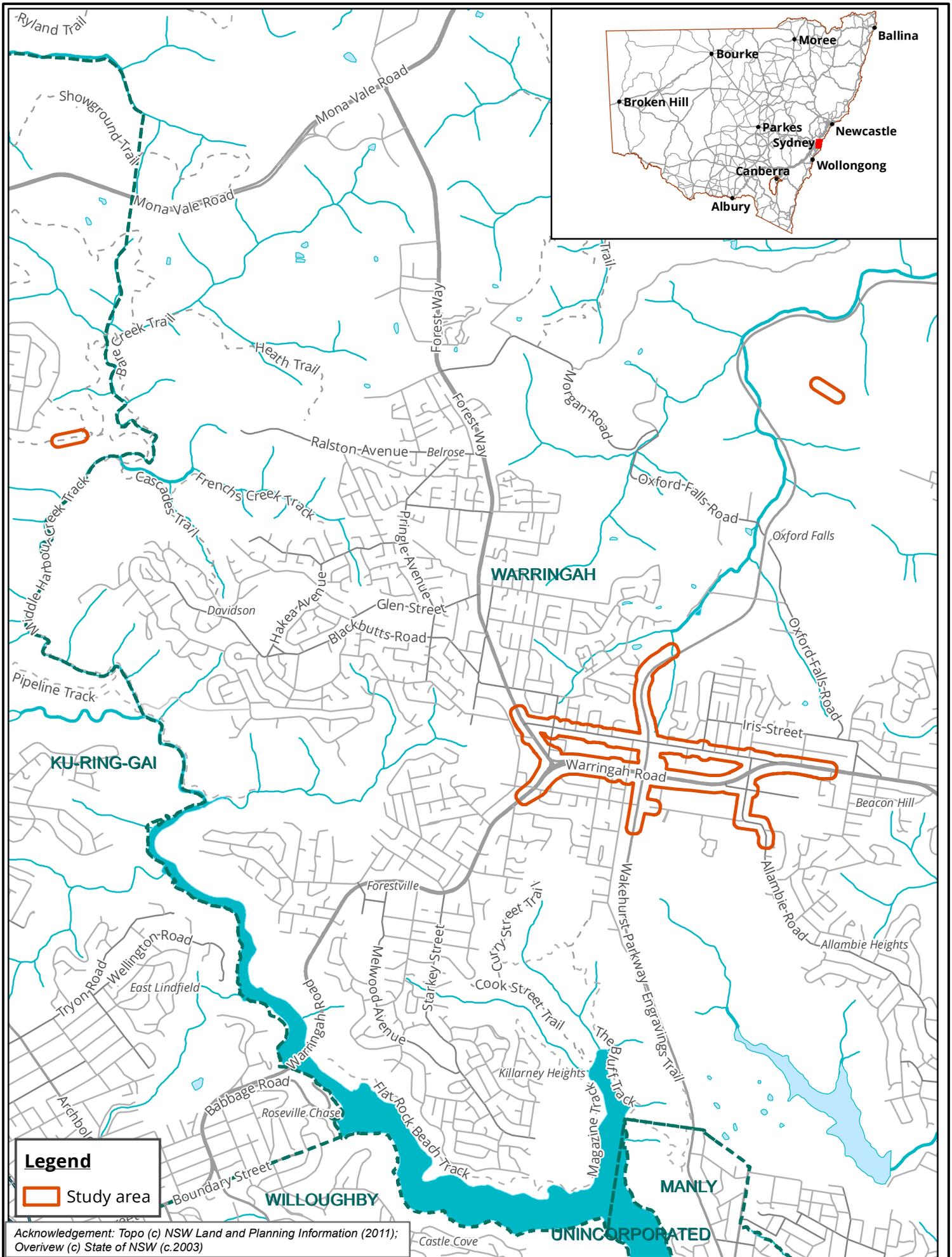
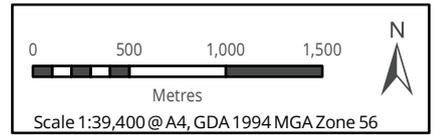


Figure 1 Location of the Study area



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 Albury, Ballarat, Melbourne,
 Newcastle, Sydney, Wangaratta & Wollongong

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2 Methods

The following section outlines the methods applied for all NBHCNE EMP monitoring surveys conducted during the 2018/2019 reporting period.

2.1 Nest box monitoring

Nest box monitoring was conducted by two ecologists on 11, 12 and 15 April 2019. All nest boxes were initially inspected from the ground for any signs of fauna occupation and to determine any maintenance required. The box interior was then examined from the ground (where possible) using a pole-mounted inspection camera. Internal inspection was undertaken to identify signs of current (fauna present) or previous (e.g. nesting material, scats, feathers) occupancy.

Where nest boxes were mounted too high to be reached with an inspection camera, extended ground-based observations were undertaken to detect signs of current or previous occupancy such as:

- fauna visible at entrance to nest box
- fauna observed entering or exiting the nest box
- nesting material visible at entrance to nest box
- chewed entrance to nest box
- white wash or bat guano at nest box entrance or beneath nest box
- scats, egg shells, regurgitated pellets, feathers or discarded food items on the ground beneath the nest box

Nest box monitoring was undertaken in accordance with recommendations of the *NBHCaNE Nest Box Strategy* (Biosis Pty Ltd 2016c) and EMP, and is consistent with the recommended methodology outlined in the NSW Roads and Traffic Authority (now NSW Road and Maritime Services) *Biodiversity Guidelines – Guide 8: Nest boxes* (RTA 2011).

2.2 Red-crowned Toadlet monitoring

2.2.1 Targeted survey

Baseline surveys for Red-crowned Toadlets within the Project area were previously conducted to ground-truth the presence of suitable habitat and establish transects that form the control and impact sites used in the EMP monitoring surveys (Biosis Pty Ltd 2016b). Suitable habitat for the species was identified at six monitoring sites, however control site 5 has been removed from the monitoring program due to non-detection of Red-crowned Toadlet across multiple monitoring periods. The control and impacts sites used in the 2018/19 monitoring season are listed in Table 2.

The following methods were employed during the 2018/19 monitoring surveys:

- A 200 metre transect was established within each site with all surveys were conducted along these transects.
- Each 200 metre transect was surveyed twice by two ecologists. Call playback was used at several points along each transect to elicit a calling response.

- At the end of each 200 metre transect survey, a tally of all Red-crowned Toadlet individuals calling was recorded to provide a measure of relative abundance at each site.
- Surveys were undertaken during optimal conditions, during or soon after heavy rainfall.

The spring 2018 monitoring for Red-crowned Toadlet was conducted on 1 November 2018. Each 200 metre transect was inspected twice, once during the late afternoon and again at night.

The autumn 2019 monitoring for Red-crowned Toadlet was conducted on the 27 and 28 March 2019. Each 200 metre transect was inspected once on each day in the late afternoon / early evening. Surveys were split across two days to target the late afternoon and early evening period when Red-crowned Toadlet calling is expected to be at its most active (NPWS 2001).

Table 2 Monitoring sites

Site	Type	Location	Latitude	Longitude
1	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	-33.7432	151.2372
2	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	-33.7451	151.2372
3	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	-33.7474	151.2365
4	Impact	Curl Curl Creek (ESU 8) in the Stage 2 Project footprint	-33.7542	151.2349
6	Control	Cascades Trail, St Ives	-33.7267	151.1844

2.2.2 Surface water monitoring review

FYJV undertakes a surface water quality program in the creeks surrounding the project site, as part of the project's Water Quality Monitoring Program. Monthly monitoring data is collected for a range of water quality parameters, including dissolved metals, nutrients (ammonia, total nitrogen, nitrate, nitrite, phosphorous), pH, temperature, total suspended solids, hydrocarbons and other analytes. The results of the water quality monitoring program is published on the project Roads and Maritime Services website.

Surface water flow data was provided by FYJV to supplement the Red-crowned Toadlet monitoring program. Surface water flow data was provided for four locations within the study area (Figure 3), with monitoring occurring in September and November 2018, and February and June 2019.

2.3 Roadkill monitoring

Roadkill monitoring transects have previously been established within the Project footprint at key locations where fauna habitat borders the road corridor (Figure 2). Monthly roadkill monitoring was undertaken by a FYJV representative walking along each of these marked transects as outlined in the Roadkill Monitoring Plan, included as Appendix 1 of the *NBHCaNE EMP* (Biosis Pty Ltd 2016a). Any observed roadkill along with the date, species and location was recorded. Transects are required to be monitored monthly. Any additional observations or reports of roadkill within the Project footprint were also recorded.



Legend

- Monitoring transects

Project footprint

- Ancillary site facility
- Stage 1 EIS boundary
- Stage 2 EIS boundary

Figure 2 Road Kill Monitoring Plan Transects



Acknowledgements:
 Topo (c) NSW Land and Planning Information (2015)
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 26555_F3_RoadKillMonitoring

0 40 80 120 160 200

Metres

Scale 1:4,100 @ A3

Coordinate System: GDA 1994 MGA Zone 56

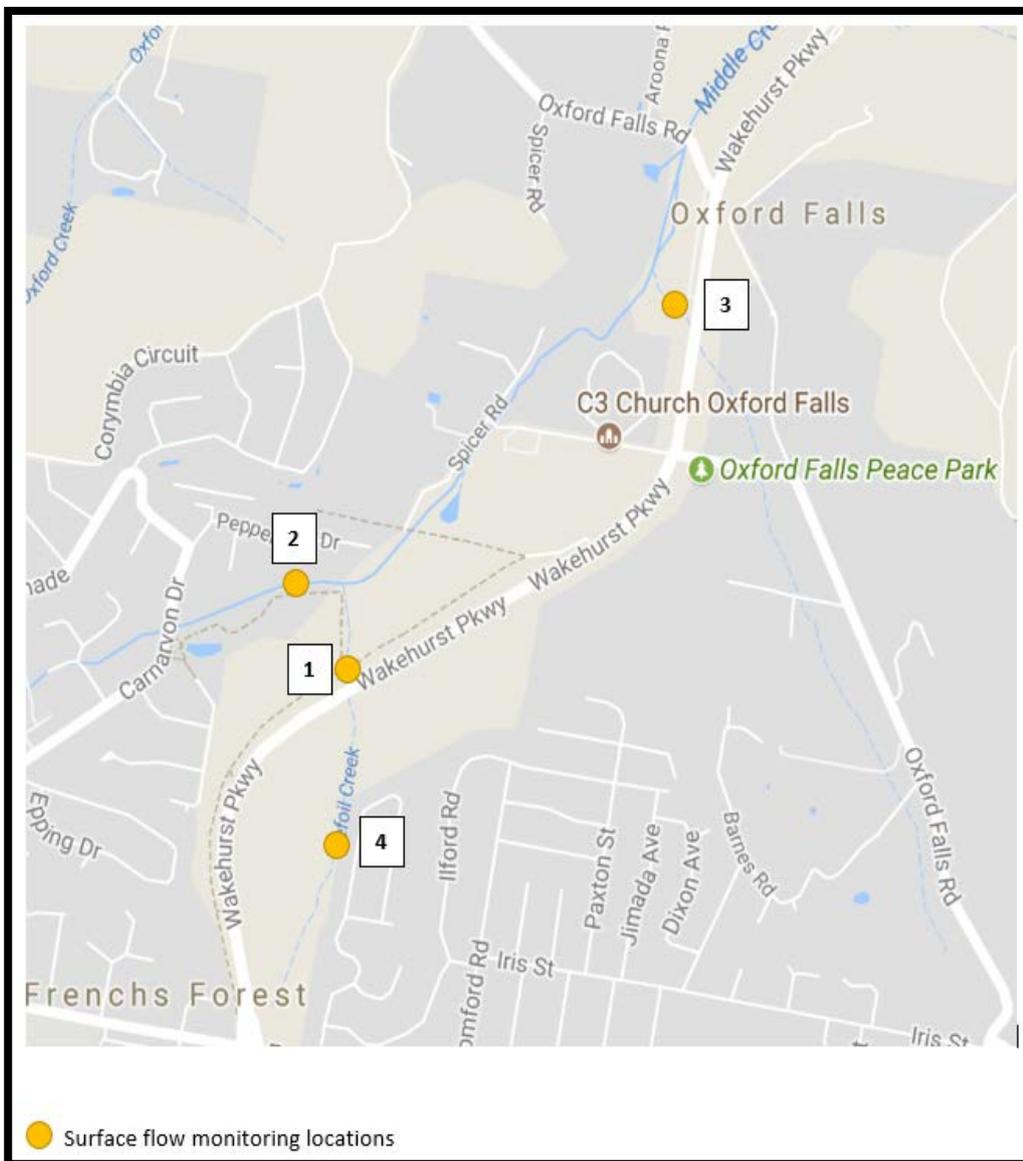
2.4 Limitations

Ecological surveys provide a sampling of fauna (or flora) at a given time and season. There are a number of reasons why some species will be detected at a site during survey, such as species dormancy, seasonal conditions, migration and breeding behaviours of some fauna. In many cases these factors do not present a significant limitation to assessing the overall ecological values of a site.

2.5 Permits and licences

The ecological monitoring undertaken on site by Biosis staff was conducted under the terms of Biosis' Scientific Licence issued under the *National Parks and Wildlife Act 1974* (SL100758, expiry date 31 March 2020). Fauna survey was conducted under TRIM 17/892 from the NSW Animal Care and Ethics Committee (expiry date 31 January 2020).

Figure 3 Location of water monitoring sites as provided by Ferrovial York Joint Venture



3 Results

The results provided below have been provided in line with the details required in Table 3.3 (Monitoring Actions) of the NBHCNE EMP (Biosis Pty Ltd 2016a). A copy of these requirements has been included in Appendix 1.

3.1 Nest box monitoring

One nest box monitoring event, April 2019, occurred within the 2018/2019 NBHCaNE EMP monitoring season. A total of 135 nest boxes were inspected and the results of these inspections are included in Table 3. The location of the trees where nest boxes are installed is provided in Figure 4.

The results of the autumn 2019 nest box monitoring inspections are briefly summarised below:

- 19 nest boxes were occupied by native fauna with a total of 26 individuals recorded. Species were Common Brushtail Possum *Trichosurus vulpecula* and Ringtail Possum *Pseudocheirus peregrinus* with both adults and infants being recorded.
- A further 16 nest boxes showed signs of previous occupation by native fauna, such as the presence of nesting material or chewed openings.
- Four nest boxes were currently occupied by Ants. Five old bee hives were also present however no active hives were found.
- Eight nest boxes required maintenance action including refitting of fallen boxes, relatching of loose doors and repositioning of shifted boxes.

Nest box maintenance actions from the 2017-18 EMP implementation monitoring periods were forwarded to Plateau Trees by FYJV and were undertaken prior to the April 2019 monitoring period. The results of the nest box monitoring inspection are discussed further in Section 4.1.

Table 3 Nest box occupation during autumn 2019 monitoring surveys

Tree ID	Easting	Northing	Autumn 2019			
			Number of boxes	Box type	Fauna recorded	Notes
1	336564.7	6264097.4	1	Possum	-	Opening chewed, nesting material evident
2	336559.0	6264104.3	1	Pygmy-possum	-	No traces of fauna evident
3	336556.1	6264106.6	1	Small bird	-	Nesting material evident
4	336551.1	6264096.8	1	Possum	-	No traces of fauna evident
5	336558.3	6264119.9	1	Small bird	3 possums (1 adult, 2 joeys)	No traces of fauna evident
6	336561.2	6264093.0	1	Large woodland bird	-	No traces of fauna evident
7	336559.5	6264090.9	1	Lorikeet	-	Opening chewed
8	336575.2	6264075.7	1	Treecreeper	-	Opening chewed, needs tilting down.
9	336579.4	6264065.3	1	Microbat	-	No traces of fauna evident
10	336573.9	6264063.4	1	Possum	1 Ringtail Possum	Nesting material evident
11	336581.8	6264054.3	1	Microbat	-	No traces of fauna evident
13	336559.5	6264053.6	1	Pygmy-possum	-	No traces of fauna evident
14	336551.1	6264059.0	1	Feathertail glider	-	No traces of fauna evident
15	336545.7	6264058.2	1	Kingfisher	-	Nesting material evident
16	336539.8	6264050.6	1	Treecreeper	-	No traces of fauna evident
17	336545.5	6264038.4	1	Possum	-	Nesting material evident
18	336531.9	6264070.7	1	Pardalote	-	No traces of fauna evident
20	336381.0	6263585.7	1	Feathertail glider	-	Spider sacs present
21	336493.2	6263673.9	1	Possum	2 Ringtail Possums (adult and joey)	Opening chewed
22	336475.9	6263667.1	1	Possum	-	Opening chewed
23	336483.3	6263682.6	1	Possum	1 Ringtail Possum	Opening chewed
24	336489.5	6263665.0	1	Dollarbird	-	Nesting material evident

Tree ID	Easting	Northing	Autumn 2019			
			Number of boxes	Box type	Fauna recorded	Notes
25	336487.5	6263659.9	1	Pygmy-possum	-	Spider webs
26	336487.6	6263669.3	1	Feathertail glider	-	Old beehive
27	336497.0	6263674.2	1	Possum	2 Ringtail Possums	No traces of fauna evident
28	336515.0	6263744.9	1	King Parrot	-	No traces of fauna evident
29	336501.0	6263670.0	1	Pygmy-possum	-	Active ant nest
30	336523.9	6263718.1	1	Possum	-	No traces of fauna evident
33	336504.5	6263679.9	3	Kookaburra, Microbat, Cockatoo	-	Spider sacs in bat box Nesting material in Kookaburra box
34	336501.8	6263668.9	2	Possum, Cockatoo	1 Common Brushtail Possum (in possum box)	Cockatoo door has fallen off, nesting material evident (Cockatoo box)
36	336525.2	6263683.1	2	Possum, Feathertail Glider	1 Common Brushtail Possum (in possum box)	No traces of fauna evident
37	336525.7	6263688.2	3	Cockatoo, Possum, Possum	-	No traces of fauna evident
38	336525.3	6263702.5	2	Pygmy-possum, Sugar Glider	-	Nesting material evident (Pygmy-possum box) Beehive (Sugar Glider box)
39	336520.9	6263704.7	1	Microbat	-	No traces of fauna evident
41	336512.3	6263704.2	2	Pygmy-possum, Possum	-	Cockatoo box on ground, not installed
43	336528.3	6263715.2	1	Possum	-	No traces of fauna evident
44	336531.2	6263729.5	3	Pygmy-Possum, Possum, Kookaburra	-	Boxes too high to see with camera. Visually assessed for fauna entering/leaving box, and evidence of fauna use (chew marks, scats around tree). No traces found.
45	336522.6	6263725.1	2	Pygmy, Cockatoo	-	No traces of fauna evident
46	336521.1	6263734.3	1	Microbat	-	Spider sacs and webs
47	336523.5	6263735.4	1	Pardalote	-	Spider webs
48	336525.6	6263738.4	2	Possum, Cockatoo	-	Possum box needs adjusting (pointing upwards)

Tree ID	Easting	Northing	Autumn 2019			
			Number of boxes	Box type	Fauna recorded	Notes
49	336542.8	6263738.0	2	Glider, Microbat	-	Active ants nest (glider box) Spider webs (microbat box)
50	336523.2	6263750.4	1	Kookaburra	-	Nesting material
51	336521.1	6263750.4	1	Feathertail Glider	-	Spider webs
52	336507.6	6263758.2	2	Kookaburra, Cockatoo	-	Nesting material evident (Kookaburra), Cockatoo box on ground, needs re-fitting
53	336519.5	6263772.9	2	Possum, Cockatoo	-	Nesting material (possum box) Cockatoo box door needs latching
54	336528.9	6263755.5	3	Possum, Feathertail Glider, Cockatoo	-	No traces of fauna evident
55	336532.8	6263798.6	2	Cockatoo, Feathertail Glider	2 Ringtail Possums (cockatoo box)	Old beehive in Feathertail box
56	336541.2	6263812.4	2	Pygmy-possum, Cockatoo	-	No traces of fauna evident
57	336546.2	6263799.2	2	Feathertail Glider, Cockatoo	-	Active ants nest (glider box), Spider sacs (cockatoo box)
58	336515.3	6263800.9	1	King-Parrot	1 Common Brushtail Possum	No traces of fauna evident
59	336365.1	6263834.2	1	Feathertail glider	-	Old beehive
60	336370.0	6263835.2	1	Possum	1 Common Brushtail Possum	No traces of fauna evident
61	336367.2	6263828.3	1	King-Parrot	1 Ringtail Possum	No traces of fauna evident
63	336385.3	6263821.8	1	Microbat	-	No traces of fauna evident
64	336395.5	6263804.3	1	Glider	-	Opening chewed, nesting material evident
65	336411.7	6263842.1	1	Feathertail Glider	-	Spider webs
66	336350.3	6263806.2	1	Possum	-	No traces of fauna evident
67	336352.9	6263802.2	1	Dollarbird	1 possum (unable to ID)	No traces of fauna evident
68	336409.4	6263682.2	1	Possum	2 Ringtail Possums (1 adult, 1 joey)	No traces of fauna evident
69	336406.8	6263726.0	1	Possum	-	Spider webs

Tree ID	Easting	Northing	Autumn 2019			
			Number of boxes	Box type	Fauna recorded	Notes
70	336378.3	6263560.7	1	Feathertail Glider	-	No traces of fauna evident
71	336398.3	6263746.9	1	Treecreeper	-	No traces of fauna evident
72	336394.7	6263748.1	1	Treecreeper	-	No traces of fauna evident
75	336395.8	6263633.7	2	Possum, Microbat	-	Spider webs (microbat box), Opening chewed (possum box)
76	336381.0	6263597.3	1	Pardalote	-	Active ants nest
77	336381.5	6263585.6	1	Possum	-	No traces of fauna evident
78	336377.9	6263578.8	1	Possum	-	Old beehive
79	336373.5	6263578.1	1	Pardalote	-	No traces of fauna evident
80	336354.3	6263563.5	1	Glider	-	Nesting material evident
81	336356.8	6263565.9	1	Dollarbird	-	No traces of fauna evident
82	336358.9	6263570.9	1	Lorikeet	-	No traces of fauna evident
83	336349.0	6263568.6	1	Dollarbird	-	No traces of fauna evident
85	336339.8	6263558.7	1	Cockatoo	-	Nesting material evident, door requires latching
86	336335.4	6263552.4	1	Possum	1 Ringtail Possum	No traces of fauna evident
87	336339.7	6263575.8	1	Glider	-	No traces of fauna evident
88	336376.9	6263559.1	1	Cockatoo	-	No traces of fauna evident
89	336366.0	6263518.4	1	Kingfisher	-	No traces of fauna evident
90	336367.1	6263516.4	1	Cockatoo	-	No traces of fauna evident
91	336358.2	6263517.1	2	Possum, Kingfisher	-	Nesting material evident (possum box), Kingfisher box needs adjusting (tilt down).
92	336356.7	6263518.3	1	Possum	-	No traces of fauna evident
93	336340.4	6263519.6	1	Cockatoo	-	No traces of fauna evident
95	336340.9	6263508.9	2	King-parrot, Possum	1 Common Brushtail Possum	No traces of fauna evident
96	336345.2	6263503.9	1	Possum	-	No traces of fauna evident
97	336344.6	6263496.9	2	King-parrot, Microbat	-	Spider webs (King-parrot box)

Tree ID	Easting	Northing	Autumn 2019			
			Number of boxes	Box type	Fauna recorded	Notes
98	336351.8	6263488.8	1	Microbat	-	No traces of fauna evident
99	336340.5	6263481.8	2	Microbat, Cockatoo	-	No traces of fauna evident
100	336324.2	6263475.0	2	Possum, Microbat	-	No traces of fauna evident
101	336317.9	6263469.7	1	Possum	-	No traces of fauna evident
104	336356.1	6263483.0	2	Possum, Cockatoo	-	No traces of fauna evident
105	336369.6	6263514.2	1	Pygmy-possum	-	No traces of fauna evident
106	336368.9	6263507.0	1	Cockatoo	-	No traces of fauna evident
107	336369.3	6263513.7	1	Possum	-	No traces of fauna evident
108	336365.8	6263513.5	1	Lorikeet	1 Ringtail Possum	No traces of fauna evident
109	336357.3	6263509.8	2	King-parrot, Small bird	-	Nesting material evident in small bird box
110	336363.6	6263488.0	1	Possum	-	Nesting material evident
111	336361.8	6263484.0	2	Pygmy-possum, Kookaburra	-	No traces of fauna evident
112	336341.4	6263491.0	1	Dollarbird	-	No traces of fauna evident
113	336335.9	6263506.5	1	Possum	-	No traces of fauna evident
115	336375.3	6263560.6	1	Dollarbird	1 possum (unable to ID)	No traces of fauna evident
116	336341.4	6263569.5	1	Microbat	-	Opening chewed
117	336359.0	6263577.8	1	Lorikeet	1 Ringtail Possum	No traces of fauna evident
118	336338.5	6263570.3	1	Dollarbird	2 Common Brushtail Possums	No traces of fauna evident
119 (N01)	336535.7	6263711.8	2	Possum, Possum	-	Spider webs
122 (N04)	336557.6	6263800.4	1	Cockatoo	-	Nesting material evident



- Legend**
- Project footprint
 - Nest box location

Figure 4 Nest box tree locations

0 25 50 75 100
 Metres
 Scale: 1:2,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



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Matter: 26555
 Date: 02 October 2019
 Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
 Location: P:\26500s\26555\mapping\26555_F4_NestboxLocations

3.2 Red-crowned Toadlet monitoring

The Project *Pathogen and Weed Management Strategy* (Biosis Pty Ltd 2016d) identified the prevalence of Frog Chytrid in 80% of all individual frogs sampled in the vicinity of Trefoil Creek. The presence of this pathogen is highly likely to confound the results of the surveys, and as such it is difficult for any deleterious change in the population to be attributed to the Project.

The initial baseline Red-crowned Toadlet surveys recorded no individuals at any of the monitoring sites, although habitat assessment confirmed the presence of suitable habitat for Red-crowned Toadlets at all sites (Biosis Pty Ltd 2016b). Despite the absence of records during the baseline surveys, it was assumed that Red-crowned Toadlet individuals were still present at Trefoil Creek, as individuals were recorded on three occasions during surveys conducted for the EIS.

The spring 2018 and autumn 2019 Red-crowned Toadlet surveys were undertaken at a total of five monitoring sites, including four impact sites and one control site. The locations of all survey sites are shown in Figure 5.

In accordance with section 2.3 of the *Red-crowned Toadlet Monitoring Plan*, surveys were undertaken in optimal conditions, during or soon after heavy rainfall. Heavy rainfall was recorded from the 5 to 21 of October, 10 days prior to the spring 2018 surveys, with a total of 225.4 mm of rain recorded at the Terrey Hills AWS station (BOM 2019a). A heavy rainfall event was also recorded from the 13 to 18 of March 2019, one week prior to the autumn 2019 surveys, with a total of 228.6 mm of rain recorded at the Terrey Hills AWS station (BOM 2019b). Given these heavy rainfall events, and the detection of calling Red-crowned Toadlet adults at the control sites during surveys, weather conditions are considered suitable for the detection of Red-crowned Toadlet during both the spring 2018 and autumn 2019 monitoring periods. The weather conditions prior to and during each of these surveys is outlined in Table 4.

Table 4 Weather conditions prior to and during survey

Survey date	Temperatures (min/max) during survey (°C)	Rainfall during survey (mm)	Total rainfall over seven days prior to survey (mm)
1/11/2018 (spring 2018)	16.9/28.9	0	18.8
27/03/2019 (autumn 2019)	13.3/22.4	0	8.6
28/03/2019 (autumn 2019)	15.5/24.3	1.0	8.0

Source: Bureau of Meteorology daily weather observations data for Terrey Hills AWS (station 066059) (BOM 2019a, 2019b).

No Red-crowned Toadlet individuals were identified at any of the impact sites monitored during the spring 2018 and autumn 2019 monitoring events. At control site six, 11 calling male Red-crowned Toadlets were heard during the spring 2018 monitoring event and two calling male Red-crowned Toadlets were heard on the first night (27 March 2019) of the autumn 2019 monitoring event (Table 5). No Red-crowned Toadlets were recorded at the impact sites during either monitoring event. These results are considered consistent with previous monitoring periods which have also failed to detect Red-Crowned Toadlet at any of the impact sites (Biosis Pty Ltd 2018a).

Table 5 Red-crowned Toadlet targeted survey results

Site ID	Site type	Location	Date	Number of transects	Number of individuals
1	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	1/11/2018	2	0
			27/03/2019	1	0
			28/03/2019	1	0
2	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	1/11/2018	2	0
			27/03/2019	1	0
			28/03/2019	1	0
3	Impact	Trefoil Creek (ESU 5) in the Stage 1 Project footprint	1/11/2018	2	0
			27/03/2019	1	0
			28/03/2019	1	0
4	Impact	Curl Curl Creek (ESU 8) in the Stage 2 Project footprint	1/11/2018	2	0
			27/03/2019	1	0
			28/03/2019	1	0
6	Control	Cascades Trail, St Ives	1/11/2018	2	3 (transect 1) 8 (transect 2)
			27/03/2019	1	2
			28/03/2019	1	0



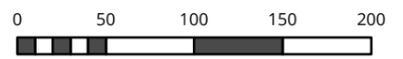
Figure 5a Red-crowned Toadlet Monitoring Sites (Impact)



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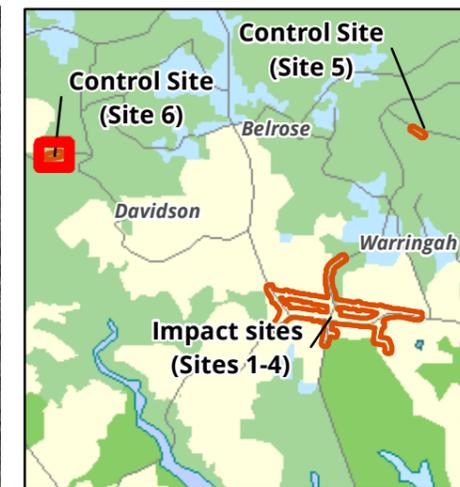
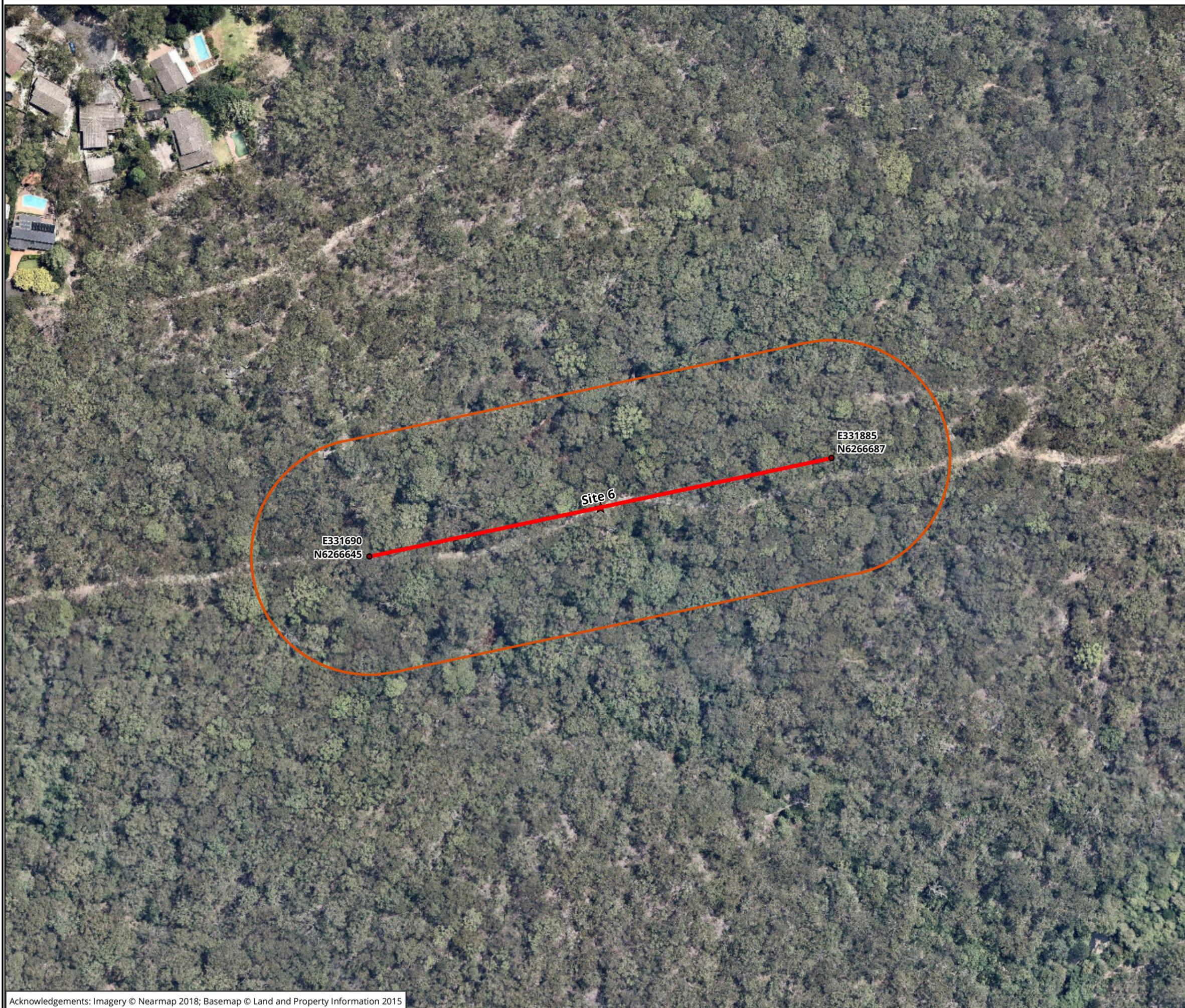
Acknowledgements:
 Topo (c) NSW Land and Planning Information (2015)

Matter: 26555
 Date: 02 October 2019,
 Checked by: MEH, Drawn by: AEDM, Last edited by: amurray
 Location: P:\26500s\26555\Mapping\
 26555_F5A_RCTMonitoring



Metres
 Scale 1:4,000 @ A3
 Coordinate System: GDA 1994 MGA Zone 56





Legend

-  Study area
-  Monitoring transect

Figure 5c Red-crowned Toadlet Monitoring Sites (Control - Site 6)



Metres
 Scale: 1:1,500 @ A3
 Coordinate System: GDA 1994 MGA Zone 56



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 Date: 02 October 2019
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 Location: P:\26500s\26555\mapping\26555_F5C_RCTMonitoring

3.2.1 Surface water flow monitoring

Surveys were conducted by FYJV following periods of sustained rainfall with monitoring events occurring on 10 September and 8 November 2018, and 27 February and 24 June 2019. Rainfall in the two week period preceding these monitoring events is shown below in Table 6.

Surface water monitoring data was successfully collected by FYJV at Site 1 and Site 2 during each of the four monitoring events. However, due to site accessibility issues Site 3 could only be measured during the first two monitoring events (10 September 2018 and 8 November 2018) as the site could no longer be safely accessed after this time. Low flow conditions throughout the 2018/19 monitoring season also resulted in Site 4 only having recordable flow readings during the November 2018 monitoring event.

Site 3 has a flow line heading in a south-east orientation that is roughly parallel with Oxford Falls Road (Figure 3). As such, this site is not affected by the project stormwater and can be considered a control site.

Table 6 Rainfall days in the two weeks preceding monitoring (Terrey Hills AWS (BOM 2019b))

Survey date	Rainfall days over 14 day period prior to survey	Total rainfall during 14 day period prior to survey
10 September 2018	8	21.0 mm
8 November 2018	3	19.1 mm
27 February 2019	6	44.6 mm
24 June 2019	3	35.2 mm

Table 7 Recorded flow volumetric rate (m³/s) at each of the four surface water monitoring sites

Survey date	Site 1	Site 2	Site 3	Site 4
10 September 2018	0.0002	0.001	0.0028	No recordable flow
8 November 2018	0.0238	0.3102	0.1237	0.0336
27 February 2019	0.0361	0.0102	Site inaccessible	No recordable flow
24 June 2019	0.2248	0.0765	Site inaccessible	No recordable flow

Recordable surface water flows were detected at the upstream Sites 1 and 2 during each monitoring event. Water flow at Site 4, located downstream along Trefoil Creek, during the 8 November 2018 monitoring event was the same as water flows recorded at the upstream Site 1. However, there was a lack of recordable flows at Site 4 during the other three monitoring events, despite flows being recorded at the upstream site. This lack of recordable flow would suggest that flows are being absorbed or redirected upstream of Site 4 during these monitoring events. Photo evidence collected during the inspections indicated that water was still persistent at Site 4 throughout the year, even though the flow was lower than the threshold for the flow meter to register.

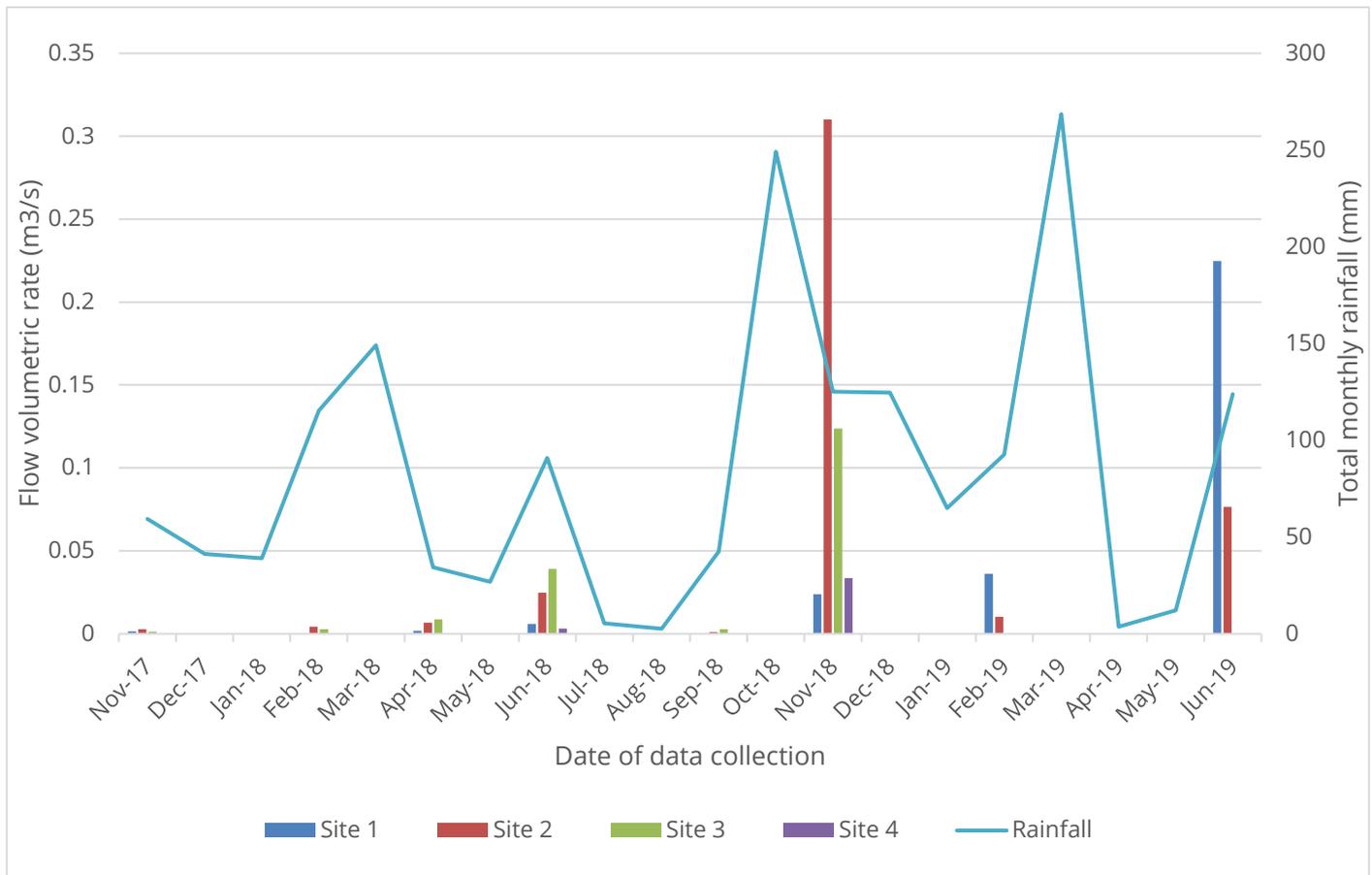


Figure 6 Flow volumetric rate (m³/s) of surface water measured at four locations within the study area

The periodic volumetric flow data and rainfall data indicates that the time lag between rainfall influencing stream flow and the magnitude of flow is lower at sites 1, 3 and 4. Sites 2 and 3 are surface water flow control sites, and the results at these sites indicate that the time lag between rainfall influencing stream flow is short, and the magnitude of these flows is relatively higher than the “impact” monitoring sites. Site 2 is also surrounded by substantially more urban development than the other sites, and as such has increased hard surfaces within its vicinity. Sites 1, 3 and 4 are surrounded by substantially larger areas of native vegetation, and as such the increased delay between rainfall and stream flow indicates rainfall is influencing stream flow in a pattern more similar to a natural system. This may be a result of stormwater detention and infrastructure designs, or it may be a result of the lack of disturbance in the immediate vicinity of the waterways.

3.2.2 Surface water quality monitoring

FYJV also undertakes a surface water quality program in the creeks surrounding the project site, as part of the project’s Water Quality Monitoring Program. Monthly monitoring data is collected for a range of water quality parameters, including dissolved metals, nutrients, pH, temperature, total suspended solids, hydrocarbons, and other analytes. FYJV has indicated that the results collected from monitoring sites SW2, SW5 and SW7 during the reporting period are consistent with urban stormwater quality parameters. The location of the surface water monitoring sites are included in Figure 7. A comparison has been undertaken between the pH values recorded during the current monitoring period and the pH results recorded during the 24 month baseline water quality monitoring undertaken by SMEC between 12 November 2014 and 4 November 2016 (SMEC 2017). The results of this comparison are included in Table 8 and appear to indicate a slight increase in the median pH values recorded in the 2018/19 monitoring period. This upwards trend was apparent across all monitoring sites. Several high pH values were also recorded during the 2018/19 monitoring season

including two which exceeded the trigger value of 8.5. One exceedance of 9.7 was recorded at SW1 (27/09/2018) and one exceedance of 9.1 was recorded at SW5 (3/12/2018). The SW5 water quality monitoring site is in close proximity to the Red-crowned Toadlet monitoring location along Curl Curl Creek (Site 4) and the high pH values recorded are likely to be impacting upon this environment. Both of these exceedances are well above the maximum values recorded for these sites during the baseline which were 7.1 at SW1 and 7.4 at SW5 (SMEC 2017).

Table 8 Water quality pH baseline results compared to the 2018/19 monitoring period

Monitoring location	Baseline pH average (median)	2018/19 pH average (median)
Impact sites		
SW2	6.9	7.4
SW4	7.25	7.6
SW5	6.65	7.6
SW7*	7.2	7.35
Control sites		
SW1	7.1	7.6
SW3	6.7	6.8
SW6	7.2	7.4

* Baseline score for SW7 is based off a reduced data set compared to other sites (7 monitoring events compared to 24). 2018/19 score is based off three wet weather events only.

Several exceedances were also recorded for copper and zinc during the 2018/19 monitoring season. Copper and zinc have been identified as the top two pollutants that threaten aquatic organisms, with ANZECC identifying the guideline concentrations for Copper and Zinc to be 1 µg/L and 15 µg/L respectively (ANZECC 2000, Johnson et al. 2017). Exceedance of these concentrations was recorded frequently at all sites. Individually copper or zinc above these concentrations is toxic to aquatic organisms, however, when combined they have a 'more than additive effect'. This means that when both metals are detected above each of their individual guideline values, the water is highly toxic to aquatic organisms. Where copper and zinc exceedances occur simultaneously, water quality is considered highly hazardous to aquatic life.



Figure 7 Surface water quality monitoring locations and drainage lines across the Project

3.3 Roadkill monitoring

Results of monthly roadkill monitoring surveys from July 2018 to June 2019 undertaken by FYJV are included in Table 9. No roadkill sightings were recorded during these surveys, however no data exists for January and February 2019. Additional roadkill sightings reported outside of these monthly surveys by the NSW Wildlife Information, Rescue and Education Service (WIRES) have been included in Table 10 however these sightings do not coincide with the roadkill monitoring transect locations. These sightings include Swamp Wallaby *Wallabia bicolor* and Ringtail Possum.

Table 9 Roadkill monitoring results from monthly monitoring surveys provided by FYJV

Year	Month	Location	Roadkill sightings
2018	July	All transects	None identified
2018	August	All transects	None identified
2018	September	All transects	None identified
2018	October	All transects	None identified
2018	November	All transects	None identified
2018	December	All transects	None identified
2019	January	No data available	
2019	February	No data available	
2019	March	All transects	None identified
2019	April	All transects	None identified
2019	May	All transects	None identified
2019	June	All transects	None identified

Table 10 Roadkill sighting data provided from WIRES Wildlife Incident Mapping database

Date	Location	Roadkill sightings
10/11/2018	Wakehurst Parkway, north of Frenchs Forest Road, closer to Dreadnought	Swamp Wallaby. Reported by WIRES.
19/02/2019	Frenchs Forest Road (East) near Nandi Avenue	Male wallaby. Reported by WIRES.
15/03/2019	Wakehurst Parkway, north of Frenchs Forest Road.	Swamp Wallaby. Reported by WIRES.
8/04/2019	Wakehurst Parkway, north of Frenchs Forest Road (not far from May Gibbs Way)	Ringtail Possum. Reported by WIRES.
18/04/2019	Wakehurst Parkway, north of Frenchs Forest Road (not far from May Gibbs Way)	Swamp Wallaby. Reported by WIRES.
27/05/2019	Aquatic Drive	Swamp Wallaby. Reported by WIRES.

4 Discussion and recommendations

4.1 Nest box monitoring

The results of the autumn 2019 nest box monitoring surveys indicate that the current uptake of nest boxes by native fauna improved over the previous year (autumn 2018 season), with 19 out of 135 nest boxes housing native fauna. In autumn 2018 only 12 nest boxes were utilised. The rate of occupancy continued to increase with 26 individuals recorded during the autumn 2019 season compared to 13 individuals in the autumn 2018 season. It is anticipated that the rate of occupancy will continue to increase over time.

Biosis has identified a number of issues with the location and installation of nest boxes during the nest-box survey with details included in Table 3. It is recommended maintenance be undertaken to fix these boxes.

European Honey Bees have been previously recorded utilising nest boxes for hives during the autumn 2017 and autumn 2018 seasons. No active hives were recorded during the autumn 2019 surveys.

4.1.1 Performance parameters/criteria assessment

The performance parameters/criteria assessment required by the *NBHCaNE EMP* (Biosis Pty Ltd 2016a) are provided in Appendix 1. The criteria specific to nest box monitoring are addressed below.

Indicators of success of nest boxes include:

- *Use of nest boxes by a wide range of native fauna species.*
- *Use of nest boxes designed for specific species by those same species*

After three years of monitoring, the nest boxes have been utilised by four native species. Nest box occupation has been dominated by Common Brushtail Possum and Ringtail Possum. This is not considered unusual given the highly urbanised nature of the project footprint.

Assessment criteria:

- *Inspection to be undertaken to record nest box utilisation (by which species, native and pest) and success yearly for five years.*
- *Reporting to outline nest box utilisation and success yearly for five years.*
- *Uptake of nest boxes by native fauna is >60% of pre-clearing tree hollow occupation.*
- *<20% uptake of nest boxes by pest species.*

The utilisation of nest boxes by native species during autumn 2019 monitoring was 14% (19 nest boxes). This increased from 9 % in autumn 2018, 5 % in autumn 2017, and 1 % in spring 2016 (Biosis Pty Ltd 2018b, 2018a). A further 16 nest boxes (12%) showed evidence of past utilisation with either the inclusion of nesting material or chewed openings.

During the vegetation preclearance surveys a total of four hollows within the project area were utilised by native fauna (two possums and two lorikeets), with a further two showing signs of usage. As such the target uptake as per the assessment criteria is 3.6 boxes or 2.7 %. The current utilisation of nest boxes exceeds this assessment target and this rate of uptake is increasing over time.

The uptake of nest boxes by pest species is in line with the assessment criteria, being 3 % in autumn 2019.

4.1.2 Recommendations

The autumn 2019 nest box monitoring has now been completed.. It is recommended that ongoing nest box monitoring and maintenance should continue in accordance with the EMP.

4.2 Red-crowned Toadlet monitoring

No Red-crowned Toadlet individuals were recorded at any of the impact sites during either the spring 2018 or autumn 2019 monitoring surveys. This is consistent with previous monitoring seasons which have failed to detect presence of any individuals since monitoring for the Project began (Biosis Pty Ltd 2018b, 2018a). The Red-crowned Toadlet baseline surveys also recorded no calling individuals at the monitoring sites, despite the presence of suitable habitat for Red-crowned Toadlet at all sites (Biosis Pty Ltd 2016b).

Due to the presence of calling Red-crowned Toadlet individuals at the control site during both the spring 2018 and autumn 2019 monitoring surveys, the monitoring survey methodology is considered to be satisfactory to detect Red-crowned Toadlet individuals at the impact sites.

4.2.1 Performance parameters/criteria assessment

The performance parameters/ criteria assessment required by the NBHCNE EMP are provided in Appendix 1. The criteria specific to Red-crowned Toadlet monitoring are addressed below.

Assessment criteria:

- *All impact and control sites are successfully established.*
- *Red-crowned Toadlets are recorded within impact sites where previously recorded (EIS) and at control sites during the same period.*
- *Red-crowned Toadlets are recorded within all impact sites in similar or greater abundance to baseline levels.*
- *Red-crowned Toadlets are successfully recorded at control sites during monitoring periods.*
- *Red-crowned Toadlet abundance will not be less than baseline levels over two consecutive monitoring periods.*

All impact and control sites have been successfully established.

No Red-crowned Toadlet individuals were recorded at impact sites during the spring 2018 and autumn 2019 monitoring surveys. This is not considered inconsistent with the surveys undertaken during the EIS where individuals were detected on only three separate occasions within Ecological Sampling Units (ESUs) 5 and 8 across the 24 survey nights undertaken for these ESUs (SMEC 2014).

No Red-crowned Toadlets were recorded during baseline surveys. The spring 2018 and autumn 2019 survey results are consistent with baseline surveys (i.e. no individuals recorded at impact sites).

Red-crowned Toadlet individuals were successfully recorded at control site 6 during the spring 2018 and autumn 2019 monitoring surveys.

4.2.2 Surface water monitoring

Surface water quality data is collected by FYJV at several creek sites across the study area in accordance with the project's Water Quality Monitoring Program. The Red-crowned Toadlet Management Plan requires that recorded parameters be reviewed to determine whether there is any correlation between changes in parameters and detection of Red-crowned Toadlets. FYJV have indicated that the surface water quality data collected at monitoring sites SW2, SW5 and SW7 during the reporting period are within the range expected

for urban stormwater quality parameters. There have been no sudden or large scale changes to water quality parameters within the reporting period. To date there have been no sightings of Red-crowned Toadlet during any of the targeted surveys so correlations between water quality and Red-crowned Toadlet cannot be made.

The surface water results indicate that recordable flows are present within impact Sites 1 and 2 throughout the year. This matches the results returned at control Site 3 during the first two monitoring period (10 September 2018 and 8 November 2018) prior to the site becoming inaccessible. Flows were only recorded at Site 4 during the 8 November 2018 monitoring period, however this site was likely to be ephemeral prior to construction, and photo evidence indicates that water was still persisting at this site even though no recordable flows could be detected by the flowmeter.

4.2.3 Adaptive management and contingency measures

The *NBHCaNE Red-crowned Toadlet Management Plan* outlines contingency measures should the non-detection of Red-crowned Toadlet individuals continue to occur. These include:

- Review surface water monitoring results and consult with design team, to determine if there is a variation between modelled and actual flows.
- Determine whether there is any correlation between parameters of the surface water monitoring results and any decrease in Red-crowned Toadlet detection during the relevant time period.
- Provide advice regarding surface water management in relation to Red-crowned Toadlet.

Review of surface water monitoring result and consultation with design team

Due to the continued non-detection of Red-crowned Toadlet across all monitoring events (Biosis Pty Ltd 2018b, 2018a), a meeting was held between Ferrovial York Joint Venture, Roads and Maritime Services and Biosis on 7 November 2019 to discuss the contingency measures outlined in the *NBHCaNE Red-crowned Toadlet Management Plan*. This meeting was attended by a FYJV Design Manager who advised that the surface water run off system is working as designed with excess run-off from hard surfaces being diverted into the below-ground detention storages located on the south-eastern corner of the intersection of Fitzpatrick Avenue East and Warringah Road, and below Aquatic Drive at the intersection of Wakehurst Parkway (SMEC 2015a). Stormwater is then gradually being discharged into the environment to prevent stormwater flooding. The correct functioning of the stormwater drainage system appears to be supported in the surface water monitoring data with a longer time lag between rainfall and volumetric surface water flow evident at impact sites 1 and 4 compared to control sites 2 and 3, as discussed in Section 3.2.1.

Determine whether there is any correlation between parameters of the surface water monitoring results and any decrease in Red-crowned Toadlet detection during the relevant time period

Studies have shown that breeding in Red-crowned Toadlets does not occur in polluted conditions, with watercourses affected by stormwater located adjacent to pristine watercourses supporting Red-crowned Toadlet populations not being utilised by the species (Thumm & Mahony 1999). Stormwater can degrade Red-crowned Toadlet habitat through disruption of catchment hydrology, alteration of soil pH and pollution inputs which are generally accepted as being deleterious to frogs (Thumm & Mahony 1999, NSW Scientific Committee 2019, Ferraro & Burgin 1993). Clean water and correct pH are particularly important for Red-crowned Toadlets which have not been recorded breeding in waters that are even mildly polluted or with a pH range outside 5.5. to 6.5 (DPIE 2017).

As no Red-crowned Toadlets have been detected at impact sites throughout the lifetime of the monitoring program it is difficult to comment on any correlations between surface water monitoring results and decreases in Red-crowned Toadlet detection. As detailed in the *NBHCaNE Red-crowned Toadlet Management Plan*, surface water quality parameters that are relevant to Red-crowned Toadlet management are:

- Chemical properties: pH, hydrocarbons, dissolved metals and Total metals
- Physical properties: electrical conductivity (EC), temperature and turbidity
- Nutrients: Total Nitrogen, Total Phosphorous, Nitrite, Nitrate and Ammonia

The baseline water quality results for the project indicated elevated levels of total heavy metals (aluminium, copper, iron, manganese, and zinc), and nutrient levels (phosphate, nitrite and nitrate) above the adopted trigger values on one or more occasions across all monitoring sites, as well as turbidity readings generally outside the adopted range for most monitoring locations. Surface water pH ranged from 6.2 to 7.7 across the 24 month period indicating neutral conditions, however these values are still higher than the recorded acceptable range for Red-crowned Toadlet of 5.5 to 6.5 (DPIE 2017). EC was also generally within the adopted range, with some minor exceedances (SMEC 2017).

During the 2018/19 monitoring period pH levels continued to be recorded above the reported acceptable range for Red-crowned Toadlet (Table 8). Several simultaneous exceedances of copper and zinc were also recorded which indicates that the water quality is highly hazardous to aquatic life. However, as the baseline pH values were also higher than the acceptable range for Red-crowned Toadlet, and included elevated levels of heavy metals above trigger values, it is unlikely that these environments were capable of supporting a sustainable population of Red-crowned Toadlets prior to the commencement of the project.

Provide advice regarding surface water management in relation to Red-crowned Toadlet

The results of the surface water monitoring report, summarised above, indicate that water quality within the locality is deteriorating to the point that Red-Crowned Toadlets would be unable to persist in these environments. The elevated pH and high concentrations of Copper and Zinc, recorded at both control and monitoring sites, is occurring at a regional scale. As such, there are no meaningful measures that could be implemented by FYJV that would result in an improvement of these parameters, as the changes are outside of the control of the project.

However, the stormwater design system may be contributing to the persistence of water within the environment following rainfall events. This persistence has been reported by FYJV during quarterly surface water monitoring, even when surface water flows are not sufficient to obtain a recordable value. Whilst the gradual release of stormwater and persistence of water in the environment is important for supporting native vegetation, Red-Crowned Toadlet relies upon ephemeral ponds and pools for breeding and the species is not known to use perennial water sources (Thumm & Mahony 1999). As such it is important that the ephemerality of these habitats within areas where Red-crowned Toadlet was identified during the pre-project Biodiversity Assessment Report field investigations (SMEC 2014, 2015b) has been preserved.

4.2.4 Recommendations

Only one Red-crowned Toadlet was heard calling during the field investigations of ESU 8 undertaken by SMEC during the development of the Biodiversity Assessment Report (BAR) for Stage 2 of the NBHCNE project (SMEC 2015b). Red-crowned Toadlet was recorded at several locations in ESU 5 during the development of the Stage 1 BAR (SMEC 2014). It is possible that the individual heard calling during the Stage 2 investigations was a false recording. However, given several individuals were recorded during the Stage 1 assessment and the presence of suitable habitat for Red-crowned Toadlets at the impact sites within the project footprint, it is likely that Red-crowned Toadlet was correctly recorded during the BAR investigations.

Given the continued non-detection of Red-crowned Toadlet across the project area it is recommended that a review be undertaken of available Red-crowned Toadlet habitat within the project footprint. This should include an assessment to determine if the required soak and ephemeral pool habitats required by the species are persisting within the locality. An assessment of the soil pH within these areas is also recommended to determine if levels are within the acceptable range for the species. Following these

assessments it is recommended that the Ecological Monitoring Plan and Red-crowned Toadlet Management Plan be updated to reflect the continued non-detection of this species in line with the adaptive management processes outlined in both of these documents. This may include reductions in the monitoring frequency to be presented to the Environment Representative for endorsement.

4.3 Roadkill monitoring

The EIS for Stage 1 (SMEC 2014) and Stage 2 (SMEC 2015a) of works report that roadkill data collected between 2010 and 2015 (by the Northern Beaches Roadkill Prevention Committee) most commonly recorded strikes of Swamp Wallaby, Brushtail and Ringtail Possum, Echidna *Tachyglossus aculeatus* and Long-nosed Bandicoot *Perameles nasuta* within the study area. These were mostly recorded on Wakehurst Parkway, with very few roadkill sightings on Warringah Road, indicating that Warringah Road is already likely a significant barrier to north-south movement of many fauna species.

Whilst no roadkill sightings were recorded during the monthly surveys for the 2018/19 monitoring period, additional records provided from the WIRES Wildlife Incident Mapping Database included four Swamp Wallabies, one unidentified wallaby, and one Ringtail Possum (Table 10). These incidents do not coincide with the roadkill transects monitored by FYJV. The species included in the WIRES records are all common to the area and most of the sightings occurred on Wakehurst Parkway. This is consistent with the original findings of the Stage 1 EIS and would suggest no significant change in the movement of fauna across the study area as a result of construction works.

4.3.1 Performance parameters/criteria assessment

The performance parameters / criteria assessment required by the *NBHCaNE EMP* are provided in Appendix 1. The criteria specific to Roadkill monitoring are addressed below.

Assessment criteria

- *No increase in the frequency of roadkill encounters during assessments.*

The frequency of roadkill encounters during monthly monitoring assessments has remained low.

- *No new species encountered during construction phase when compared to baseline data.*

No baseline roadkill data was collected before construction began, however roadkill monitoring results have been consistent with previous years (Biosis Pty Ltd 2018b).

4.4 Adaptive Management Measures

In light of the work undertaken and data collected so far, Biosis recommends the following modifications to the Ecological Monitoring Program:

- Given the continued non-detection of Red-crowned Toadlet throughout the implementation of the EMP, recommendations have been provided in section 4.2.3 for the review and updating of the EMP and Red-crowned Toadlet Monitoring Plan.

The measures implemented so far under the NBHCNE EMP have been effective in minimising impact to the environment as a result of the construction activities. Monitoring should continue to ensure any potential future impacts are quickly identified and managed accordingly.

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Appendices

Appendix 1 NBHCNE EMP Monitoring Actions

Monitoring Actions from the NBHCaNE EMP (Biosis Pty Ltd 2016a) are provided below which identify actions, timing, responsibility and performance criteria designed in order to monitor the effectiveness of the ecological mitigation measures to be implemented as part of the Project (Table 11). This addresses the requirements of Condition B20 of the CoA.

Table 11 Monitoring actions and performance parameters of the NBHCNE EMP (Biosis 2016a)

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
Clearing procedure monitoring						
FFMP section 7, Appendix C, Appendix D, Appendix E and Appendix G.	Removal of hollow-bearing trees	Hollow-bearing trees are to be removed under the supervision of a suitably qualified ecologist by felling and not with the use of an excavator. Each hollow-bearing tree will be carefully lowered to the ground and immediately inspected by an ecologist for fauna. The Environment Manager (or appointed ecologist) is to supervise the removal of key fauna habitats and relocate any healthy resident native fauna to adjacent habitat and to transfer any injured fauna to a wildlife carer.	During clearing operations, specifically at least 24 hours after the removal of non-habitat trees and understorey vegetation.	Pre-clearing survey techniques, timing and responsibilities for surveying in accordance with the FFMP and form a component of the annual reporting to the Secretary, OEH and relevant Council, or as otherwise agreed by those agencies. The reports will include: <ul style="list-style-type: none"> • Survey date. • Time. • Surveyors. • Weather conditions. • Details of methods used during pre-clearing surveys and clearing operations. • Fauna species displaced by clearing, species, captured, species released and any wildlife. • Mortalities resulting either directly or 	Environment Manager	The performance of removal of hollow-bearing trees procedures will be assessed against: <ul style="list-style-type: none"> • Low rates of fauna injury and mortality resulting from clearing operations, particularly of threatened species. • Successful capture and release of fauna displaced by clearing operations. • Rapid processing, treatment and release of injured fauna. • Accurate quantification of fauna habitat features and hollow-bearing trees being removed. • Data collation and reporting of these measures. <p>Assessment criteria:</p> <ul style="list-style-type: none"> • Zero direct harm to wildlife.

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
				<p>indirectly from the clearing operations.</p> <ul style="list-style-type: none"> • Location of fauna within clearing footprint (recorded with GPS) and release locations. • Hollow-bearing tree register, and comparison of this data to nest box plan (assess the adequacy of nest boxes installed and how they are mitigating the loss of tree hollows). • Discussion of the effectiveness of those methods employed. • Recommendations for future pre-clearing and/or clearing procedures. 		<ul style="list-style-type: none"> • Incidental harm to be managed/reported on by Ecologist/Environment Manager. <p>Incidents to be raised through toolbox meetings with all construction workers.</p>
	Monitoring of vegetation clearance in areas adjacent to ecologically sensitive areas or vegetation to be retained.	Pre-clearance survey was undertaken to document the actual extent of native vegetation. Following the installation of protective fencing and signage, on-going monitoring is to be undertaken to ensure no	Monitoring of vegetation clearance to be undertaken: <ul style="list-style-type: none"> • On a weekly basis during construction by the on site environmental officer. 	Pre-clearing survey techniques, timing and responsibilities for surveying are detailed in the FFMP. The following documentation is to be kept on record following each monitoring event and	Environment Manager	The performance of pre-clearing and clearing procedures will be assessed against: <ul style="list-style-type: none"> • Successful removal of intended vegetation without accidental damage to vegetation

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
		<p>accidental clearing is undertaken in native and derived plant communities and associated habitat for threatened and non-threatened terrestrial biodiversity (demonstrates avoidance).</p> <p>A register of sensitive site maps will be maintained.</p>	<ul style="list-style-type: none"> Immediately after construction by the on site environmental officer. 	<p>form a component of the annual reporting to the Secretary, OEH and relevant Council, or as otherwise agreed by those agencies:</p> <ul style="list-style-type: none"> Survey date. Time. Surveyors. Location and extent of vegetation clearance, including photo-point monitoring. Location and photographs of protective fencing and signage. Discussion of the effectiveness of those methods employed. If there is any deterioration or damage to protective fencing and signage and if maintenance is required. 		<p>proposed for retention.</p> <ul style="list-style-type: none"> Data collation and reporting of these measures. Assessment criteria: Zero impact to vegetation marked for protection Reporting regarding vegetation clearance and water quality to be prepared and provided to relevant stakeholders as per Project Approval parameters and/or requirements

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
Nest Box monitoring						
FFMP Section 7 and Appendix G.	Monitoring of nest boxes	A visual inspection of each nest box will be undertaken by an appropriately trained zoologist using a ground-based nest-box surveillance camera or in conjunction with a qualified arborist if tree climbing is required.	Monitoring of nest boxes to be undertaken: <ul style="list-style-type: none"> • During construction • Immediately after construction • At least 6 months to a year after construction, preferably in summer and twice a year for up to five years. 	Brief monitoring reports are to be produced following each nest box monitoring session, as outlined in Biosis (2015), and these form a component of the annual reporting to the Secretary, OEH and relevant Council, or as otherwise agreed by those agencies The following information will be collected for each nest box: Nest box Identification number. Time each nest box was inspected. Inspection date, weather conditions (precipitation, cloud cover, temperature) If the nest box is occupied by native fauna, and if so, the species. If the nest box is not occupied by a native species, record any signs of use by native species such as feathers, droppings,	Environment Manager	Indicators of success of nest boxes include: <ul style="list-style-type: none"> • Use of nest boxes by a wide range of native fauna species. • Use of nest boxes designed for specific species by those same species Assessment criteria: <ul style="list-style-type: none"> • Inspection to be undertaken to record nest box utilisation (by which species, native and pest) and success yearly for five years. • Reporting to outline nest box utilisation and success yearly for five years. • >60% uptake of nest boxes by native species. • <20% uptake of nest boxes by pest species.

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
				<p>scats, hair or nesting material.</p> <p>If the nest box is occupied by a pest species such as European bees, or Common Myna.</p> <p>Is there any deterioration of the nest box and is any maintenance required.</p> <p>Any changes to the surrounding habitats, such as clearing.</p>		
	Nest box maintenance regime	<p>The maintenance regime will involve:</p> <ul style="list-style-type: none"> The removal of pest species such as Common Myna, Common Starling and European Bee. The replacement of fallen, damaged or deteriorated nest boxes. The repositioning or relocation of nest boxes that show no sign of use after several successive monitoring periods The removal or excess 	Annual until completion of the project (operation phase), with maintenance assessments undertaken during nest box monitoring.	<p>The following information will be collected for each nest box and is to be submitted in annual reporting to the Secretary and relevant Council, form a component of the annual reporting to the Secretary, OEH and relevant Council, or as otherwise agreed by those agencies:</p> <ul style="list-style-type: none"> Nest box Identification number. Time each nest box was inspected. Inspection date, weather conditions 	Environment Manager or Operator	<p>Indicators of success of nest boxes include:</p> <ul style="list-style-type: none"> Use of nest boxes designed for specific species by those same species. Low rate of use of nest boxes by pest species Low level of maintenance of nest boxes. <p>Assessment criteria:</p> <ul style="list-style-type: none"> <5% of nest boxes requiring maintenance over a five year span.

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
		nesting material that may block access to the nest box over time.		<p>(precipitation, cloud cover, temperature).</p> <ul style="list-style-type: none"> If the nest box is occupied by a pest species such as European bees, or Common Myna. Maintenance completed. 		
Pathogen and Weed monitoring						
FFMP Section 7 and Appendix B.	Noxious weed mapping will occur prior to clearing works.	Noxious weed mapping will occur progressively throughout construction prior to clearing works in each location. Weed management will occur throughout the extent and duration of the project in accordance with Pathogen and Weed Management Strategy.	Noxious weed mapping to be undertaken: <ol style="list-style-type: none"> Prior construction. 	Any additional instances of weeds or pathogens that are identified are to be provided, with co-ordinates and species identification to ensure weed and pathogen mapping remains current.	Environment Manager	<p>Indicators of success of the Weed Management Procedure include:</p> <ul style="list-style-type: none"> No new noxious weed and pathogen infestations within the Project footprint and in adjacent bushland as a result of the Project. <p>Assessment criteria:</p> <ul style="list-style-type: none"> No new noxious weed species (in addition species list within this plan) to establish in the Project footprint.
	Weed and pathogen management measures will	Pathogen mapping will occur progressively throughout construction when signs of infection are	Noxious weed management to be undertaken: <ol style="list-style-type: none"> Prior construction 	The project area would be continually monitored for weed invasion during weekly site inspections, and	Environment Manager	Indicators of success of the Weed Management Procedure include:

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
	occur throughout the extent and duration of the project in accordance with this plan.	evident. Pathogen management will occur throughout the extent and duration of the project, with testing to be undertaken to confirm presence or absence of pathogens in medium to high risk areas.	2. During construction	any other inspections or audits undertaken as part of CEMP requirements. The presence of weed infestations would be reported as part of the inspection process, and include actions to be undertaken to manage these infestations		<ul style="list-style-type: none"> A reduction in the area of noxious weed and pathogen infestations within the project footprint. Assessment criteria: <ul style="list-style-type: none"> A 50% reduction in identified weed infestations to be achieved in year 1 within the project footprint, with gradual improvement for the following two years.
	Weed and pathogen management during rehabilitation	Rehabilitated sites.	Stabilisation of catchments.	Rehabilitated sites would be monitored during inspections, with pathogen and weed management to be undertaken if required to manage any new infestations.	Environment Manager	Indicators of success of the Weed Management Procedure include: <ul style="list-style-type: none"> Control of weed infestation during rehabilitation of sites. Assessment criteria: <ul style="list-style-type: none"> No uncontrolled weed infestations.
Red-crowned Toadlet monitoring						
FFMP section 7, Appendix 2 (in this document) Appendix B, Appendix D and	Establish monitoring sites and collect baseline data	Monitoring sites will be selected from within the Project (5 impact sites) and in the wider locality (1 control site).	To be completed prior to the commencement of works. Ideally in late winter/early spring during or soon after	The baseline survey results will be incorporated in the Red-crowned Toadlet Monitoring Plan (Appendix 2) in the Ecological	Environment Manager	All impact and control sites are successfully established. Red-crowned Toadlets are

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
Appendix E		Monitoring will be conducted at night during optimal conditions along a 200m transect within each site. Surveys will be undertaken at each site over two nights. Surveys will involve listening for calling frogs, and using call-playback to elicit a call response from frogs. Active searching of suitable habitat will be undertaken if no frogs are calling during the survey period.	rainfall periods.	<p>Monitoring Program, to be completed prior to the commencement of construction works. The baseline survey results will include:</p> <ul style="list-style-type: none"> • Survey date. • Time. • Impact and control site locations. • Surveyors. • Weather conditions. • Details of methods used during monitoring surveys • Results of the surveys (i.e. number of calling Red-crowned Toadlets recorded at each site). • Discussion of the results, including impacts of ongoing construction and operation of the Project and effectiveness of mitigation measures. <p>Recommendations for future monitoring procedures.</p>		recorded within impact sites where previously recorded (EIS) and at control sites during the same period.

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
FFMP Section 7 and Appendix G.	Monitoring of all impact and control sites	Monitoring will be conducted at night during optimal conditions along a 200m transect within each site. Surveys will be undertaken at each site over two nights. Surveys will involve listening for calling frogs, and using call-playback to elicit a call response from frogs. Active searching of suitable habitat will be undertaken if no frogs are calling during the survey period.	To be completed annually. Ideally in late winter/early spring during or soon after rainfall periods.	Annual monitoring survey results report to be submitted at the completion of each monitoring period. Reports will be completed in accordance with the FFMP and are to be submitted in annual reporting to the Secretary and relevant Council, or as otherwise agreed by those agencies. The reports will include: <ul style="list-style-type: none"> • Survey date. • Time. • Impact and control site locations. • Surveyors. • Weather conditions. • Details of methods used during monitoring surveys • Results of the surveys (i.e. number of calling Red-crowned Toadlets recorded at each site). • Discussion of the results, including impacts of ongoing 	Environment Manager	<p>Red-crowned Toadlets are recorded within all impact sites in similar or greater abundance to baseline levels.</p> <p>Red-crowned Toadlets are successfully recorded at control sites during monitoring periods.</p> <p>Red-crowned Toadlet abundance will not be less than baseline levels over two consecutive monitoring periods.</p>

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
				<p>construction and operation of the Project and effectiveness of mitigation measures.</p> <ul style="list-style-type: none"> Recommendations for future monitoring procedures. 		
Roadkill monitoring						
FFMP Appendix B and section 7	Roadkill monitoring.	<p>Roadkill monitoring transects have been established within the Project footprint at key locations at which fauna habitat abuts the road corridor (Figure 1). Transects will be assessed by walking along the marked transects, with observed roadkill to be recorded. Photos of roadkill will be taken for verification by the Project Ecologist to confirm the identification of animals encountered.</p>	<p>Roadkill monitoring to be undertaken monthly undertaken at dawn/early morning : Prior construction During construction Operational phase for up to 12 months</p>	<p>Brief roadkill monitoring reports are to be produced following each roadkill monitoring session, with the findings to be submitted in annual reporting to the Secretary and relevant Council, or as otherwise agreed by those agencies shortly after the clearing operations have been completed. The following information will be collected for each nest box:</p> <p>Date. Transect number. Individual roadkill (to species if possible). Time of day.</p>	<p>Environment Manager with operational phase monitoring requirements to be determined post-construction.</p>	<p>Indicators of the success of roadkill control measures and assessment criteria include: No increase in the frequency of roadkill encounters during assessments. No new species encountered during construction phase when compared to baseline data.</p>

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
				<p>GPS waypoint of each individual.</p> <p>Any changes to the surrounding habitats, such as clearing.</p>		
Microbat habitat monitoring						
FFMP Section 7 and Appendix C, D, E, F and G.	Microbat Habitat Monitoring	<p>Prior to any disturbances of potential microbat habitat a Project Ecologist is to inspect culverts and other potential non-hollow roost sites one week before works are undertaken. Inspections will be conducted during the day with the use of a powerful hand held torch to determine whether microbats are occupying the culverts. Any signs of historical use by microbats (e.g. dead specimens, bat droppings etc.) will also be recorded.</p>	<p>Microbat habitat monitoring to be undertaken:</p> <ol style="list-style-type: none"> 1. Prior construction 2. During construction 	<p>Following pre-clearance assessments, the findings of the microbat habitat monitoring is to be included within the Pre-clearing report which would be undertaken in accordance with the FFMP and form a component of the annual reporting to the Secretary, OEH and relevant Council, or as otherwise agreed by those agencies. The reports will include:</p> <ul style="list-style-type: none"> • Survey date. • Time (to verify works undertaken outside of winter torpor periods). • Surveyors. • Weather conditions. • Details of microbats identified during pre- 	Environment Manager	<p>The performance of microbat habitat monitoring will be assessed against:</p> <ul style="list-style-type: none"> • Successful removal of artificial structures without disturbance to threatened microbats. • Data collation and reporting of these measures. • Assessment criteria: • Zero impact to threatened microbat species. • Reporting regarding microbat/fauna habitat and provided to relevant stakeholders as per Project Approval parameters and/or requirements.

Reference	Action	Description	Timing of action	Reporting	Responsibility	Performance parameters / Assessment criteria
				clearing surveys and clearing operations. <ul style="list-style-type: none"> • Microbat species displaced by clearing, captured or released. • Mortalities resulting either directly or indirectly from the clearing operations. • Discussion of the effectiveness of those methods employed. Recommendations for future pre-clearing and/or clearing procedures.		
Revegetation monitoring						
Urban Design and Landscape Plan	Revegetation and rehabilitation measures	Specific rehabilitation measures for each watercourse will be documented in Urban Design and Corridor Landscape Plan.	Refer to <i>Urban Design and Landscape Plan</i> .			

Appendix 2 FYJV NBHCNE EMP Progress Update

A progress update provided by FYJV for each of the EMP monitoring actions during the 2018/2019 monitoring period is provided below in Table 12.

Table 12 Progress of NBHCNE EMP action items over the 2018/2019 monitoring period

EMP Action	Monitoring events from August 2018 to July 2019
1. Pre-clearing procedures	<p>FYJV utilises a Pre-Clearing Checklist and Permit system to manage all vegetation clearing activities. This checklist documents the monitoring of vegetation areas prior to clearing. During the reporting period, because of the advanced stage of construction there was limited clearing of vegetation. The two main sites included:</p> <ul style="list-style-type: none"> • Minor vegetation clearing associated with drainage line (near Warringah Road / Wakehurst Parkway intersection). • Minor vegetation clearing associated with installation of a new section of fauna exclusion fencing along Wakehurst Parkway. <p>Biosis undertook a pre-clearing inspection or desktop consistency assessment of the vegetation at both these locations prior to clearing.</p>
2. Nest boxes	<p>Nest box monitoring is undertaken by Biosis annually with one monitoring event occurring in April (autumn) 2019. FYJV manages the maintenance of the nest boxes through another subcontractor.</p>
3. Red-crowned Toadlet habitat	<p>Red-crowned Toadlet monitoring is undertaken by Biosis with two monitoring events occurring, one in spring 2018 and one in autumn 2019.</p> <p>To supplement the monitoring by Biosis, FYJV undertake a surface water flow and quality monitoring program. This includes surface water flow monitoring in the creek, as well as a water quality monitoring program, and the results are forwarded to Biosis for consideration in their report.</p>
4. Weeds and pathogens	<p>Biosis prepared detailed noxious weed maps in November 2016.</p> <p>FYJV undertake monitoring and management of weeds and pathogens during construction. Weed management is undertaken progressively through a landscaping subcontractor.</p>
5. Unexpected threatened species finds	<p>FYJV arrange specialist inspections as required.</p> <p>During this monitoring period there were no new unexpected threatened species finds.</p>
6. Powerful owl habitat	<p>FYJV review the two potential Powerful Owl habitat trees established within the projects' bushland areas.</p> <p>No impact occurred to these areas during the current monitoring period.</p>
7. Revegetation	<p>Revegetated areas are monitored annually following the initial revegetation works/ Revegetation is documented in the project's Urban Design and Landscape Plan.</p> <p>FYJV arranged an independent audit of the implementation of the Urban Design and Landscape Plan in the current monitoring period which took place on 25 July 2019.</p>

8. Road kill monitoring	Roadkill monitoring is undertaken monthly by FYJV environmental staff.
9. Microbat habitat monitoring	Pre-impact inspection of large diameter culverts and man-made structures are undertaken by Biosis ecologists prior to project impacts. During the current monitoring period Biosis also undertook inspections of a disused house on Warringah road that is being demolished for the project.