FOXGROUND AND BERRY BYPASS

2019 Post construction Ecological, Aquatic, and Weed Monitoring Report

February 2020

Project Number: 17-647

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ACRONYMS AND ABBREVIATIONS

Cwth	Commonwealth
CFFMP	Construction Flora and Fauna Management Plan
CoA	Conditions of Approval
EcMP	Ecological Monitoring Program
EA	Environmental Assessment
EEC	Endangered ecological community – as defined under relevant law applying to the proposal
tfNSW	Transport for New South Wales
GGBF	Green and Golden Bell Frog
ha	hectares
km	kilometres
m	Metres
NSW	New South Wales
OEH	(NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water
SoC	Statement of Commitments
sp/spp	Species/multiple species

1. INTRODUCTION

Transport for New South Wales (TfNSW) (formerly Roads and Maritime Services) upgraded 12.9 km of the Princes Highway between Toolijooa Road north of Foxground, to Schofields Lane (the Foxground and Berry Bypass Project), and between Croziers Lane south of Berry (the Southern Extension) (Figure 1-1). The three phases of this project in relation to biodiversity monitoring were pre-construction (2014-2015), construction (2016-2017) and operation (2018 to present).

TfNSW have contracted NGH to provide Post-Construction Ecological services broadly including the following:

- Nest box monitoring
- Aquatic monitoring
- Weed monitoring
- Ecological monitoring
- Specialist advice on ecological matters as required by TfNSW.

1.1. PURPOSE OF THE REPORT

The purpose of this report is to present data collected throughout 2019 across three types of monitoring programs and to compare to the requirements of the Ecological Monitoring Program (EcMP) (PB 2014). The monitoring programs include:

- Ecological monitoring (Diurnal and nocturnal transect surveys, Tracks, Scats and Signs, Call Playback, and Camera surveys)
- Aquatic monitoring (Four 2019 sessions; two in Autumn, two in Spring)
- Weed monitoring

The annual report includes the following information:

- **Introduction** – background description and aims of the monitoring (this chapter)
- **Methodology** – description of methodology undertaken including personnel, project location and specific survey site locations for ecological, aquatic, and weed monitoring (refer to Section 2)
- **Results -** monitoring results (refer to Section 3)
- **Discussion** –comparison of results to performance indicators (refer to Section 4)
- **Review of mitigation measures** – the effectiveness of each mitigation measure will be reviewed (where appropriate) at the end of the monitoring period (refer to Section 4.4)
- **Recommendations** – suggestion of adaptive responses and contingency measures potentially required (where appropriate) based on the results of the monitoring session such as the implementation of contingency measures or modification of monitoring timing, frequency or methodology (refer to Section 5).

This report presents the second year of post-construction monitoring data.

Figure 1-1 Location of the Foxground and Berry Bypass Project Map 1 of 4

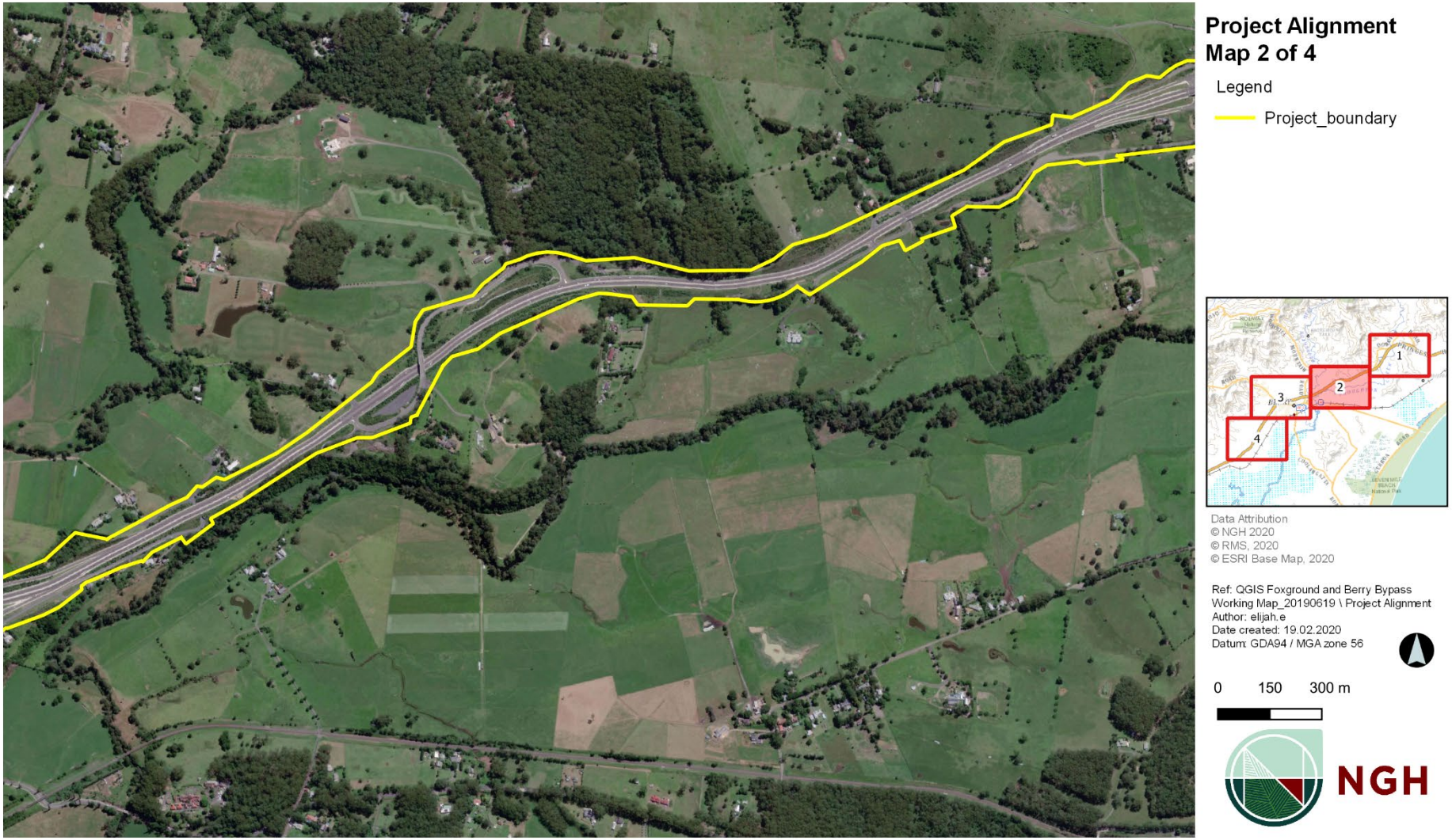

Figure 1-2 Location of the Foxground and Berry Bypass Project Map 2 of 4

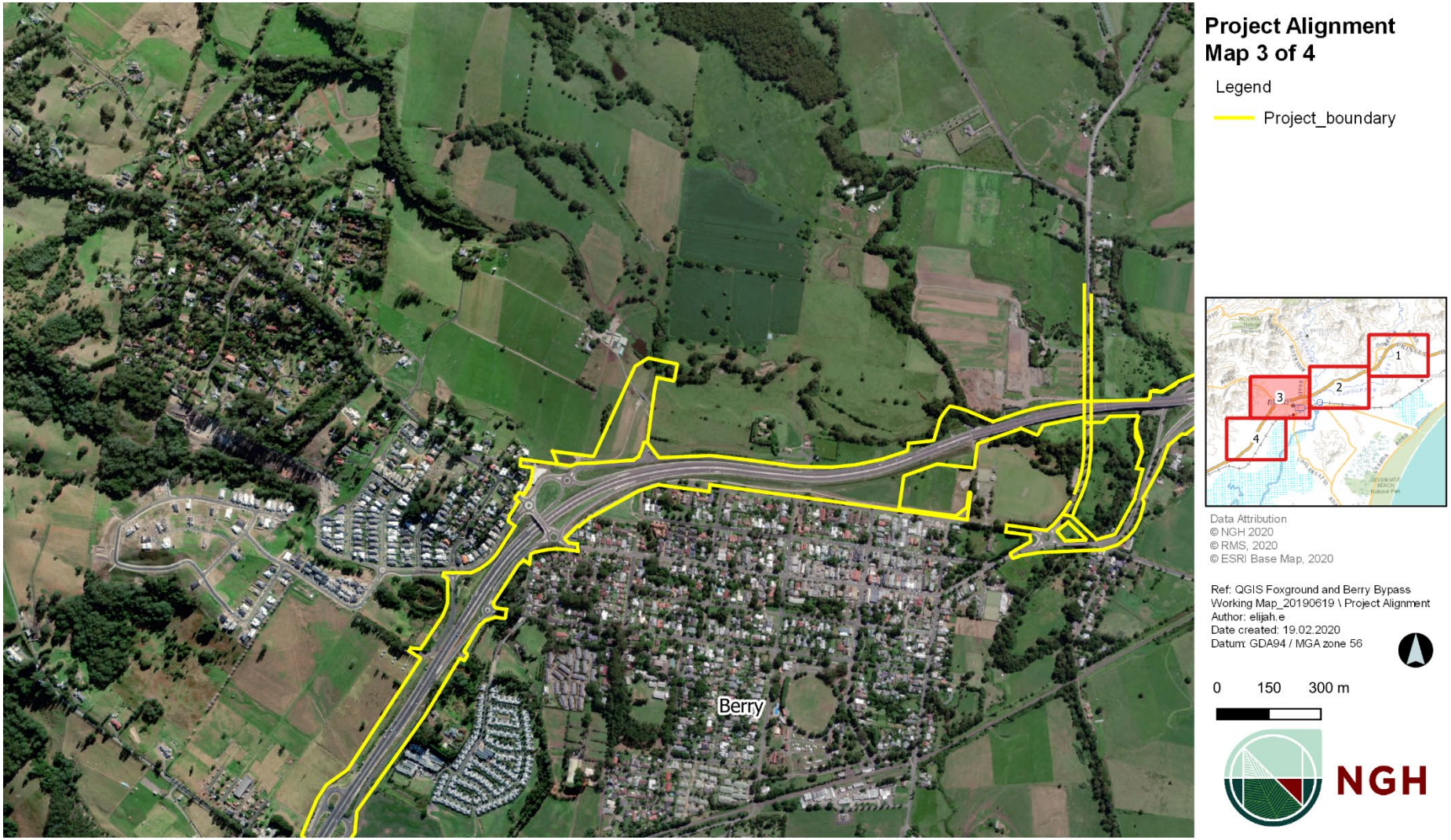

Figure 1-3 Location of the Foxground and Berry Bypass Project Map 3 of 4

Figure 1-4 Location of the Foxground and Berry Bypass Project Map 4 of 4

1.1.1. Ecological Monitoring

Requirements regarding ecological monitoring during the post-construction period are outlined in the following documents:

- Minister's Condition of Approval (CoA) B9 whereby TfNSW are required to develop an Ecological Monitoring Program to monitor the effectiveness of the biodiversity mitigation measures implemented as part of the project.
- The TfNSW Statement of Commitments (SoC)
- Construction Flora and Fauna Management Plan sub-plan (CFFMP) (Roads and Maritime 2014)
- Ecological Monitoring Program (EcMP) (PB 2014)
- The mitigation measures listed in the Foxground and Berry Bypass Environmental Assessment (EA) (AECOM 2012).

The CFFMP (Roads and Maritime 2014) and EcMP (PB 2014) prepared for the Project detail the actions that need to be taken to meet those requirements (see Table 1-1)

In accordance with Section 6.2 of the EcMP (PB 2014), annual reporting is to be completed for all monitoring surveys outlined in the EcMP. This includes monitoring during the pre-construction, construction and post-construction periods. The Baseline Ecological Monitoring Results Report (PB 2015) has been used to compare pre-construction monitoring results with post-construction monitoring results.

Table 1-1 Conditions relevant to ecological monitoring requirements during the post-construction period

ID	Condition	Limitations	Fulfilment of commitments	Reference
Minister of Planning and Infrastructure - Conditions of Approval				
A1	The proponent shall carry out the project generally in accordance with the: Major Project Application MP10_0240 Princess Highway upgrade – Foxground and Berry bypass – Environmental Assessment (Volumes 1-2), prepared by AECOM Australia Pty Ltd for Roads and Maritime Services and dated November 2012 Princess Highway upgrade – Foxground and Berry bypass – Submissions Report, prepared by AECOM Australia Pty Ltd for Roads and Maritime Services and dated May 2013, including the revised Statement of Commitments contained therein Conditions of Approval	Discussed below	EcMP prepared in accordance with the documents outlined in A1 where applicable	EcMP - Section 1.1
B9	The proponent shall develop an **Ecological Monitoring Program** to monitor the effectiveness of the biodiversity mitigation measures implemented as part of the project. The program shall be developed by a suitably qualified and experienced ecologist in consultation with the OEH and DPI (Fishing and Aquaculture) and shall include but not necessarily be limited to:	Aspects of the EcMP are likely to be modified if changes in habitat usage are detected	The Ecological Monitoring Program (EcMP) was developed by a qualified and experienced ecologists and in consultation with OEH and DPI (Fishing and Aquaculture)	The EcMP
	(a) An adaptive monitoring program to assess the effectiveness of the mitigation measures identified in conditions B3 and B36 (b) and shall amendment	-	An adaptive EcMP was prepared to monitor the effectiveness of the biodiversity mitigation	EcMP - Sections 3, 4, 5 and 6

ID	Condition	Limitations	Fulfilment of commitments	Reference
	to the measures as necessary. The monitoring program shall nominate performance parameters and criteria against which effectiveness of fauna crossings and exclusion fencing implemented as part of the project		measures in accordance with the conditions and commitments of the project.	This report – Section 4.4
	(b) Mechanisms for developing additional monitoring protocols to assess the effectiveness of any additional mitigation measures implemented to address additional impacts in the case of design amendments or unexpected threatened species finds during construction (where these additional impacts are generally consistent with the biodiversity impacts identified in the Project in the documents listed under Condition A1)	-	The EcMP provides monitoring methodologies, performance parameters, potential contingency measures and reporting requirements of the Project	EcMP - Sections 3, 4, 5 and 6 This report – Section 4.4 and 5
	(c) Monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the project to traffic (for operation/ongoing impacts) until such time as the effectiveness of the mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods after opening of the project to traffic, unless otherwise agreed by the Director General. The monitoring period may be reduced with the agreement of the Director General in consultation with the OEH and DPI (Fishing and Aquaculture), depending on the outcomes of the monitoring	-	Monitoring to be undertaken pre- construction, during construction and post-construction as specified in this condition	EcMP - Sections 3, 4, 5 and 6 This report
	(d) Provision for the assessment of data to identify changes to habitat usage and whether this can be directly attributed to the project	-	The EcMP outlines data collection and assessment processes	EcMP - Sections 3, 4, 5 and 6

ID	Condition	Limitations	Fulfilment of commitments	Reference
	(e) Details of contingency measures that would be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project	-	Contingency measures are outlined in the EcMP	EcMP - Section 5
	(f) Provision for annual reporting of monitoring results to the Director General and the OEH and DPI (Fishing and Aquaculture), or as otherwise agreed by those agencies	-	This report is the second post-construction annual report of results that will be sent to the Director General and OEH and DPI (Fishing and Aquaculture)	EcMP - Section 6 This report
	The program shall be submitted to the Director General for approval no later than 6 weeks prior to the commencement of construction that would result in the disturbance of native vegetation (unless otherwise agreed by the Director General)	-	The EcMP program was submitted to the Director General over 6 weeks prior to commencement of construction resulting in disturbance of native vegetation	Not applicable.
B36 (b)	A **Construction Flora and Fauna Management Sub-plan (CFFMP)** to detail how construction impacts on ecology will be minimised and managed. The sub-plan shall be developed in consultation with the OEH and DPI (Fishing and Aquaculture) and shall include, but not necessarily be limited to	-	A separate CFFMP was prepared to address and manage the impacts of construction for the Project. The EcMP outlines monitoring requirements for the aspects specified below	EcMP - Section 2
	Detail of pre-construction surveys undertaken by a suitably qualified and experienced ecologist to verify the construction boundaries/footprint of the project based on detailed design and to confirm the vegetation to be cleared as part of the project (including hollow, threatened flora and fauna species and riparian vegetation)	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2

ID	Condition	Limitations	Fulfilment of commitments	Reference
	Updated sensitive area/vegetation maps based on (i) above and previous survey work	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	Details of general work practices and mitigation measures to be implemented during construction to minimise impacts on native fauna and native vegetation (particularly threatened species and EECs) not proposed to be cleared as part of the project, including, but not necessarily limited to: fencing of sensitive areas, a protocol for the removal and relocation of fauna during clearing, engagement of a suitably qualified and experiences ecologist to identify locations where they would be present to oversee clearing activities and facilitate fauna recues and re- location, clearing timing with consideration to breeding periods, measures for maintaining existing habitat features (such as bush rock and tree branches etc.), seed harvesting and appropriate topsoil management construction worker education, weed management (including controls to prevent the introduction or spread of *Phytophthora cinnamomi*), erosion and sediment control and progressive re-vegetation	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	Specific procedures to deal with EEC/threatened species anticipated to be encountered within the project corridor including re-location, translocation and/or management and protection measures	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	A procedure for dealing with unexpected EEC/threatened species identified during	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as	EcMP - Section 2

ID	Condition	Limitations	Fulfilment of commitments	Reference
	construction including cessation of work and notification of the OEH, determination of appropriate mitigation measures in consultation with the OEH (including relevant re-location measures) and update of ecological monitoring and/or biodiversity offset requirements consistent with conditions B7 and B8		part of overall ecological performance monitoring	
Revised Statement of Commitments – from within the Submissions Report				
Manage impacts on flora and fauna				
BD2	Pre-clearing fauna surveys, clearing procedures, including staged clearing where there are hollow trees, and methods to control noxious and environmental weeds and pests will be developed and implemented prior to clearing activities, in consultation with a suitably qualified and experienced ecologist	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
BD3	Natural and artificial habitat features, such as bat roost and nest boxes, will be installed to replace hollow-bearing trees that are removed	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
BD4	A fauna monitoring program will be developed in consultation with OEH. This program will allow the assessment of the effectiveness of fauna mitigation measures including nest boxes, bat roost boxes, fauna underpasses, rope bridges and fauna fencing	-	The EcMP addresses the fauna monitoring requirements of the project such that effectiveness of the mitigation measures can be assessed. It has been prepared in consultation with OEH and DPI (Fishing and Aquaculture)	EcMP - Section 3
Foxground and Berry Bypass Submissions Report Sections				

ID	Condition	Limitations	Fulfilment of commitments	Reference
Section 2.10 (Page 152)	Vegetation clearing would be restricted to those areas where it is necessary and opportunities to minimise clearing would be considered during detailed design with a particular focus on retention of habitat trees. During construction, retained vegetation such as individual trees, stands of trees or patches of native vegetation would be fenced with highly visible temporary fencing. This would be undertaken in accordance with 'Guide 2 Exclusion zones' of Roads and Maritime' Biodiversity Guidelines: Protecting and managing biodiversity on Roads and Maritime projects (RTA 2011)	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	The ancillary areas assessment methodology is detailed in Section 2.7 (pages F22 to F23) of Appendix F - Technical paper: Terrestrial Flora and Fauna to the environmental assessment. The assessment criteria for terrestrial biodiversity aim to identify ancillary areas where there would be: n no substantial vegetation clearing (unless required for project alignment) n low conservation significance for flora and fauna n no removal of EECs, threatened species or threatened fauna habitat (unless required for project alignment)	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring. Ancillary sites are not expected to require any monitoring as they have been located in areas of low environmental significance, as per the requirements of the EA. Where any ancillary sites are located within the project footprint, and require staged vegetation removal, the monitoring and reporting proposed for all clearing as part of the project would apply. This is addressed in the first row of Table 3.2 in the EcMP	EcMP - Section 2
	In addition no physical disturbance would occur outside the boundaries of the proposed ancillary sites. In accordance with 'Guide 2 – Exclusion Zones' (RTA 2011), buffers and temporary fencing would be installed to mark 'no-go' areas if ancillary sites are located directly adjacent to EECs or areas	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2

ID	Condition	Limitations	Fulfilment of commitments	Reference
	of medium-high conservation significance. According to the ancillary facility assessment criteria, the definition of medium-high conservation significance includes: n an area with native vegetation which may be EEC or not n threatened (or migratory) flora or fauna records/occurrences n moderate to good potential habitat for threatened (or migratory) species including intact soil profile, intact structural layers, mature fruiting trees, hollow-bearing trees and fallen woody debris n water source			
	Further to the safeguards highlighted above, refinements may be made to the design features and construction methods to further minimise vegetation clearing during the detailed design phase of the project	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	As detailed above, a vegetation management plan would be prepared to guide revegetation and restoration works. The vegetation management plan would be prepared in consultation with local Landcare groups, the Southern Rivers CMA and affected land owners and would consider the opportunities and constraints surrounding ownership and continuing management of specific parcels of land	-	Refer to separate Vegetation Management Plan for the project	Not Applicable
Section 2.10 (Page 154)	Mitigation measures such as fauna fencing, fauna underpasses and rope bridges have been located in areas with the greatest potential for impact based	Baseline monitoring limited to spring / summer. Post-construction monitoring	This EcMP addresses the fauna monitoring requirements of the project such that	EcMP - Section 2 and Section 3

ID	Condition	Limitations	Fulfilment of commitments	Reference
	on existing constraints, movement patterns and fauna habitat utilisation (in areas with remnant vegetation). Some of these include:	methodology may require modification if any significant changes in habitat usage are detected	effectiveness of the mitigation measures can be assessed.	This report – Section 2.4
	In areas along Broughton Mill Creek identified as potential dispersal habitat for the Green and Golden Bell Frog (*Litoria aurea*), a frog-proof fence would also be provided to encourage movement of this species beneath the bridge	-	EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2 and Section 3 This report – not applicable
	Rope bridges would be provided to facilitate movement of arboreal mammals. Use of barbed wire in the vicinity of rope bridges and associated structures is not recommended due to the potential for gliders to become caught and killed in barbed wire fences	-	EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2 and Section 3 This report
	Fauna fencing would be provided to avoid or minimise impacts to and improve the safety of native fauna by guiding fauna to crossing points. The current concept design generally includes wire rope safety barriers, except in locations were space is constrained (such as bridges) where concrete barriers would be required. In these locations, Roads and Maritime would use Type F concrete barriers to allow for movement of small mammals, amphibians and reptiles across these areas. Fauna fencing for the project would consist of a 1.8 metre high chain link fence.	-	EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2 and Section 3

ID	Condition	Limitations	Fulfilment of commitments	Reference
	Farm boundary fencing will be provided in some areas. Roads and Maritime would encourage the use of fauna-friendly fencing design when fencing farm boundaries along the road corridor. The type of fencing used would be subject to agreements with landholders. In open agricultural land between areas of remnant vegetation the potential for small native mammals to occur is limited. Therefore, installing fauna fencing in these areas is not considered to be warranted	-	EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2 and Section 3
	Monitoring of fauna – vehicle collisions would be undertaken during the operation phase of the Project If road kill becomes an issue during the operational phase of the project additional fencing of these locations would be considered	-	The EcMP includes specific road kill monitoring requirements for the Project	EcMP - Section 2 and Section 3 This report – Section 2.3, 3.1 and 4.1
Section 2.10 (Page 155)	In summary Roads and Maritime Biodiversity Guidelines (Guide 6 Weed management) outlines the requirements for management of terrestrial and aquatic environmental and noxious weeds during construction and suggests best practice methods for weed management during maintenance works. In addition to implementing the management practices recommended in Roads and Maritime' Biodiversity Guidelines: Protecting and managing biodiversity on Roads and Maritime projects (RTA, 2011), the following mitigation measure would be implemented: • Control drainage that may contain weed seeds or high levels of nutrients. • Use weed-free topsoil in landscaping and re-vegetate disturbed sites with locally indigenous	-	The EcMP refers to the Weed Management Strategy in the CFFMP. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2.4, Section 3 See Weed Monitoring Reports (NGH)

ID	Condition	Limitations	Fulfilment of commitments	Reference
	species (local provenance). • Monitor and control weed populations that establish in disturbed areas, with particular attention to eradication of noxious weeds. Weed invasions would be monitored and controlled by a person experienced in weed management. • Incorporate weed management strategies into the vegetation management plan, detailing necessary weed control works, particularly in areas where the weeds may impact on threatened species and/or their habitats.			
Environment Assessment Report – Biodiversity mitigation and management measures				
Pre-construction				
General construction impacts on flora and	Conduct a hollow-bearing tree/stag watch survey prior to construction. Undertake stag-watching to identify the number and type of nest boxes required and where to install them. The optimal season for stag-watching is spring; a hollow-bearing tree/stag survey however, can be conducted any time of year	-	EcMP outlines methodology for undertaking hollow bearing tree and stag watching survey within full extent of the project.	EcMP - Sections 3, 4, 5 and 6
Fauna	Install bat roost and nest boxes at a ratio of 1:1 for each hollow removed by the project	-	EcMP outlines surveys that would inform the number of bat roosts and nest boxes required to be installed at a 1:1 ratio for each hollow that will be removed. Nest box installation and management also discussed in accordance with Roads and Maritime Biodiversity Guidelines	EcMP - Sections 3, 4, 5 and 6 See Nest Box Monitoring Reports (NGH)

ID	Condition	Limitations	Fulfilment of commitments	Reference
	Installation of bat roost and nest boxes would take place at least one month prior to the commencement of construction	-	EcMP outlines surveys that would inform the number of bat roosts and nest boxes required to be installed at a 1:1 ratio for each hollow that will be removed. Nest box installation and management also discussed in accordance with Roads and Maritime Biodiversity Guidelines	EcMP - Sections 3, 4, 5 and 6
	Install nest boxes in accordance with Roads and Maritime 'Biodiversity Guidelines: Guide 8 – Nest Boxes' (RTA 2011)	-	EcMP outlines methodology for surveys of bridges and culverts to detect roosting microbats. Refers to the need of a Bat Management Plan if bats are detected during surveys	EcMP - Sections 3, 4, 5 and 6 See Nest Box Monitoring Reports (NGH)
	Prior to construction, conduct a survey of any bridges or culverts scheduled for removal in order to detect roosting microbats. If detected, prepare and implement a Bat Management Plan	-	EcMP outlines methodology for surveys of bridges and culverts to detect roosting microbats. Refers to the need of a Bat Management Plan if bats are detected during surveys	EcMP - Sections 3, 4, 5 and 6
Construction				
Mortality of individuals	Ensure that vegetation clearance complies with Roads and Maritime Biodiversity Guidelines: Guide 4 - Clearing of vegetation and removal of bushrock (RTA, 2011)		Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
Monitoring - Monitoring impacts during pre-construction, construction and operational phases				
	Prepare pre-construction, construction and operational monitoring programs which would use	Data likely to be highly qualitative therefore data	EcMP outlines the developed ecological monitoring program. A 'Before and After at	EcMP - Section 3 and Section 4

ID	Condition	Limitations	Fulfilment of commitments	Reference
	the 'Before and After at Control and Impact sites' approach and set out the type and frequency of monitoring to be carried out, allocate responsibilities and monitoring parameters where relevant	analysis will be conducted where possible. Baseline monitoring limited to spring/ summer only	Control and impact sites' (BACI) approach is not to be strictly applied, as outlined in Section 3. The type and frequency of monitoring, and monitoring parameters are also provided	This report
	Ensure a qualified ecologist is present for staged habitat removal in accordance with the Roads and Maritime' Biodiversity Guidelines (RTA 2011) and fauna rescue/relocation	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2
	Undertake monitoring of edge effects and weed management measures as outlined in the Flora and Fauna Management Plan	-	Refer to CFFMP for detail. EcMP includes requirement for report and monitoring results as part of overall ecological performance monitoring	EcMP - Section 2.4, Section 3 See Weed Monitoring Reports (NGH)
	Undertake bi-annual monitoring of nest boxes and bat roost boxes by a qualified and licensed ecologist during construction and annual monitoring for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring after the completion of three years monitoring	-	EcMP outlines a 3 year bi-annual monitoring program for nest boxes.	EcMP - Section 2.1. Section 2.3, Section 3 and Section 4 See Nest Box Monitoring Reports (NGH)
	Undertake bi-annual monitoring of dedicated fauna underpasses and rope bridges (using equipment such as remote cameras) by a qualified and licensed ecologist for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring for a further two years in the event a negative impact on species is detected	Baseline monitoring limited to spring only as a result of time restrictions Due to inadequate planning for remote camera installation, post-construction monitoring was delayed until Spring 2018.	EcMP outlines a 3 year bi-annual monitoring program. Discussions with Roads and Maritime confirmed that only annual monitoring would be required.	EcMP - Section 2.2, Section 3 and Section 4 This report – Sections 2.4, 3.2 and 4.2

ID	Condition	Limitations	Fulfilment of commitments	Reference
	Conduct road kill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location. The local council road cleansing teams or Wildlife Rescue South Coast may be contracted to undertake the monitoring or alternatively Roads and Maritime Southern Region would undertake the monitoring	Additional baseline monitoring will be limited to the number of weeks remaining until construction in approximately January 2015	EcMP outlines the weekly road kill monitoring methodology. This has included pre-construction road kill monitoring on the existing Princes Highway section. Weekly monitoring during the post-construction phase was completed by NGH for 52 weeks	EcMP - Section 3 and Section 4 This report – Section 2.1, 3.1 and 4.1
	Conduct aquatic ecology monitoring during the pre-construction, construction and operational periods of the project in accordance with the aquatic ecology monitoring program outlined in Appendix G of the Aquatic Ecology and Water Quality Management Technical Paper provided at Appendix G of this environmental assessment. Sampling would be undertaken during Spring and Autumn, with the monitoring to continue for a minimum of one year after the project is opened to traffic. Monitoring locations would include the created diversion channel between Town Creek and Bundewallah Creek in order to provide an indication of the successful establishment of a natural creek ecosystem	Baseline monitoring limited to spring/ summer only as a result of time restrictions	EcMP outlines aquatic ecology monitoring program in accordance with the program outlined in the Environmental Assessment. Aquatic ecology monitoring to occur downstream of impact areas, with reference to upstream water quality monitoring results also to be provided	EcMP - Section 2.5, Section 3 and Section 4. See Aquatic Monitoring Reports (NGH)
	In accordance with the aquatic ecology monitoring program, periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity	-	EcMP outlines the requirement of periodic review of aquatic monitoring and the use of results to address unforeseen impacts on biodiversity, including consideration for the potential of additional mitigation requirements	EcMP - Section 2.5, Section 3 and Section 4. See Aquatic Monitoring Reports (NGH)

ID	Condition	Limitations	Fulfilment of commitments	Reference
	Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforseen impacts on biodiversity	General responses to address unforseen impacts provided only	EcMP outlines an adaptive ecological monitoring program, result assessment and recommends performance criteria and potential contingency measures to address unforeseen impacts on biodiversity	EcMP - Section 3 and Section 4

1.1.2. Aquatic Monitoring

A number of requirements regarding aquatic monitoring during the post-construction period are outlined in the following documents:

- Minister's Conditions of Approval (CoA)
- The TfNSW Statement of Commitments (SoC)
- Construction Flora and Fauna Management Plan sub-plan (CFFMP) (Fulton Hogan, 2014)
- Ecological Monitoring Program (EcMP) (PB 2014)

In accordance with Section 6.2 of the Ecological Monitoring Program (EcMP) (PB 2014), annual reporting is to be completed for all monitoring surveys outlined in the EcMP. This includes aquatic monitoring post-construction.

The EcMP requires that the following aquatic monitoring be undertaken post construction:

Table 1-2 Aquatic monitoring requirements as stated in the EcMP.

Monitoring method	Data to be collected
Habitat assessments – at each creek to determine the suitability of the site to support listed species and based on AUSRIVAS protocols.	Identify habitat variables such as benthic substrate, water depth and vegetation/water % coverage (including shading).
Water quality – will be measured with a Yoekal hand held multi-probe at each site undertaken in accordance with the appropriate guidelines (AS/NZS 6557.1:1998, AS/NZS 5667.6:1998 and Australian Guidelines for Water Quality Monitoring and Reporting (2000).	pH, turbidity (NTU), conductivity (s/cm), temperature (°C) and dissolved oxygen (% saturation and mg/L).
Macrophyte and emergent vegetation – will be identified and mapped at each site. Species abundance will also be quantitatively surveyed using five metre wide 25 m long transects.	Species identified, mapping and species abundance.
Macroinvertebrates – at each site following the AUSRIVAS protocols for NSW.	Macroinvertebrates would be sampled and identified to family species level and enumerated.
Fish assessment - at each site a single wing fyke net (12mm or 20mm) and six bait traps would be deployed and set to ensure a diversity of structural habitats are surveys where possible. Mesh seine nets (5-6mm bar) can also be used.	Fish would be identified to species, enumerated, weighed and measured.

In accordance with the EcMP, the surveys were undertaken directly downstream of the creek crossings to monitor downstream impacts of construction. Upstream water quality monitoring via sampling control sites were also monitored to provide background water quality levels. Aquatic monitoring was conducted biannually (within Autumn and Spring) for a 3 year period which commenced at the start of the operational phase (2018). This monitoring is a continuation of surveys undertaken between 2014 (pre-construction) and 2015-2017 (Construction period). Post-construction monitoring involved 4 sessions per year; two in Autumn, and two in Spring. Previous years involved four sessions per year, two in Autumn and two in Spring. All results are included in this Annual Monitoring Report.

1.1.3. Weed Monitoring

A number of requirements regarding the management of weeds during the construction period are outlined in the following documents:

- Minister's Conditions of Approval (CoA)
- The TfNSW Statement of Commitments (SoC)
- The mitigation measures listed in the Foxground and Berry bypass Environmental Assessment (EA) (AECOM, 2012)

The Construction Flora and Fauna Management sub-plan (CFFMP) (FH 2014) and Ecological Monitoring Program (EcMP) (PB 2014) prepared for the project details the actions that need to be taken to meet those requirements.

The EcMP requires that the following monitoring be undertaken post construction:

Table 1-3 Weed monitoring requirements as stated in the EcMP

Timing and frequency	Monitoring method	Data to be collected	Reporting
Annual monitoring for a minimum 3 year period to commence at the start of the operational phase. Any time of year.	Conduct post-construction monitoring of re-vegetated areas and extent of study area for the introduction/spread of weed species.	On visual inspection of the study area the following weed data would be collected: • Species of weeds identified • Extent of infestations – cover and abundance • Extent of previously identified weed infestations - map if possible.	Results included in Annual Weed Monitoring Report

2. METHODOLOGY

2.1. PERSONNEL

The personnel that were involved in the preparation of this 2019 monitoring are presented in Table 2-1.

Table 2-1 Personnel and their roles

Name	Position	Role
Elijah Elias	Ecologist	Project manager, report preparation, ecological monitoring surveys, aquatic monitoring surveys, weed monitoring survey
Freya Gordon	Senior Ecologist	Report Preparation
Aleksei Atkin	Technical Lead - Ecology	Technical Review
Natascha Arens	Director – Sydney Office	High Level Review
Danielle Packer	Ecologist	Aquatic monitoring surveys
Cameron Radford	Ecologist	Ecological monitoring surveys
Narawan Williams	Fauna Ecologist	Camera automated detection
Amy Rowles	Fauna Ecologist	Camera automated detection

2.2. ECOLOGICAL MONITORING

2.2.1. Post-Construction Monitoring Summary

Table 2-2 below provides a summary of the post-construction ecological monitoring requirements as stated in the EcMP. Any deviations from those requirements are also provided, including reasons for alterations to the methodology

Table 2-2 Post-construction ecological monitoring requirements as stated in the EcMP.

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
Roadkill surveys	Along the upgraded stretch of the Princes Highway between Toolijoola Road and O'Keefes Lane in Berry, NSW	Weekly basis for a period of up to 52 weeks to commence at the start of the operational phase (31 October 2017)	Conduct roadkill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location. The local council road cleansing teams or Wildlife Rescue South Coast may be contracted to undertake the monitoring or alternatively TfNSW Southern Region would undertake the monitoring	Roadkill Monitoring was undertaken by Fulton Hogan from November 1 2017 to December 25, 2017. Roadkill monitoring by NGH did not begin until 20 February 2018, as that was when the contract was awarded. NGH carried out 52 weeks of roadkill monitoring from February 2019 to February 2020.
Camera –automated motion detection	At locations where connectivity structures have been	Annually (within spring/ summer) for a 3 year period to	Cameras will be strategically placed in areas likely to be used	Figure 2-1 of the EcMP map identified rope crossings and

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
	constructed (e.g. underpasses, rope crossings) See Figures 2-1 to 2-10 below.	commence at the start of the operation al phase. The monitoring session would involve 15 units, each recording constantly for one, 11 day session per year.	as movement pathways by native wildlife such as: • Above ephemeral waterways established animal tracks • Existing bridges/culverts. Cameras would be triggered by animal motion and would operate at day and night to record both nocturnal and diurnal animals.	underpasses where cameras should be placed. Some locations are different to those identified within the EcMP due to those crossing structures being placed in different locations during the construction phase. TfNSW was consulted throughout and approved the locations monitored in this report.
Transect surveys - Spotlighting	Along each transect (Figures 2-1 to 2-10)	Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase.	Spotlighting would be completed after dusk along each transect at a rate of approximately one kilometre per hour using 50 watt spotlights. Animals observed, including arboreal, flying and ground-dwelling mammals as well as nocturnal amphibians, reptiles and birds will be identified by their distinctive vocalisations or by sight with the aid of binoculars and recorded. Spotlighting would be concentrated on areas that	None

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
			contain suitable habitat features for nocturnal species including trees, shrubbery, rock outcrops, water bodies/wet areas and the ground surface.	
Transect surveys - Call Playback	At one point along each transect (Figures 2-1 to 2-10)	Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. Each monitoring session would involve one call playback session along each transect.	Call playback targeting threatened species of nocturnal bird (e.g. Bush Stone-curlew), mammals (e.g. Koala, Yellow-bellied Glider) and frogs (e.g. Green and Golden Bell Frog) would be conducted using standard methods as per below that are most often used for owls (Debus 1995). Calls for target species would be broadcast via megaphone after dusk. The survey would involve an initial listening period of 5-10 minutes, followed by a spotlight search of 10 minutes to detect any animals in the vicinity. The calls of the targeted species would then be played intermittently for 5 minutes followed by a 10 minute listening period. After the calls are played, another 10 minutes of spotlighting would be done in	None

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
			the vicinity to check for animals attracted by the calls, but might not be vocalising The direction and estimated distance of response calls will be recorded to provide data on the location of targeted species with respect to proposed structure locations.	
Transect surveys - Tracks, Scats, and signs searches	Along each transect (Figures 2-1 to 2-10)	Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. Each monitoring session will involve one, one hour search along each transect.	Searches will be conducted for signs of animal activity along each transect and would include searches of: • tree trunks for scratches (e.g. Koala) and feeding wounds (e.g. Yellow-bellied Glider) • the base of trees for scats of arboreal mammals • the ground layer for scats of kangaroos, wallabies and the Common Wombat • the soil surface for characteristic diggings of terrestrial mammals (e.g. Short-beaked Echidna, Long-nosed Potoroo)	None

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
			• sandy and muddy areas for animal tracks	
Transect surveys - Herpetology searches	Along each transect (Figures 2-1 to 2-10)	Annually (within spring / summer) for a 3 year period to commence at the start of the operational phase. Each monitoring session will involve one, one hour search along each transect.	Herpetofauna (frogs and reptiles) active searches would involve looking for active specimens and eye shine (frogs only) within suitable habitat within the study area. The survey would involve searches for: • active or basking reptiles in sunlit areas • sheltering frogs and reptiles: • underneath logs and rocks • in rock crevices • under decorticating bark on trees • amongst leaf litter. Specimens would be identified visually, by aural recognition of call (frogs only) or collected by hand for identification. Frogs and reptiles would also be surveyed during spotlighting and call playback events and	None

Survey Type	Post construction Monitoring -Location	Post construction monitoring - Timing and frequency	Monitoring requirements as per the EcMP	Departures from the EcMP
			opportunistically across the study area.	

2.2.2. Camera Automated Detection

Cameras were strategically placed at locations where connectivity structures have been constructed (e.g. underpasses and rope crossings), with locations shown in Figures 2-1- to 2-4. Cameras were set to burst photo mode, triggered by animal motion, and operated day and night to record both nocturnal and diurnal fauna utilising connectivity structures. The monitoring session involved the deployment of 15 Reconyx infrared motion detecting cameras. Each unit recorded constantly for a minimum 11-day session during November 2019. All cameras were retrieved on 8th December 2019. Detailed locations and site notes are provided in Table 2-3.

Table 2-3 Deployed cameras and installation notes

Site	Camera ID	Date installed	Easting	Northing	Notes	Crossing structure type	Crossing (from 2015) PB
1	4	4-5/11/2019	289632	614986	Bundewallah Creek, west of Woodhill Mountain Rd. Northbound.	Rope bridge	BABN
2	10	4-5/11/2019	289627	6149930	Broughton Mill Creek, east of Woodhill Mountain Rd. Southbound.	Rope bridge	BMCS
3	13	4-5/11/2019	291875	6150926	Northbound	Rope bridge	PH5N
4	12	4-5/11/2019	291938	6150933	Northbound	Fauna underpass	PH4N
5	3	4-5/11/2019	292230	6150878	Southbound	Rope bridge	PH3S
6	14	4-5/11/2019	292290	6150916	Southbound	Dual use underpass	PH2N
7	7	4-5/11/2019	294140	6151765	Broughton Creek. Southbound	Rope bridge	BCC3N
8	2	4-5/11/2019	294157	6151729	Broughton Creek. Southbound	Rope bridge	BCC3S

Site	Camera ID	Date installed	Easting	Northing	Notes	Crossing structure type	Crossing (from 2015)	PB
9	1	4-5/11/2019	294393	6152199	Broughton Creek. Southbound	Rope bridge	BCC2W	
10	15	4-5/11/2019	294826	6152825	Broughton Creek. Northbound.	Rope bridge	BCC1N	
11	11	4-5/11/2019	294872	6152755	Broughton Creek. Southbound	Rope bridge	BCC1S	
12	6	4-5/11/2019	296216	6152703	Toolijooa. Southbound	Rope bridge	TR2S	
13	9	4-5/11/2019	294430	6152193	Broughton Creek. Northbound	Rope bridge	BCC2E	
14	5	4-5/11/2019	292797	6151078	Broughton. Southbound	Dual use underpass	PH1S	
15	8	4-5/11/2019	296328	6152636	Toolijooa. Northbound	Fauna underpass	TR1S	

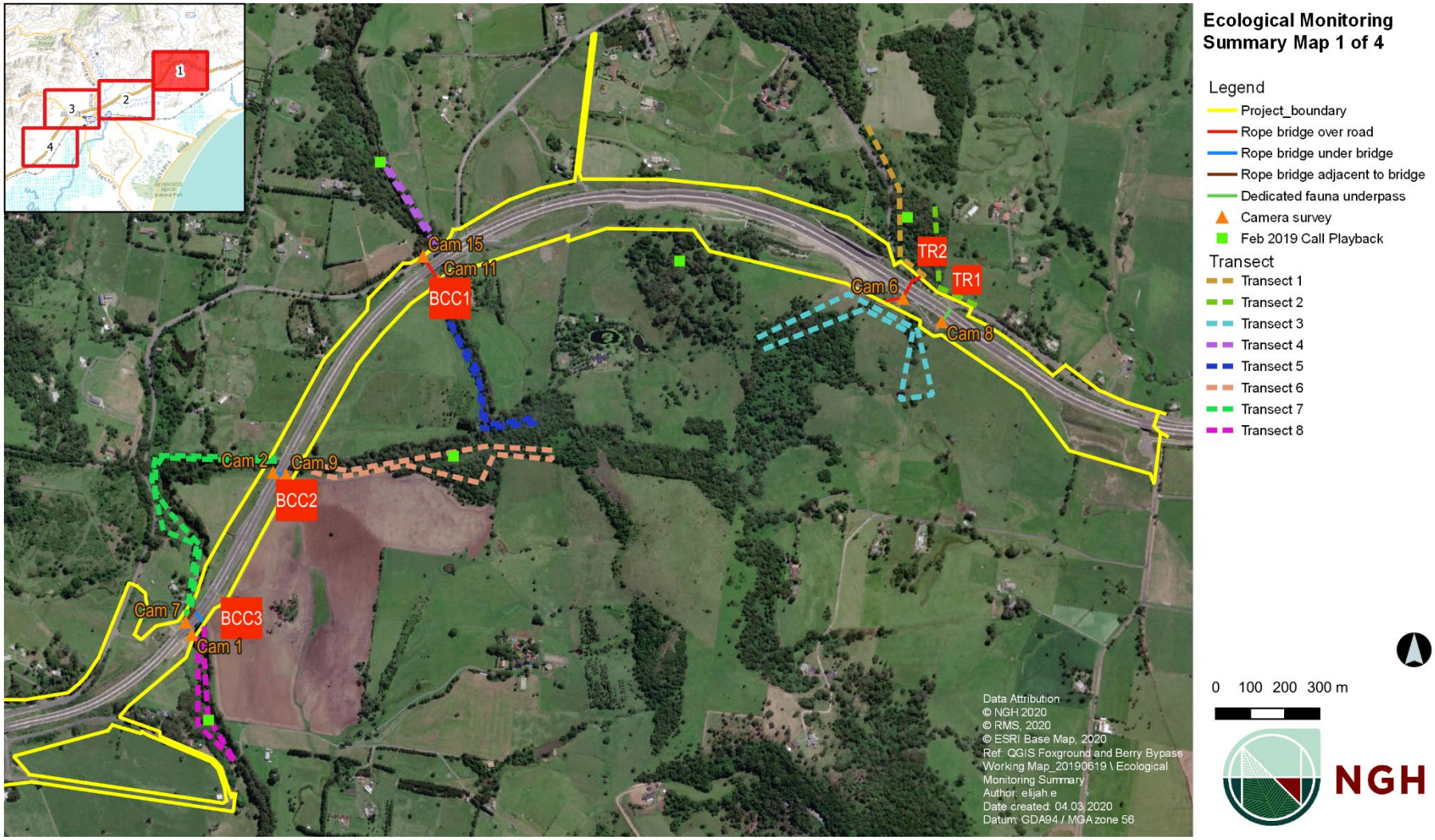

Figure 2-1 Ecological Monitoring Summary (Camera, Transect and Call Playback locations) Map 1 of 4

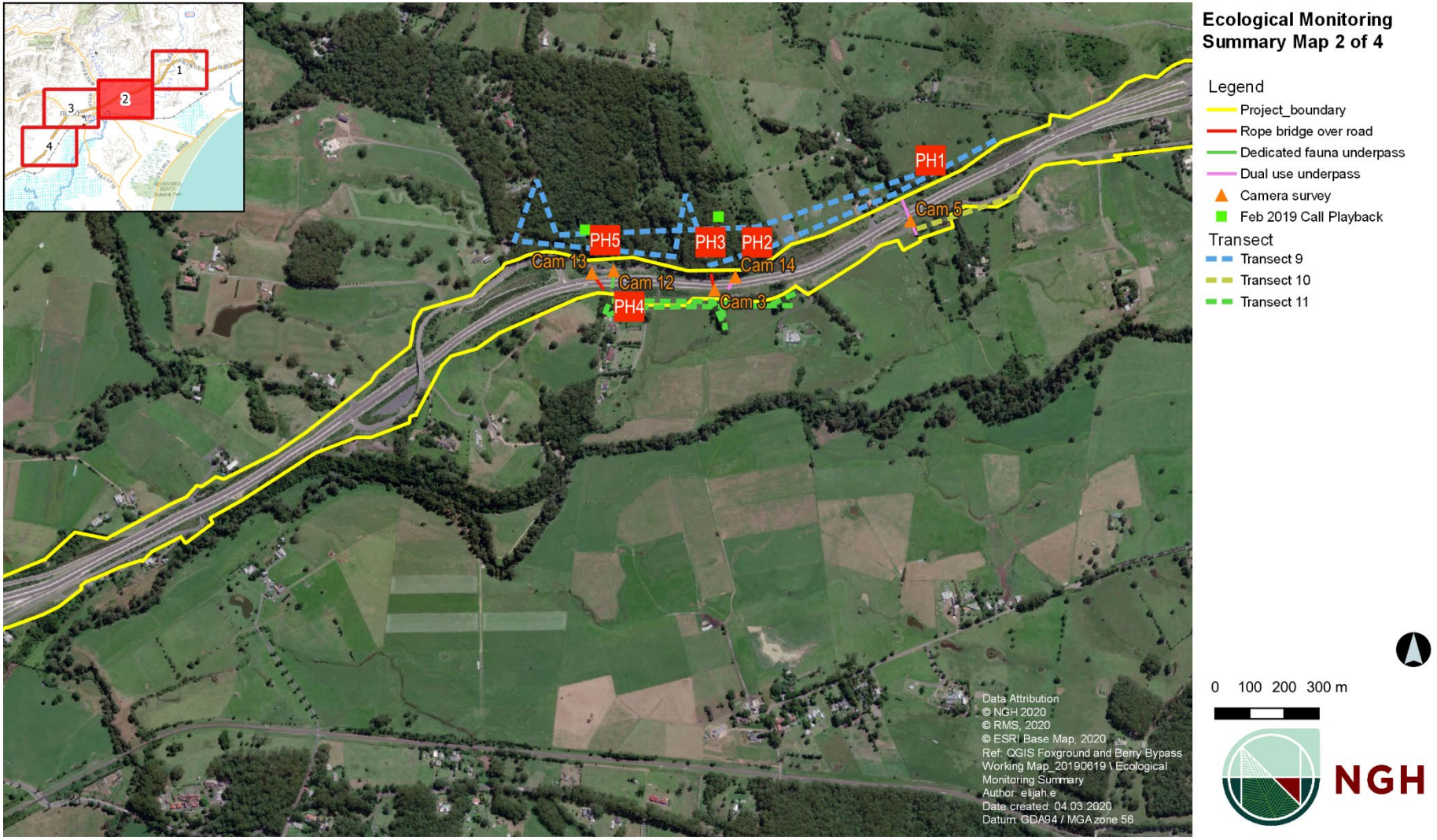

Figure 2-2 Ecological Monitoring Summary (Camera, Transect and Call Playback locations) Map 2 of 4

Figure 2-3 Ecological Monitoring Summary (Camera, Transect and Call Playback locations) Map 3 of 4

Figure 2-4 Ecological Monitoring Summary (Camera, Transect and Call Playback locations) Map 4 of 4

Limitations

The cameras were set to burst photo mode to ensure correct identification, and only one photo from each burst was added to the dataset tally to mitigate double counts of individual animals. Where animals were clearly the same animal triggering the camera with multiple bursts, a period of five (5) minutes from the detection of the first animal to the next count of the same species was implemented. As the camera time between bursts was set lower than expected to ensure all species/individuals were recorded, sightings of the same species within the same/similar time and location were only counted as one sighting. If an individual would return at a later time, there would be no definitive way of determining from this survey method if it is a new or returning individual.

2.2.3. Transect Surveys

Transect surveys were carried out in February 2019 and included including spotlighting, herpetological surveys, tracks, scats and signs searches, and call playback. Opportunistic observations were also recorded.

The dates, weather conditions and survey effort for each transect survey session in 2019 is outlined in Table 2-4. The locations of each transect is presented in Figures 2-1- to 2-4.

Table 2-4 Transect survey dates, conditions (Berry Masonic Village Weather – 068003 Rainfall) (Kiama Bombo Headland – 068242 Temperature) and survey effort

Date	Temp max (ºC)	Rainfall (mm)	Survey Type	Person hours	Notes (e.g. transect number)
18/02/2019	26.5	0.0	Diurnal	180 mins	T13, T14
			Spotlight	240 mins	T13, T14
			Call Playback	45 mins	T14- Squirrel glider, Masked Owl, Sooty Owl, Powerful Owl
19/02/2019	22.3	0.0	Diurnal	120 mins	T9
			Spotlight	180 mins	T9
			Call Playback x 2	90 mins	T9- BS Curlew, Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl
20/02/2019	21.6	0.0	Diurnal	150 mins	T4, T10, T11
			Call Playback	60 mins	T4- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl T11- Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl
			Spotlight	210 mins	T4, T10, T11
21/02/2019	21.9	10.6	Diurnal	120 mins	T7, T8
			Call Playback	30 mins	T8- Black Bittern, Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl
			Spotlight	180 mins	T7, T8
22/02/2019	21.7	0.0	Diurnal	90 mins	T3

Date	Temp max (ºC)	Rainfall (mm)	Survey Type	Person hours	Notes (e.g. transect number)
25/02/2019	25.8	0.0	Diurnal	90 mins	T5
26/02/2019	26.1	0.0	Diurnal	120 mins	T1, T2
			Call Playback	45 mins	T2- BS Curlew, Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl
			Spotlight	180 mins	T1, T2
27/02/2019	24.1	0.0	Diurnal	90 mins	T6
			Call Playback	30 mins	T6
			Spotlight	240 mins	T5, T6
01/03/2019	27.0	0.0	Call Playback	45 mins	T3- BS Curlew, Squirrel Glider, YB Glider, Barking Owl, Sooty Owl, Masked Owl, Powerful Owl
			Spotlight	150 mins	T3

2.2.4. Spotlighting

Spotlighting was completed after dusk along each transect (Table 2-4, Figures 2-1- to 2-4) at a slow walking pace using Led Lenser H14R.2 headtorches. The fauna observed, which included arboreal, flying and ground-dwelling mammals as well as nocturnal amphibians, reptiles and birds were identified by their distinctive calls or by sight, and recorded. Spotlighting was concentrated in areas which contained suitable habitat features for nocturnal species including trees, shrubbery, rock outcrops, water bodies/wet areas and the ground surface.

2.2.5. Herpetological surveys

Active diurnal searches for frogs and reptiles were conducted along each transect (Figures 2-1- to 2-4).

The survey involved searches for:

- active or basking reptiles in sunlit areas
- sheltering frogs and reptiles: underneath logs and/or rocks, under decorticating bark on trees, or amongst leaf litter.

Specimens were identified visually, by call recognition (frogs only), or collected by hand for identification.

Frogs and reptiles were also surveyed for during spotlighting and call playback events and opportunistically across the study area.

2.2.6. Tracks, Scats and Signs Search

Diurnal searches were conducted for signs of animal activity along each transect (Figures 2-1- to 2-4) and included searches of:

- tree trunks for scratches (e.g. Koala) and feeding wounds (e.g. Yellow-bellied Glider)
- the base of trees for scats of arboreal mammals
- the ground layer for scats of kangaroos, wallabies, Common Wombats, and exotic mammals
- the soil surface for characteristic diggings of terrestrial mammals (e.g. Short-beaked Echidna, Long-nosed Potoroo)
- sandy and muddy areas for animal tracks

2.2.7. Opportunistic

Opportunistic sightings were recorded during transect surveys. This included, but was not limited to, birds of prey flying overhead, birds, frog calls, fox sightings etc.

2.2.8. Call Playback

Call playback surveys were conducted in accordance with Table 3.3 of the EcMP. Species selected for call playback included, but was not limited to, those target species identified in the EcMP, and were tailored for the habitat of the transect and the likelihood of presence. The list included; Bush-stone Curlew, Squirrel Glider, Yellow Bellied Glider, Barking Owl, Masked Owl, Sooty Owl, Powerful Owl, and Koala. Species' calls were played in order from smaller/least territorial to larger/most territorial. This was essential especially for owls, for if a Powerful Owl call was played first, this may alarm gliders and smaller owls, impacting our results.

All call playback surveys occurred after dusk at a location along each transect for a minimum of 10 minutes as per the EcMP. An initial listening period of 5-10 minutes was allowed, followed by a spotlight search of the area for 10 minutes to detect any animals in the area that had not vocalised their presence. Calls for target species were then broadcasted via megaphone. The calls of the targeted species were played intermittently for 5 minutes followed by a 10-minute listening period. After the calls were played, another 10 minutes of spotlighting was completed in the vicinity to check for animals attracted by the call playback but might not be vocalising.

Limitations

The weather during fieldwork can have an impact on fauna survey results. The rain experienced on the 21/2/19 may have caused terrestrial and arboreal mammals to shelter in the night. In contrast, the weather would have provided enhanced activity in frog species. Weather conditions during the survey period are detailed in Table 2-4.

Transect 12 was deemed inaccessible as the surveyors did not have permitted access by the land owner. Therefore, diurnal surveys, as well as spotlight and call play back surveys, were not conducted at this location.

The transects surveyed during the 2019 monitoring period aligned with those detailed within the EcMP (PB, 2014), however it is understood that the exact locations of transects are not identical to those identified within the FBB Baseline Ecological Monitoring Report (PB, 2015).

2.3. AQUATIC MONITORING

2.3.1. Aquatic Monitoring Sites

Aquatic monitoring was undertaken twice during Autumn and twice during Spring in 2019 (Table 2-5). In accordance with AUSRIVAS aquatic monitoring protocols, Autumn is considered to be between 15 March and 15 June and Spring between 15 September and 15 December). Six downstream aquatic monitoring sites, 100 metres in length, were monitored. It should be noted that while the site identification numbers have been kept from previous reports, the location of sites 13 and 25 have been modified compared to the pre-construction aquatic assessment undertaken by JSA Environmental in Spring 2014 (JSA 2016) to account for access restrictions. In addition, two control sites were monitored as per the recommendations in the 2015 annual report: Control Site 1 along Broughton Mill Creek (upstream of site 25) and Control Site 2 along Broughton Creek (upstream of site 13). Control Site 2 was not monitored until Spring 2016; approval from Fulton Hogan to monitor the site was not received until Spring 2016.

Aquatic monitoring has been undertaken at eight sites (Figures 2-5 to 2-9)

- 13 – Broughton Creek
- 16 – Broughton Creek
- 17 – Broughton Creek
- 22 – Bundewallah Creek
- 25 – Broughton Mill Creek
- 27 – Bundewallah Creek
- Control 1 – Broughton Mill Creek
- Control 2 – Broughton Creek

Table 2-5 Dates of Aquatic Monitoring

	Post Construction (2018)	Post Construction (2019)
Autumn	Session 1: 16-18 April 2018	Session 1: 2-3 April 2019
	Session 2: 5-7 June 2018	Session 2: 15-17 April 2019
Spring	Session 1: 24-26 September 2018	Session 1: 9-11 October 2019
	Session 2: 20-22 November 2018	Session 2: 28-29 October 2019

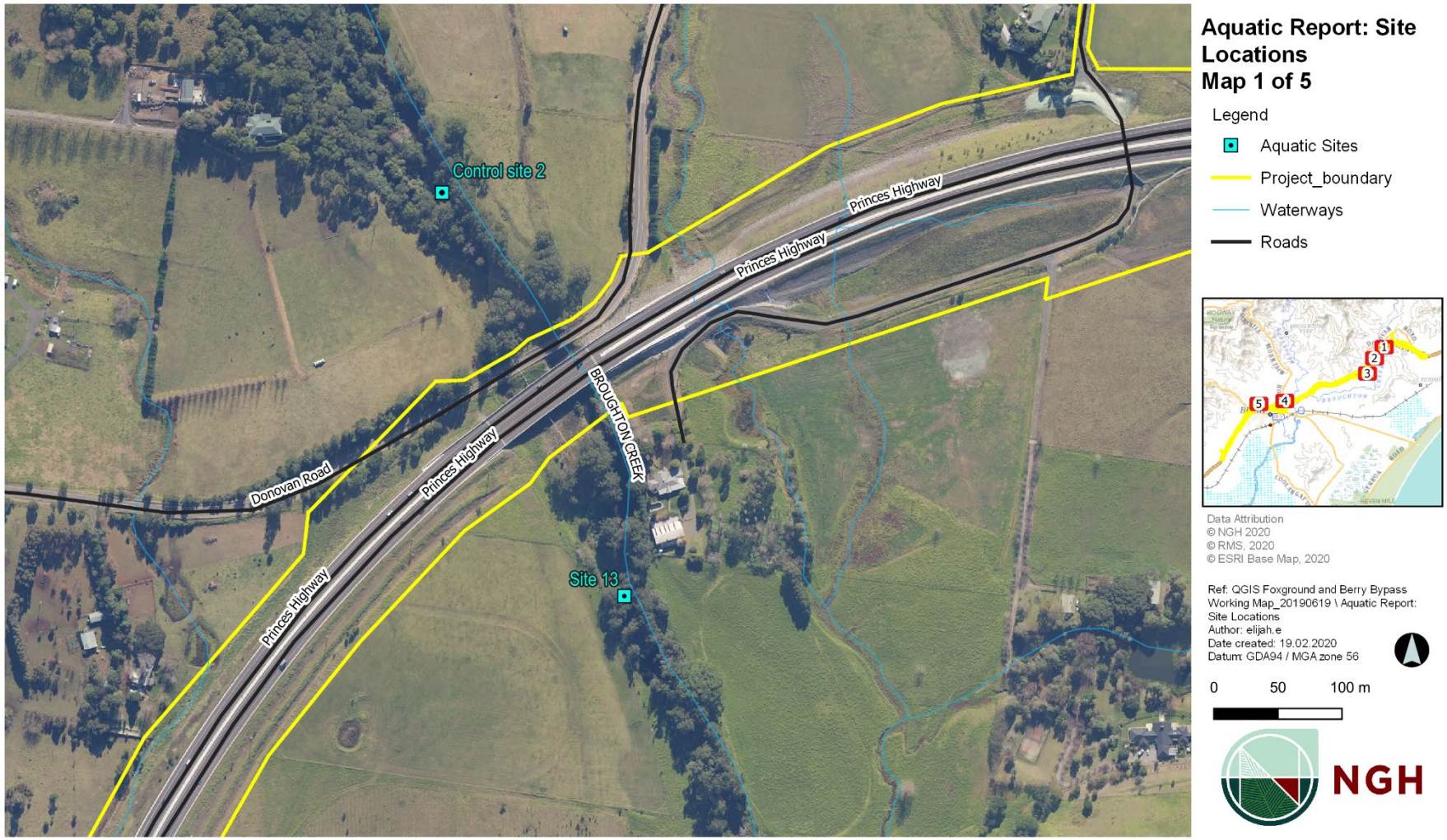

Figure 2-5 Aquatic Monitoring Sites Map 1 of 5

Figure 2-6 Aquatic Monitoring Sites Map 2 of 5

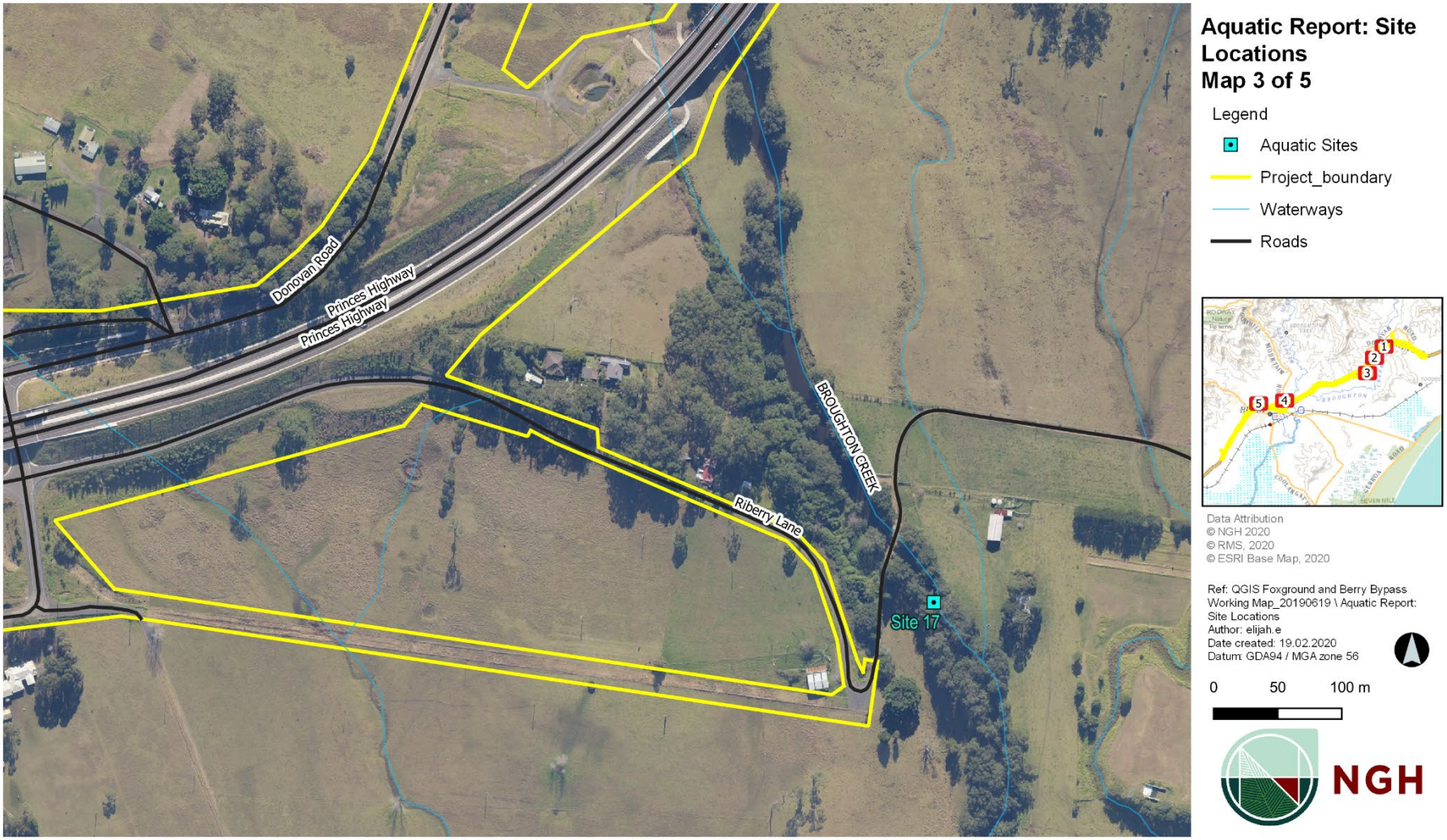

Figure 2-7 Aquatic Monitoring Sites Map 3 of 5

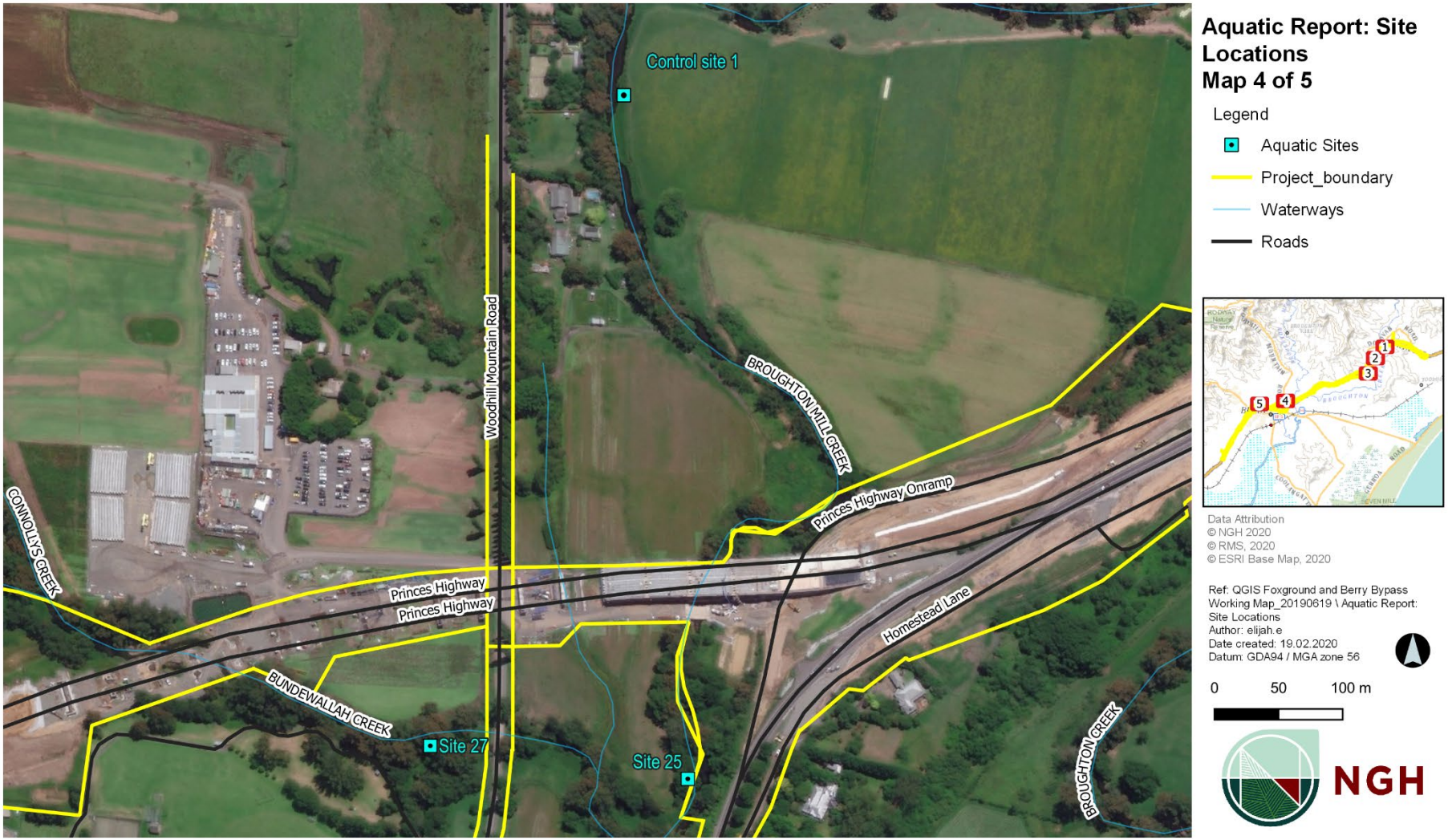

Figure 2-8 Aquatic Monitoring Sites Map 4 of 5

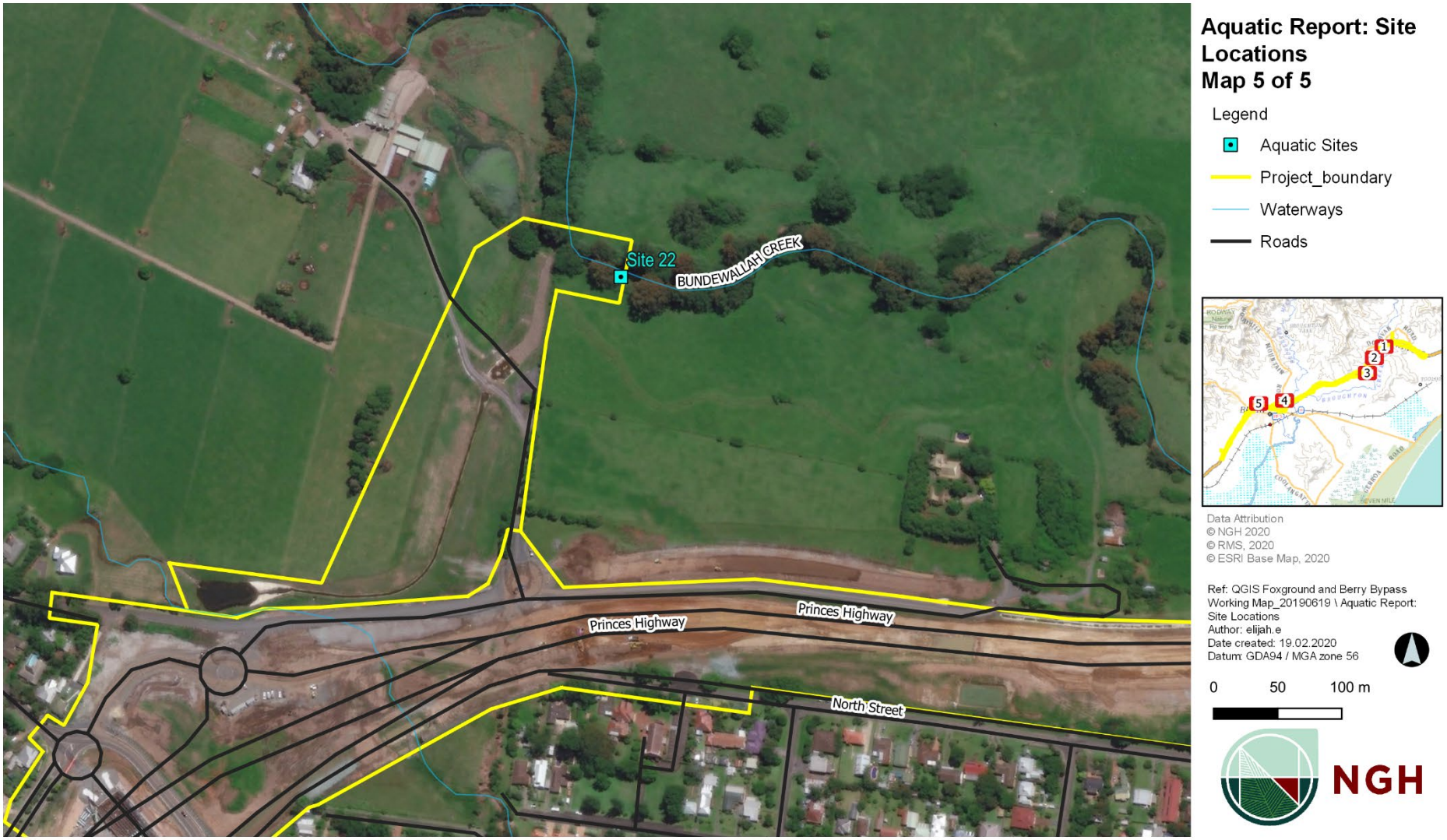

Figure 2-9 Aquatic Monitoring Sites Map 5 of 5

2.3.2. Habitat Assessment

The AUSRIVAS field data sheets were completed for each site to obtain an overview of the site attributes. The following was recorded:

- Riparian vegetation structure
- Shading of river
- Water levels
- Description of natural substrate
- Detritus cover
- Percentage cover of Algae/Moss/Macrophytes in 100 metre section
- Other instream habitats
- Land use
- Visual assessment of disturbance related to human activities

2.3.3. Water Quality

Water quality was monitored using a handheld multiparameter water quality meter. The following data was taken:

- Temperature ºC
- pH
- Conductivity ms/cm
- Turbidity NTU
- Dissolved oxygen in mg/L and %

2.3.4. Macrophyte and Emergent Vegetation

Macrophyte and emergent aquatic vegetation within the creek were identified within the 100 metre section of creek at each site. Furthermore, a 25 metre by 5 metre transect within the creek was surveyed at each site and abundance of macrophytes and emergent vegetation recorded. The location of each transect is provided in Figures 2-5 to 2-9. A photograph of each transect was also taken for comparison purposes between monitoring sessions (Appendix F).

Cover/abundance assessments were based on visual estimates of foliage cover (after Carnahan 1997), scored using a modified Braun-Blanquet 6-point scale:

1. 1 to a few individuals present, less than 5% cover
2. many individuals present, but still less than 5% cover
3. 5 - < 20% cover
4. 20 - < 50% cover
5. 50 - < 75% cover
6. 75 - 100% cover

2.3.5. Macroinvertebrates

Macroinvertebrates were sampled in edge and riffle habitats in accordance with the NSW AUSRIVAS Sampling and Processing Manual (Department of Environment and Conservation, 2004). A kick net (250 micron mesh size) was used and a 10 metre section of each type of habitat was sampled. The samples were then sorted in accordance with AUSRIVAS on site for a minimum of 40 minutes and preserved in 70% ethanol. Macroinvertebrate samples were identified to family. The resulting data was analysed using SIGNAL and EPT scores (see below) to provide an assessment of the existing 'health' of the waterway based on the water quality and abundance and diversity of the macroinvertebrate families present.

SIGNAL score

Families of aquatic invertebrates have been awarded sensitivity scores, according to their tolerance or intolerance to various pollutants. These scores have been determined by examining data from studies of various pollutants in south-eastern Australian streams. The scores are a compromise in cases where species within a family respond in different ways to a pollutant, and where the family responds differently to different types of pollutants. The index is calculated by totalling these scores and dividing by the number of graded families present (most, but not all, families have SIGNAL grades). Waterways with high SIGNAL scores are likely to have low levels of salinity, turbidity and nutrients such as nitrogen and phosphorus.

EPT score

The EPT score is named for three orders of aquatic insects that are common in the benthic macroinvertebrate community: Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The EPT score is equal to the total number of families represented within these three orders in the sample (Mandaville 2002). Any loss of families in these groups usually indicates disturbance.

The grading guidelines for each score that are used to describe the health of a stream or river are provided in Table 2-6.

Table 2-6 Macroinvertebrate grading guidelines

SIGNAL Score	Stream health	EPT Score	Stream health
<4	Severe pollution	0-6	Poor
4-5	Moderate pollution	7-13	Fair
5-6	Mild pollution	14-20	Good-fair
6-7	Clean	21-27	Good
>7	Excellent	>27	Excellent

2.3.6. Fish Assessment

Fish surveys were undertaken using passive trapping techniques. Six bait traps were deployed at each site. All nets were set to ensure a diversity of available fish habitat was sampled at each site. The surveys included:

- 6 x Bait traps with a funnelled opening at each end were set close to emergent vegetation, submerged macrophytes and woody debris. Bait traps are a quick and easy method of sampling fish amongst woody debris, dense vegetation, steep banks and deep waters.

Fish were identified to species level and released.

In response to a recommendation in the 2018 aquatic monitoring report, and in consultation with TfNSW, the use of fyke nets was discontinued due to the ethical risks on animals associated with their use.

2.4. WEED MONITORING

A systematic weed survey was conducted at all survey locations by an ecologist on the 11th December 2019 as part of the Post-construction Ecological Monitoring program (Figure 2-12 - Figure 2-15).

The aim of the survey was to determine weed species presence, abundances, and to map the distribution of weed infestations. Data was collected using a Global Positioning System (GPS) enabled tablet running GIS Pro mapping software. The tablet was pre-loaded with topographic, aerial imagery and the project boundary base layer. At each survey point a photograph was taken in order to capture any changes in land condition and weeds species composition from previous and future monitoring events. Polygons were drawn around areas of weeds observed during the survey to capture the identity of weed species present and their abundances. The polygons were saved directly to a GIS shapefile. Weed species targeted in this survey included:

- those listed as Priority Weeds for the South-east region under the *Biosecurity Act 2015* (Biosecurity Act)
- environmental weeds

Documented waypoints in this report signify the approximate location of each survey point where each site photograph was taken rather than the location of each individual weed. A brief site description was recorded where possible to aid with record keeping and as a basis for future management decisions.

Figure 2-10 Weed Monitoring Locations Map 1 of 4

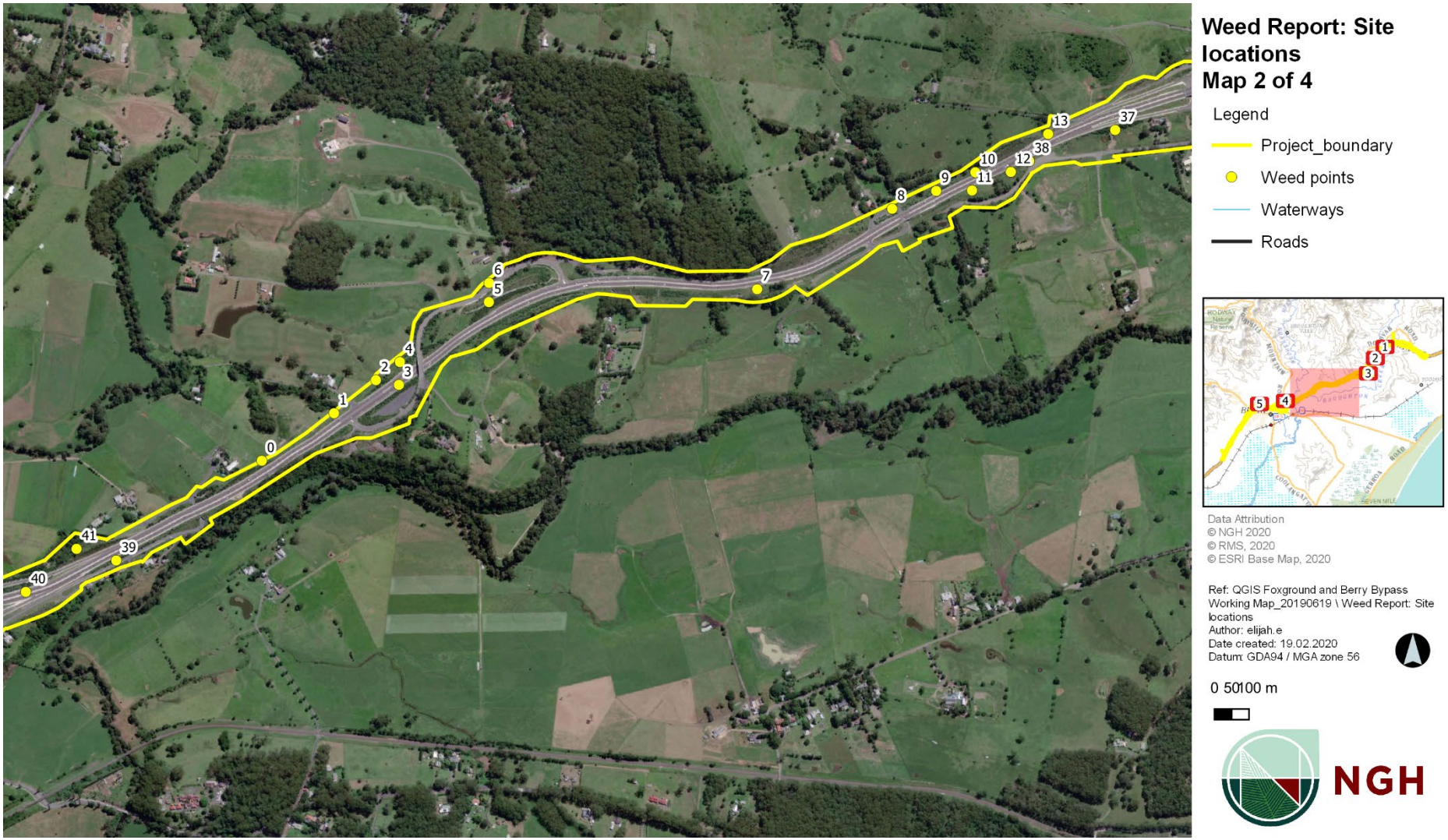

Figure 2-11 Weed Monitoring Locations Map 2 of 4

Figure 2-12 Weed Monitoring Locations Map 3 of 4

Figure 2-13 Weed Monitoring Locations Map 4 of 4

3. RESULTS

3.1. ECOLOGICAL MONITORING

3.1.1. Camera Automated Detection

A total of 740 sightings were recorded by the 15 deployed cameras over the 11-day survey period. This includes a variety of bird, possum, glider, reptile and exotic fauna sightings. The camera with the most sightings recorded was camera 14 with 180 sightings, followed by cameras 7 and 8 with 125 and 87 sightings respectively (Table 3-1). All of these cameras are located at underpasses, which are utilised by a variety of species, not just arboreal species and birds.

A total of 29 confirmed species were detected by the 15 deployed cameras over the 11-day survey period. Each camera varied in species richness detected from two to eight species. The cameras which detected the greatest diversity (eight species) were cameras 5, 7 and 14. The number of species detected by each camera is detailed in Table 3-1. Locations of cameras are shown in Figures 2-1- to 2-4 above.

Table 3-1 Number of sightings and species richness per camera

Site No.	Camera	Crossing Name	Number of sightings recorded	Number of species detected	Species type detected	Crossing structure type
1	4	BABN	46	3	Bird	Rope bridge
2	10	BMCS	26	4	Bird, arboreal mammal	Rope bridge
3	13	PH5N	7	4	Bird	Rope bridge
4	12	PH4N	4	3	Bird, microbat, exotic mammal	Fauna underpass
5	3	PH3S	19	2	Bird	Rope bridge
6	14	PH2N	180	8	Bird, exotic mammal, terrestrial mammal, reptiles, amphibian	Dual use underpass
7	7	BCC3N	125	8	Bird	Rope bridge
8	2	BCC3S	37	6	Bird, arboreal mammal	Rope bridge
9	1	BCC2W	39	3	Bird, arboreal mammal	Rope bridge
10	15	BCC1N	17	4	Bird	Rope bridge
11	11	BCC1S			No data	Rope bridge

Site No.	Camera	Crossing Name	Number of sightings recorded	Number of species detected	Species type detected	Crossing structure type
12	6	TR2S	15	4	Bird	Rope bridge
13	9	BCC2E	52	7	Bird, arboreal mammal, amphibian	Rope bridge
14	5	PH1S	86	8	Bird, reptile, exotic mammal	Dual use underpass
15	8	TR1S	87	6	Bird, arboreal mammal	Fauna underpass

The most common species detected across the project by camera monitoring was the Lewin's Honeyeater (*Meliphaga lewinii*) which was recorded by eight different cameras. This was followed by Superb Fairy-wren (*Malurus cyaneus)* and Grey Shrike-thrush (*Colluricincla harmonica)* which were recorded by seven cameras each. The Common Ringtail Possum (*Pseudocheirus peregrinus*) was detected by five cameras (2, 7, 8, and 12). Camera 12 and Camera 7 had 55 detected sightings and 37 respectively. Four Sugar Gliders (*Petaurus breviceps)* were recorded at Camera no. 9. These results confirm that the Common Ringtail Possums and Sugar Gliders are using the rope bridges in these areas. No Common or Mountain Brushtail Possums were detected by the 15 cameras deployed. As for 2018 surveys, we suggest that perhaps brushtail possums may prefer to not use the rope bridges. However, in some areas, rope bridges are not connected to trees providing connectivity to adjacent bushland which limits the ability for them to be used by species other than flying or gliding species. See Table 3-2 below for detailed results.

Table 3-2 Species and individuals detected during camera surveys

Common Name	Scientific Name	Individuals recorded by each camera															
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	Total
Mammal																	
Common Ringtail Possum	*Pseudocheirus peregrinus*	4	2						10	5	6						**27**
Sugar Glider	*Petaurus breviceps*									4							**4**
Microbat	Suborder Microchiroptera												1				**1**
Short-beaked echidna	*Tachyglossus aculeatus*														12		**12**
Black Rat*	*Rattus rattus*					4							2				**6**
Cat*	*Felis catus*					4											**4**
Red Fox*	*Vulpes vulpes*					3									1		**4**
Bird																	
Unknown Bird	-														1		**1**
Dusky Woodswallow	*Artamus cyanopterus*		14					18									**32**
Common Myna*	*Acridotheres tristis*		1							1							**2**
Grey Shrikethrush	*Colluricincla harmonica*		1				9	2	1		2			3		2	**20**
Australian Raven	*Corvus coronoides*			17										2			**19**
Australian Magpie	*Cracticus tibicen*						1										**1**
Magpie Lark	*Grallina cyanoleuca*		18		10			84		2							**114**
Superb Fairywren	*Malurus cyaneus.*	34	1			24		3	71	38					1	34	**172**
Lewin's Honeyeater	*Meliphaga lewinii*	1					3	8	3		9		1	1		8	**34**
Yellow faced honey eater	*Lichenostomus chrysops*													1			**1**
Willy Wagtail	*Rhipidura leucophrys*				19			3		1	9					6	**38**
Grey Fantail	*Rhipidura albiscapa*							6									**6**
Laughing Kookaburra	*Dacelo novaeguineae*				17				1							1	**19**

Common Name	Scientific Name	Individuals recorded by each camera															
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	Total
Eastern Yellow Robin	*Eopsaltria australis*								1								**1**
Nankeen Kestrel	*Falco cenchroides*						2										**2**
Common Starling*	*Sturnus vulgaris*			2				1									**3**
Reptile and Amphibian																	
Carpet/Diamond Python	*Morelia spilota*					1											**1**
Red-bellied Black Snake	*Pseudechis porphyriacus*					14									6		**20**
Fence Skink	*Cryptoblepharus virgatus*					1									5		**6**
Eastern Water Skink	*Eulamprus quoyii*					35											**35**
Garden Skink	*Lampropholis guichenoti*														23		**23**
Peron's Tree Frog	*Litoria peronii*									1					131		**132**
Total		**39**	**37**	**19**	**46**	**86**	**15**	**125**	**87**	**52**	**26**	**0**	**4**	**7**	**180**	**17**	

*= exotic

3.1.2. Transect Surveys

Spotlighting

A total of 32 species were detected during spotlight surveys across all transects in the project alignment. Locations of transects are shown in Figure 2-1 to Figure 2-10. Spotlighting data plays a vital component in the dataset as it accounts for the detection of nocturnal fauna, in particular arboreal nocturnal fauna like the Common Brushtail Possum, the Common Ringtail Possum, and the Sugar Glider. Data on Grey-headed Flying-foxes is also important as there is a known colony which populates Bundewallah Creek near Berry town centre.

The Grey-headed Flying-fox *Pteropus poliocephalus* and the Common Ringtail Possum *Pseudocheirus peregrinus* were the most frequently observed species during spotlighting, being detected at 9 and 8 different transects respectively. Additionally, microbats were detected in 7 different transects. Table 3-3 below summarises the species detected in each transect.

One threatened species was detected during our spotlighting survey, Powerful Owl *Ninox ninox*. One individual was seen feeding on a juvenile Grey-headed Flying-fox on transect 13. An additional individual was heard calling in the distance in the same transect suggesting a breeding pair.

Table 3-3 Species and individuals detected during spotlight surveys in all transects (X=presence)

Common Name	Scientific Name	Individuals recorded in each transect												
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Mammal														
Black Rat*	*Rattus rattus*						X						X	X
Common Brushtail Possum	*Trichosurus vulpecula*									X	X		X	X
Common Ringtail Possum	*Pseudocheirus peregrinus*	X	X		X	X			X	X			X	X
Grey-headed Flying Fox	*Pteropus poliocephalus*		X		X	X	X	X	X	X			X	X
Microbat (unidentified)	Microchiroptera				X	X	X	X	X	X			X	
Red Fox*	*Vulpes vulpes*							X				X		X
Rusa Deer*	*Rusa timorensis*			X										
Sugar Glider	*Petaurus breviceps*			X		X				X				X

Common Name	Scientific Name	Individuals recorded in each transect												
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Swamp Wallaby	*Wallabia bicolor*	X	X	X			X			X				
Wombat							X							
Brown Antechinus		X												
Long Nosed bandicoot		X												
European Rabbit													X	
Bird														
Domestic Goose*	*Anserina sp.*							X						
Dusky Moorhen													X	
Masked Lapwing													X	
Pacific Black Duck	*Anas superciliosa*			X									X	
Southern Boobook	*Ninox boobook*			X										
White-faced Heron	*Egretta novaehollandiae*						X		X					
Sacred Kingfisher								X						
Brown Cuckoo Dove										X				
Powerful Owl	*Ninox ninox*												X (2 individuals)	
Aquatic														

Common Name	Scientific Name	Individuals recorded in each transect												
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Common Eastern Froglet	*Crinia signifera*					X		X	X		X			
Eastern Dwarf Tree Frog	*Litoria fallax*			X		X		X			X		X	X
Short-finned Eel	*Anguilla australis*					X			X					X
Bleating Tree Frog	*Litoria dentata*			X				X			X			X
Striped Marsh Frog	*Limnodynastes peronii*									X	X			X
Common Yabby	*Cherax destructor*		X											
Eastern Water Dragon					X	X	X							
Southern Leaf Green Tree	*Litoria nudidigita*					X		X	X				X	X
Peron's Tree Frog								X			X			X
Australian Bass									X					

Herpetological Surveys

A total of eight species were identified across all transects during herpetological diurnal surveys. Table 3-4 summarises the species found within each transect. The Rainbow Skink *Lampropholis delicata* was the most frequently identified species during diurnal herpetological searches. A total of three lizard species were observed, two frog species, and three snake species.

A recently shed Red-bellied Black Snake skin was found along the creek line in Transect 6. A healthy Diamond Python *Morelia spilota,* approximately 2 m in length was also observed basking in the long grass in Transect 3. Additionally, an Eastern Brown Snake, just greater than a metre was found basking in the sun approximately 200 m from the Diamond Python in Transect 3.

Table 3-4 Herpetological survey observations within each transect

Common Name	Scientific Name	Individuals recorded in each transect												
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Diamond Python	*Morelia spilota*			X										
Eastern Water Dragon	*Intellagama lesueurii*						X						X	X
Eastern Water Skink	*Eulamprus quoyii*						X				X	X	X	X
Rainbow Skink	*Lampropholis delicata*	X	X	X			X					X	X	X
Eastern Dwarf Tree Frog	*Litoria fallax*	X	x								X			
Eastern Brown Snake	*Pseudonaja textilis*			X										
Red-bellied Black Snake	*Pseudechis porphyriacus*						X							
Striped Marsh Frog	*Limnodynastes peronii*									X				

Tracks, Scats, and Signs search

Fifteen types of Tracks, Scats, and Signs were observed in the project alignment with none detected on transects 3, 8, and 11. Fresh deer tracks were identified in Transect 1 and 2. These transects are surrounded by a private property and Donovan Rd both with barbed wire fencing. The area is a wet sclerophyll gully with dense *Lantana camara* throughout. Deer scat was also observed in these two transects, and deer are known to be present in the area from 2018 monitoring.

Additional data collected from this survey method included wombat burrows and warrens, bird nests and macropod and fox scats. It is apparent that foxes occupy all areas in and around the alignment.

Underpasses were checked for Red Fox scats and macropod scats with no results.

Results of the searches are summarised in Table 3-5 below.

Table 3-5 Tracks, Scats, and Signs within each transect

Common Name	Scientific Name	Observation Type	Individuals recorded in each transect												
			T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Eastern Grey Kangaroo	*Macropus giganteus*	scat									X				
Eastern Grey Kangaroo	*M. giganteus*	tracks									X				
Red Fox	*Vulpes vulpes*	scat	X	X			X	X			X			X	X
Red Fox	*V. vulpes*	den				X					X				
Red Fox	*V. vulpes*	tracks									X				
European Rabbit	*Oryctolagus cuniculus*	burrows									X	X			
European Rabbit	*O. cuniculus*	scat									X	X			
Deer	Species unknown	tracks	X	X											
Deer	Species unknown	scat	X	X											

Common Name	Scientific Name	Observation Type	Individuals recorded in each transect												
			T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T13	T14
Black Rat	*Rattus rattus*	scat	X	X											
Thornbill sp.	*Acanthiza sp.*	nest			X			X			X				
Common Wombat	*Vombatus ursinus*	burrow/warren						X	X		X				X
Swamp Wallaby	*Wallabia bicolor*	scat						X			X				
Common Brushtail Possum	*Trichosurus vulpecula*	scat												X	
Cattle	*Bos taurus*	scat													X

Opportunistic Species Records

A total of 72 species across all transects were detected by opportunistic observation during diurnal transect surveys. These were species not originally targeted in the EcMP or FBB Baseline monitoring (PB, 2014, PB 2015). As such, these instances of species, though recorded during a transect, were considered incidental observations for the sake of comparison with previous survey data, and were not included in the species counts for survey techniques where they were not the target. These observations may be useful for comparison during later years of monitoring.

Opportunistic observations included 64 species of birds, including five bird of prey species (Nankeen Kestrel *Falco cenchroides,* Wedge-tailed Eagle *Aquila audax*, Grey Goshawk *Accipiter novaehollandiae*, Brown Falcon *Falco berigora*, and Black-shouldered kite *Elanus axillaris*) and one owl species (Southern Boobook, *Ninox boobook*). The remaining species included four aquatic species; Common Yabby *Cherax destructor,* Australian Bass *Percalates novemaculeata*, Short-finned Eel *Anguilla australis*, and two Platypus *Ornithorhynchus anatinus* (transects 6 and 7). Opportunistic observations also included Swamp Wallaby, *Wallabia bicolor*, European rabbits, *Oryctolagus cuniculus* a Common Brushtail Possum *Trichosurus vulpecula* during diurnal searches, and a colony of Grey-headed Flying-foxes, *Pteropus poliocephalus*.

Transect 8 had the largest diversity of the transects surveyed with 18 species detected, all of which were birds (Table 3-6). Transects 3, 5, 7, 9, and 14 had the next largest bird diversity with 15 species found in each. This was followed by Transects 4 and 6 with 14 bird species, Transect 10 with 13 bird species, and Transects 2,11, and 13 with 12 bird species recorded.

Table 3-6 Opportunistic species diversity

Transect	Number of species
1	14
2	13
3	15
4	14
5	15
6	16
7	16
8	18
9	16
10	14
11	13
13	16
14	16

Call Playback

No threatened species were detected during call playback surveys in 2019. Additionally, surveys at other call playback points resulted in no responses being detected. Call playback locations can be seen in Figure 2-1 to Figure 2-10

3.2. AQUATIC MONITORING

The results of the 2019 monitoring have been compared with the results of the pre-construction, the during construction surveys where available and where meaningful comparisons can be made (refer to Section 2.7 for limitations), and the 2018 monitoring. Two pre-construction surveys were undertaken in Spring 2014, with no Autumn surveys undertaken (JSA 2016). This was due to a limited timeframe where monitoring was only possible in Spring 2014 (Parsons Brinkerhoff 2014). The following, therefore, compares the results of the 2014 pre-construction monitoring (Spring 2014), the 2015 (Spring and Autumn) monitoring, the 2016 (Spring and Autumn) monitoring, the 2017 (Spring and Autumn) monitoring, the 2018 (Spring and Autumn) monitoring, and the 2019 (Spring and Autumn) monitoring.

3.2.1. Habitat Assessment

Substrate levels of the six treatment sites (Site 13, 16, 17, 22, 25, and 27) can be seen below in Figure 3-1. 'Cobble' had the largest proportion across all sites (treatment and control) in most years surveyed. This trend continued in 2019. 'Cobble' average percentages in treatment sites were similar in 2018 and 2019 with 43.54% and 46.67% respectively. Similarly, control site 'cobble' averages were 41.25% and 46.88% for 2018 and 2019 respectively. In addition to this, similar percentage averages for 'Boulder', 'Pebble', and 'Gravel' between treatment and control sites in 2018 and 2019 were observed. Most substrates were observed in similar proportions between treatment and control sites post-2016. The only exception to this is 'Bedrock' which is observed in highly varied proportions in the control sites. In 2017 and 2019 'Bedrock' was observed in large proportions in control sites (28.75% and 18.13%) compared to treatment sites (0.21% and 0.42%). This. may be due to the movement of substrate downstream from control sites.

Photographs of each site are provided in Appendix F.

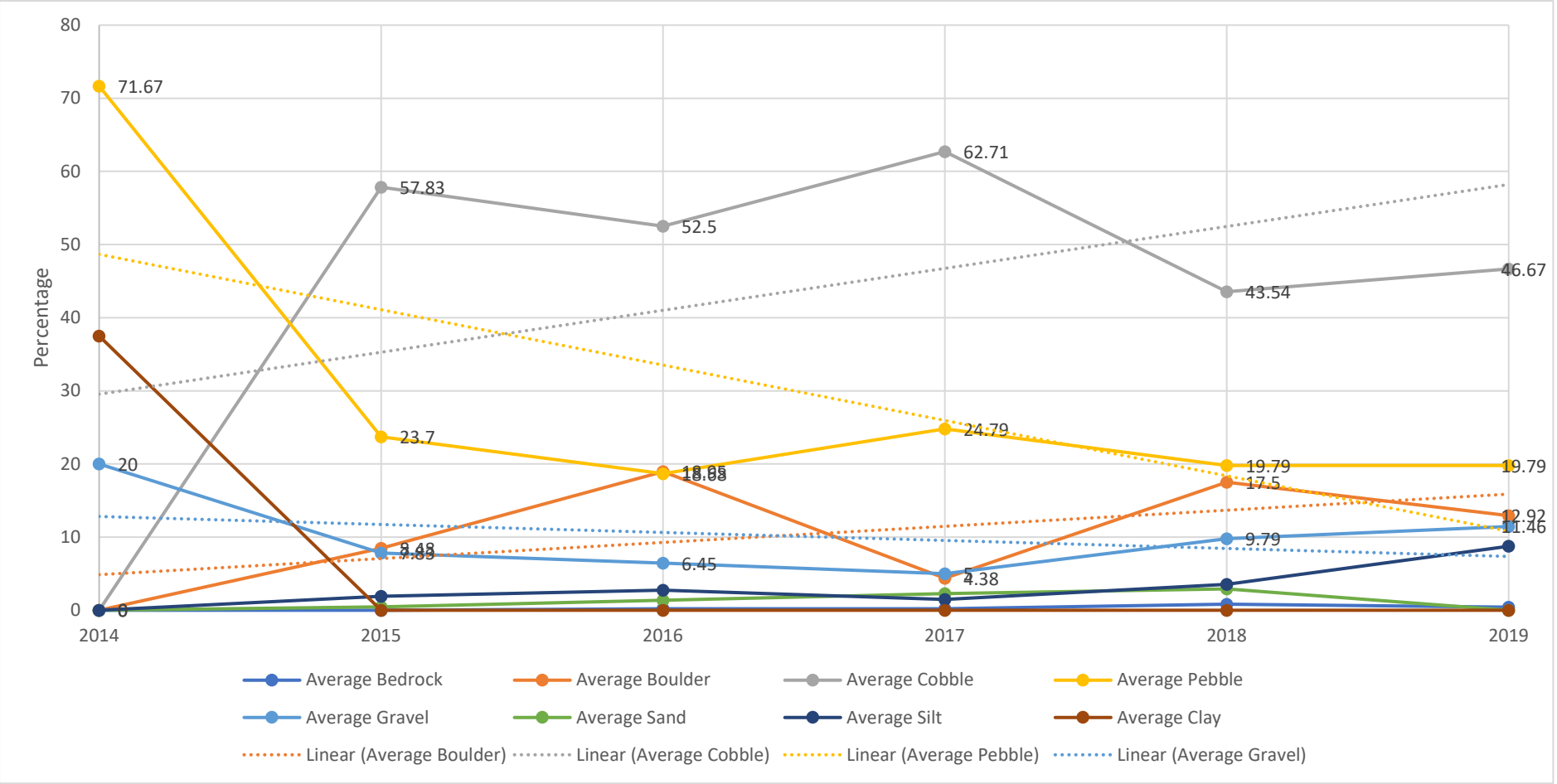

Figure 3-1 Substrate averages in treatment sites between 2014 and 2019

Substrate levels of the two control sites (CS1, CS2) are presented in Figure 3-2.

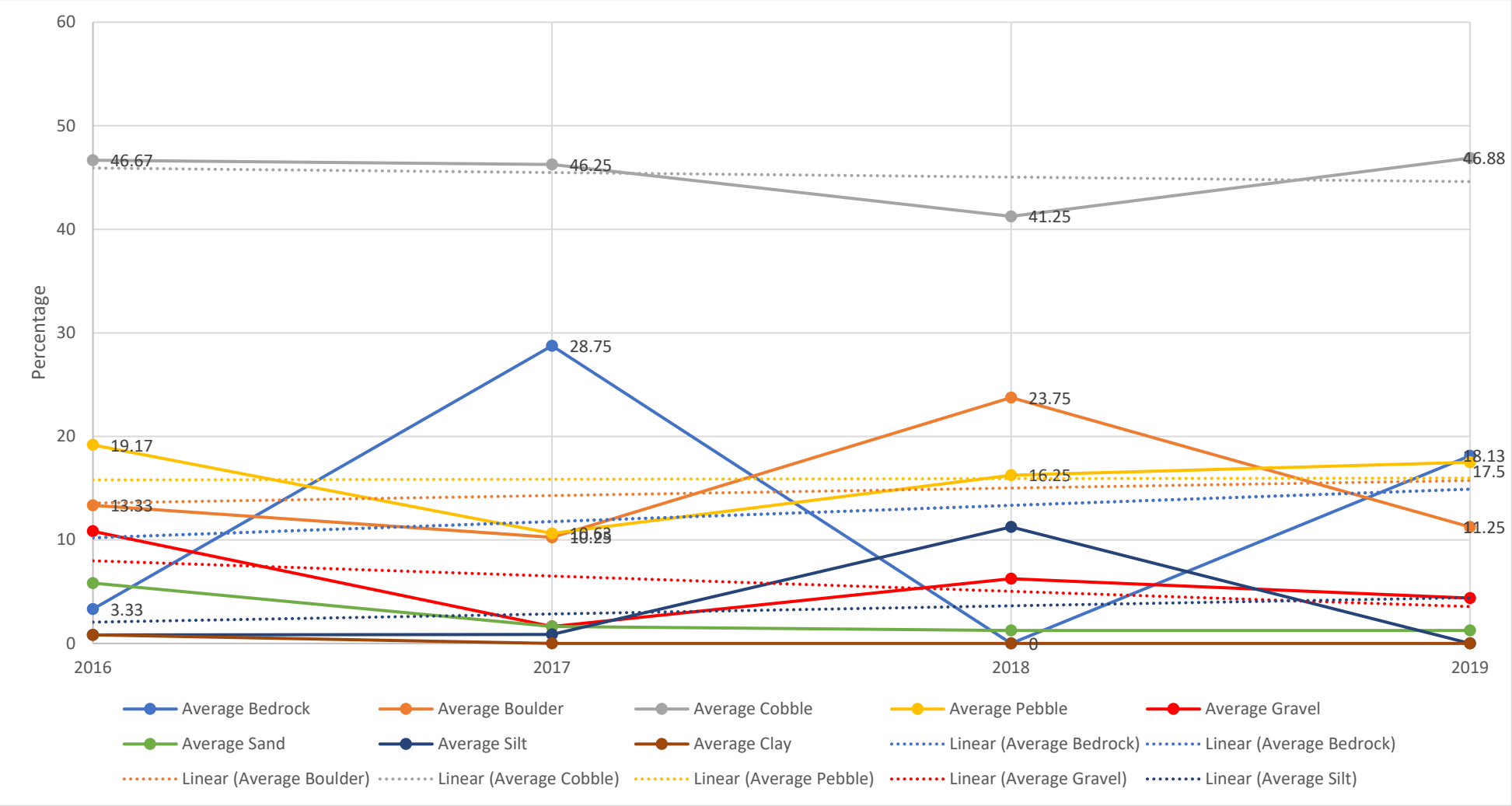

Figure 3-2 Substrate averages in control sites between 2016 and 2019

Instream vegetation graphs below show the change in average Algae, Moss, and Macrophytes percentage from 2016 onward at each of the sites (Figure 3-3 to Figure 3-10).

Site 13

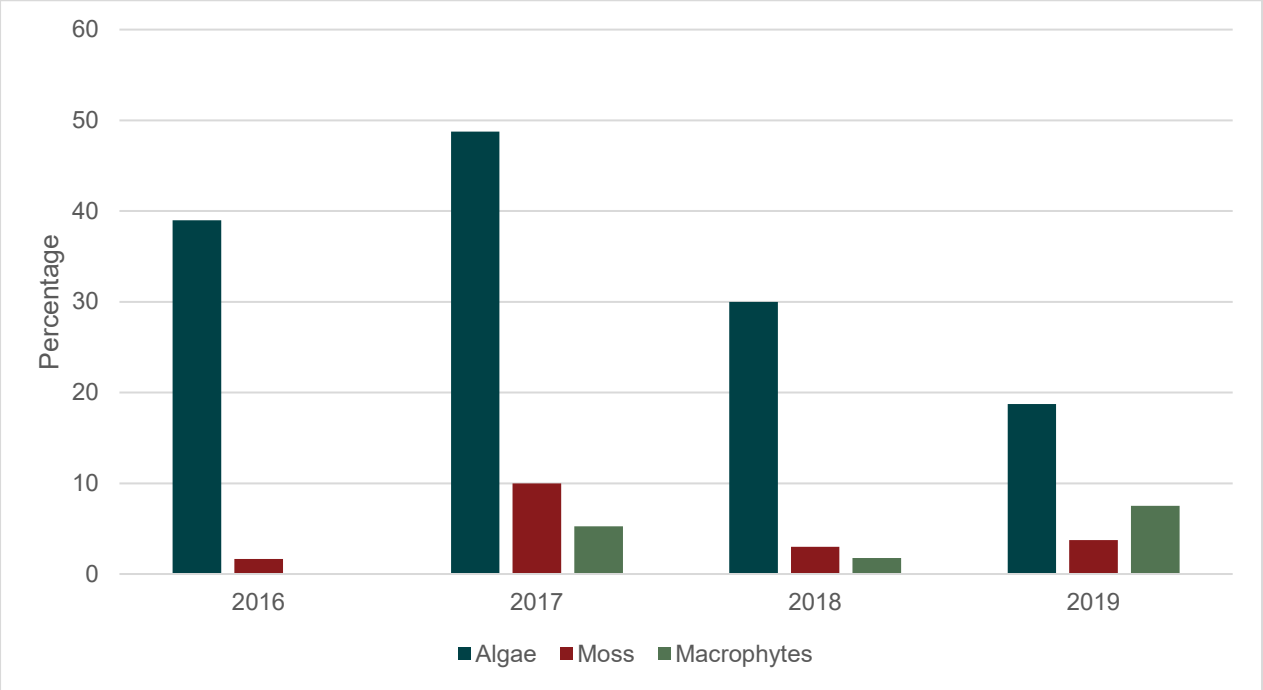

Figure 3-3 Site 13 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Site 16

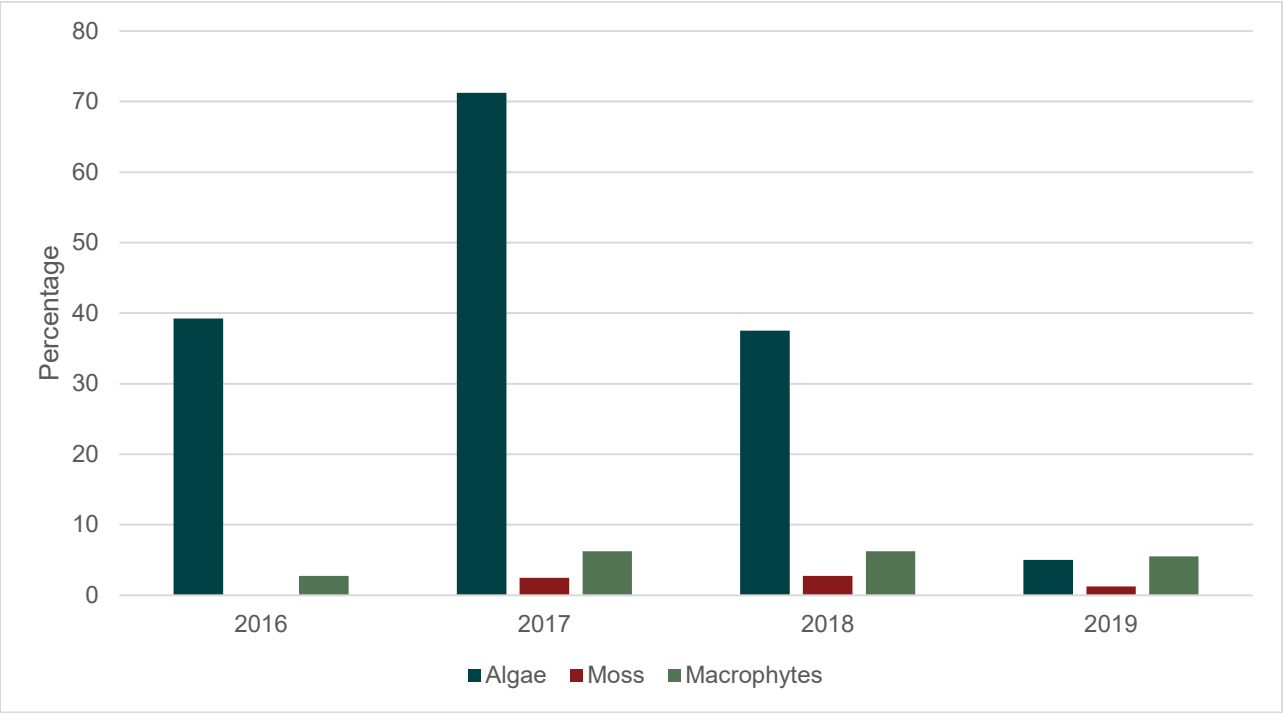

Figure 3-4 Site 16 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Site 17

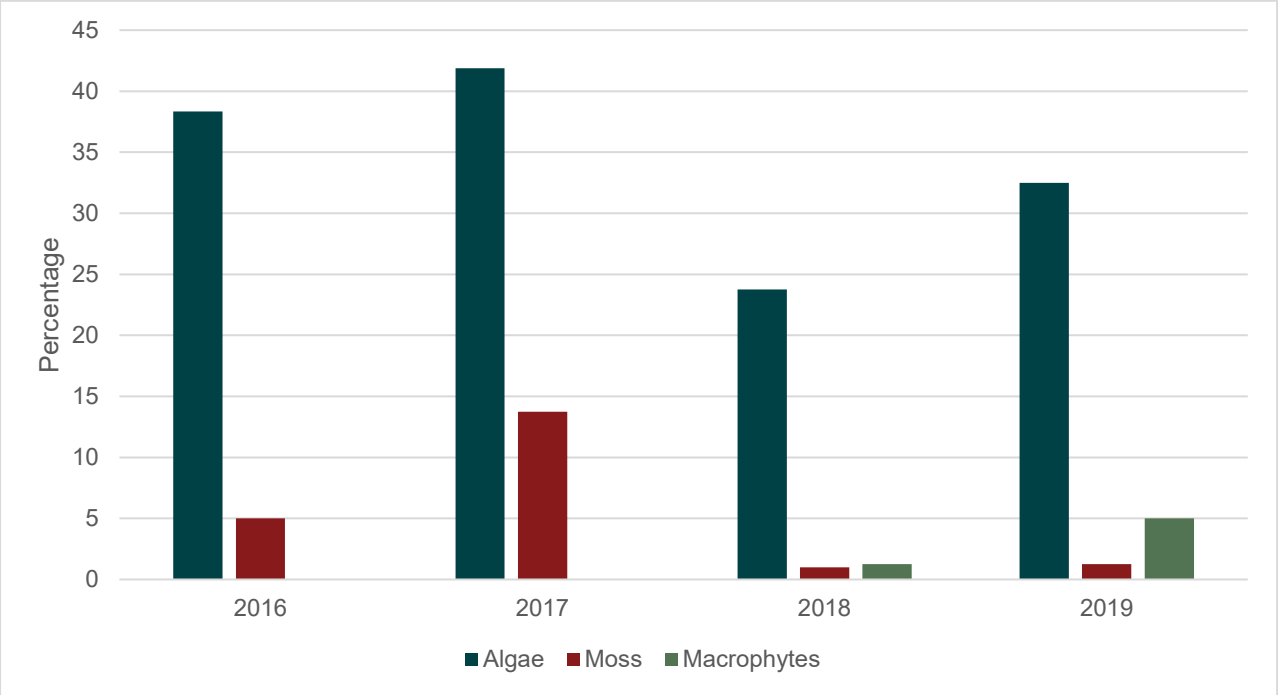

Figure 3-5 Site 17 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Site 22

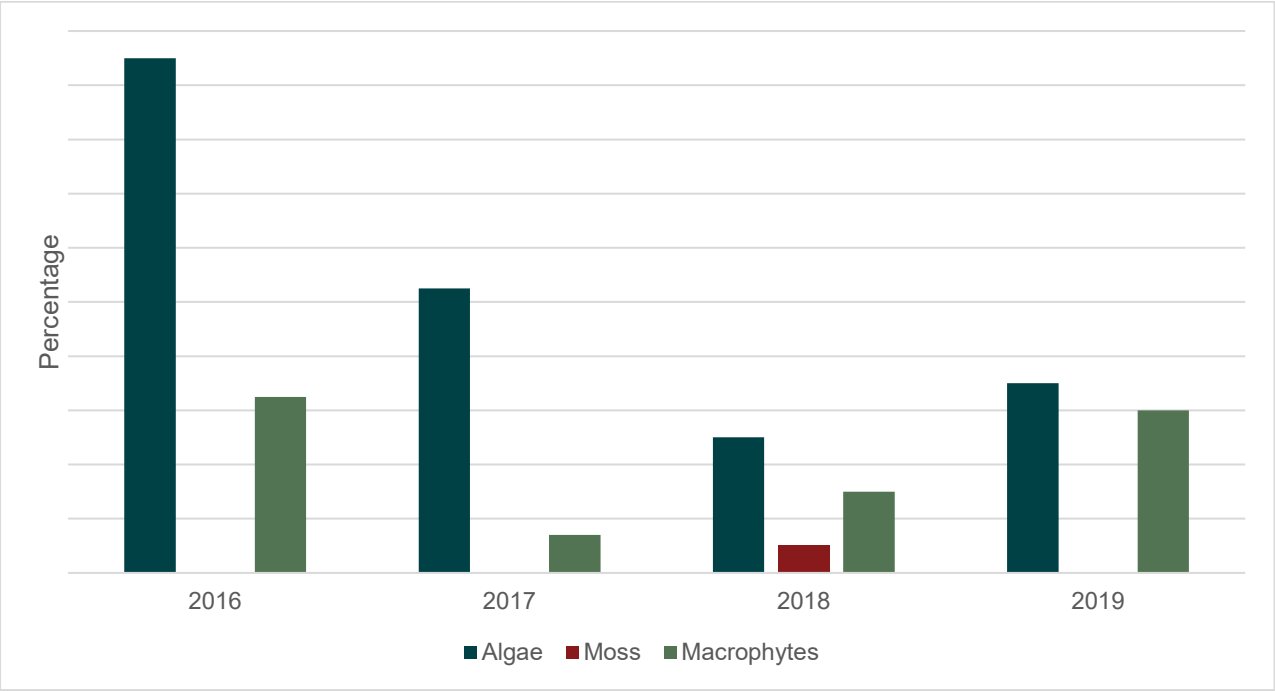

Figure 3-6 Site 22 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Site 25

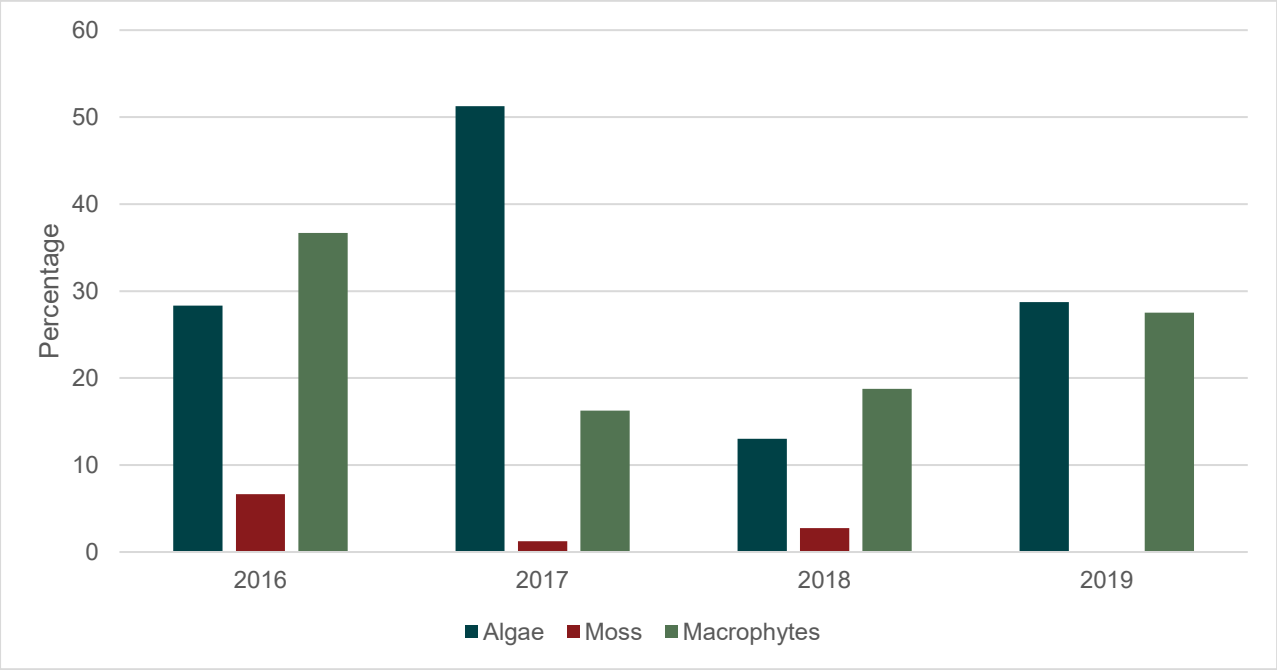

Figure 3-7 Site 25 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Site 27

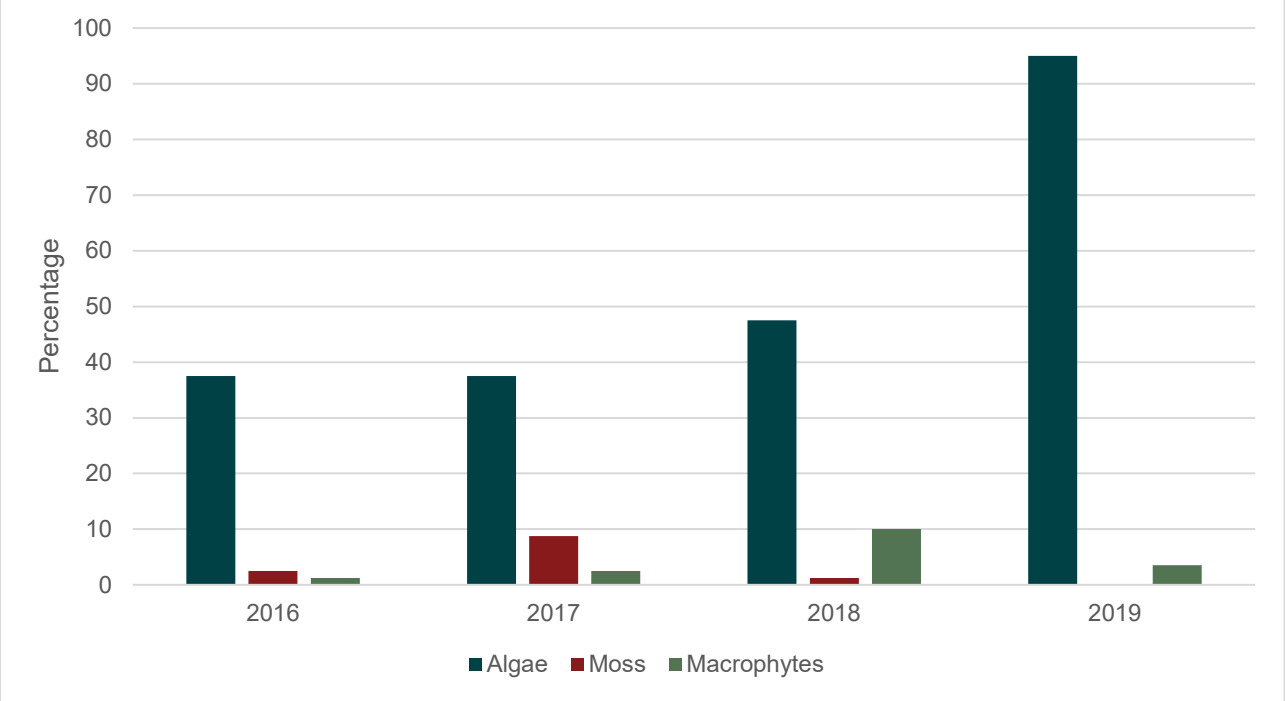

Figure 3-8 Site 27 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Control Site 1

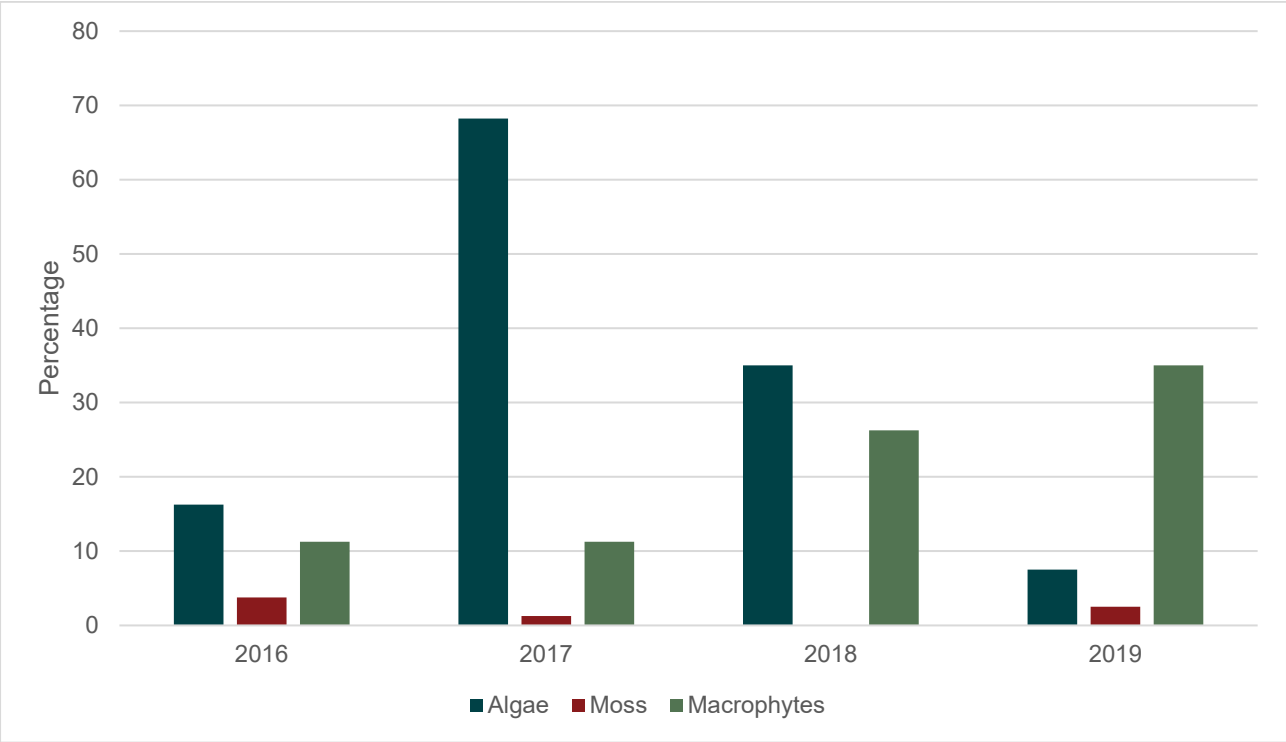

Figure 3-9 Control Site 1 Algae, Moss and Macrophyte percentages between 2016 and 2019.

Control Site 2

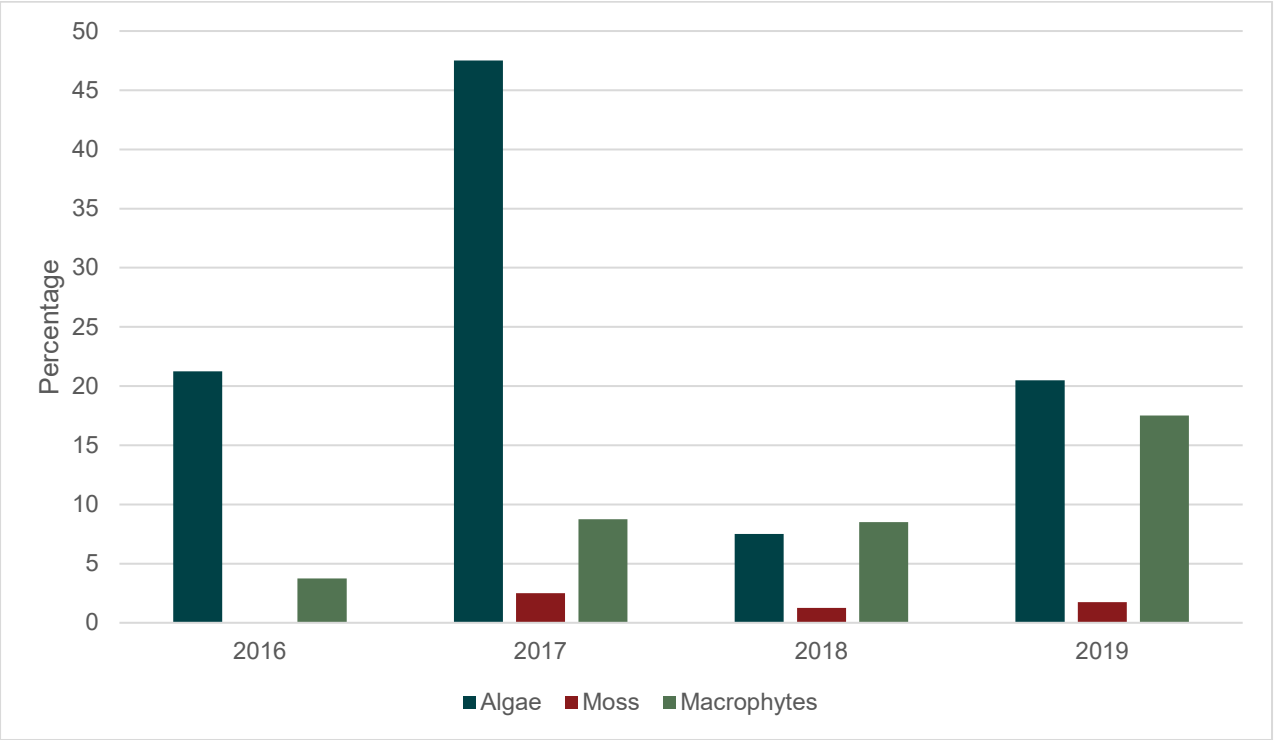

Figure 3-10 Control Site 2 Algae, Moss and Macrophyte percentages between 2016 and 2019.

3.2.2. Water Quality

The results of water quality monitoring from all sites are presented in Table 3-7 below.

Table 3-7 2019 Water quality results across sites 13,16,17,22,25,27, and control sites 1 and 2.

*Note: Trigger values are concentrations that, if exceeded, would indicate a potential environmental problem, and so 'trigger' a management response (ANZECC/ARMCANZ Guidelines 2000). Green cells indicate results that are within the ANZECC/ARMCANZ trigger value range, where red cells are those results that have fallen outside the trigger value range and indicate a *potential* environmental problem. The results below were recorded within a previously disturbed and degraded system which accounts for the prevalence of red cells.

Site	Timing	Session	Temperature °C	pH	Conductivity ms/cm	Turbidity NTU	Dissolved oxygen % saturation
ANZECC/AR MCANZZ Trigger value[1]			NA	6.5-8	200-300	6-504	85-110%
Control site 1	Autumn 2019	Session 1	16	7.59	132.8	4.6	84.9
Control site 1	Autumn 2019	Session 2	16.5	7.33	124.5	4.7	102.3
Control site 1	Spring 2019	Session 1	16	5.28	109.8	3.1	107
Control site 1	Spring 2019	Session 2	17.7	7.01	123.3	11.3	100.2
Control Site 2	Autumn 2019	Session 1	15.9	6.65	146.4	15.2	83.5
Control site 2	Autumn 2019	Session 2	17.3	6.37	134.5	5.7	92.7
Control site 2	Spring 2019	Session 1	14.6	6.81	119.7	6.8	90.4
Control site 2	Spring 2019	Session 2	19.5	6.21	147.6	3.3	83.1
Site 13	Autumn 2019	Session 1	16.1	7.07	147.7	8.1	87.1
Site 13	Autumn 2019	Session 2	17.6	7.47	148.2	2.6	82.1

Site	Timing	Session	Temperature °C	pH	Conductivity ms/cm	Turbidity NTU	Dissolved oxygen % saturation
Site 13	Spring 2019	Session 1	14.9	6.87	121.6	3.3	96.5
Site 13	Spring 2019	Session 2	18.7	6.24	148.5	2.1	82.5
Site 16	Autumn 2019	Session 1	16.8	7.27	150.2	5.5	82.3
Site 16	Autumn 2019	Session 2	15.8	7.24	136.2	2.4	92.3
Site 16	Spring 2019	Session 1	14.8	6.71	128.7	1.7	74.5
Site 16	Spring 2019	Session 2	20.6	5.63	157.4	1.8	74.3
Site 17	Autumn 2019	Session 1	17.3	7.34	135	2.3	94.3
Site 17	Autumn 2019	Session 2	18.8	7.54	151.2	14.7	109.60
Site 17	Spring 2019	Session 1	17.6	6.97	143.8	3.8	112.4
Site 17	Spring 2019	Session 2	17.5	5.89	166.2	5.4	60.5
Site 22	Autumn 2019	Session 1	19.3	7.22	204.9	8.5	97.3
Site 22	Autumn 2019	Session 2	17.6	6.9	195.2	4.2	67.2
Site 22	Spring 2019	Session 1	16.2	6.17	196.1	75.3	81.6
Site 22	Spring 2019	Session 2	15.1	6.58	310.2	24.2	15.8
Site 25	Autumn 2019	Session 1	18.1	7.71	125.5	25.5	85.4
Site 25	Autumn 2019	Session 2	17.3	7.25	121.5	31.6	95.4
Site 25	Spring 2019	Session 1	14.9	7	109.8	82.6	52.6

Site	Timing	Session	Temperature °C	pH	Conductivity ms/cm	Turbidity NTU	Dissolved oxygen % saturation
Site 25	Spring 2019	Session 2	22.7	6.1	147.7	14.1	51.6
Site 27	Autumn 2019	Session 1	18.9	6.27	207.3	3.6	75.3
Site 27	Autumn 2019	Session 2	19.3	5.31	211	4.9	54.1
Site 27	Spring 2019	Session 1	16	5.59	192.3	23.3	75.3
Site 27	Spring 2019	Session 2	18.1	6.39	206.5	3.5	39.5

The following was observed during the 2019 monitoring period (with all results in):

- Water temperatures recorded at the treatment sites were between 14.8ºC and 22.7ºC, and 14.6ºC and 19.5ºC for control sites. Temperatures varied according to the season and the conditions of the waterway. This variation was also consistent throughout the pre-construction and construction period.
- pH readings in 2019 were variable ranging between 5.31 and 7.71 in treatment sites, and 5.28 and 7.59 in control sites. Soil and animal health will not generally be affected by water with pH in the range of 4-9, however values between 4 and 6 should be regarded with caution due to the potential for corrosion and fouling (ANZECC/ARMCANZ 2000). pH levels only dropped below 6.0 in 3 of 6 treatment sites, and in 1 of 2 control sites. pH values fell within the ANZECC/ARMCANZ 2000 guidelines trigger value range 15 of 24 times (62.5%) for treatment sites, and 5 of 8 (62.5%) times for control sites in 2019.
- Conductivity had the lowest proportion of values fall within the guideline levels in 2019; 5 of 32 (15.6%) from all sites. Control sites did not achieve a single reading within the trigger value range in 2019. Of the 27 readings that fell outside of the trigger value range, conductivity was too low. Low conductivity values are often observed following seasonal rainfall (ANZECC/ARMCANZ 2000), while high conductivity is an indication of low flow conditions. High conductivity is not uncommon in agricultural areas due to factors such as gradual runoff from cultivated land, and stock faeces and urine (Biggs *et al.* 2002).
- For treatment sites in 2019, turbidity levels fell within the guideline range 10 of 24 times (41.7%). For control sites in 2019, only 3 of 8 times (37.5%) fell within the trigger value range. Turbidity was low in 2019 with the highest value recorded being 75.3 NTU from Spring Session 1 Site 22.
- For treatment sites dissolved oxygen values fell within the ANZECC/ARMCANZ guideline range 9 of 24 times (37.5%) in 2019. For control sites 5 of 8 (62.5%) readings fell within the guideline range. Only site 27 lacked a result within the guidelines. The low flow conditions and pooling of water would lower the dissolved oxygen which would result in potentially stressful conditions for some species, but due to consistency throughout the monitoring period this is unlikely to be attributed to construction activities.

Table 3-8 below show the comparison of water quality parameters between pre-construction data (2014) and the most current data (2019) of the treatment sites. Columns for +/- 10% as well as a pass/fail column have been included to address the performance target and criteria. This is discussed further in section 4.2.

Table 3-9 below shows the comparison of water quality parameters between during construction (2016-2017) and the most current data (2019) of control sites. Columns for +/- 10% as well as a pass/fail column have been included to address the performance target and criteria. This is discussed further in section 4.2.

Table 3-8 Treatment site water quality comparison between pre-construction and 2019 results

Site	Water Quality Parameters	2014 average	2019 average	Plus 10%	Minus 10%	Pass/Fail
Site 13	Temperature °C	16.225	16.825	17.8475	14.6025	Pass
	pH	6.7725	6.9125	7.44975	6.09525	Pass
	Conductivity µs/cm	104.225	141.5	114.6475	93.8025	Pass
	Turbidity NTU	48.13333333	4.025	52.94667	43.32	Pass
	Dissolved oxygen % saturation	76.34	87.05	83.974	68.706	Pass
Site 16	Temperature °C	15.8	17	17.38	14.22	Pass
	pH	6.83	6.7125	7.513	6.147	Pass
	Conductivity µs/cm	121.025	143.125	133.1275	108.9225	Fail
	Turbidity NTU	3.2	2.85	3.52	2.88	Pass
	Dissolved oxygen % saturation	74.53	80.85	81.983	67.077	Pass
Site 17	Temperature °C	15.975	17.8	17.5725	14.3775	Fail
	pH	6.93	6.935	7.623	6.237	Pass
	Conductivity µs/cm	118.325	149.05	130.1575	106.4925	Fail
	Turbidity NTU	11.3	6.55	12.43	10.17	Pass
	Dissolved oxygen % saturation	78.5225	94.2	86.37475	70.67025	Pass
Site 22	Temperature °C	16.8	17.05	18.48	15.12	Pass

Site	Water Quality Parameters	2014 average	2019 average	Plus 10%	Minus 10%	Pass/Fail
	pH	6.5875	6.7175	7.24625	5.92875	Pass
	Conductivity µs/cm	206.475	226.6	227.1225	185.8275	Pass
	Turbidity NTU	8.2	28.05	9.02	7.38	Fail
	Dissolved oxygen % saturation	57.0075	65.475	62.70825	51.30675	Pass
Site 25	Temperature °C	16.675	18.25	18.3425	15.0075	Pass
	pH	6.34	7.015	6.974	5.706	Pass
	Conductivity µs/cm	103.625	126.125	113.9875	93.2625	Fail
	Turbidity NTU	4.666666667	38.45	5.133333	4.2	Fail
	Dissolved oxygen % saturation	69.0875	71.25	75.99625	62.17875	Pass
Site 27	Temperature °C	16.525	18.075	18.1775	14.8725	Pass
	pH	6.07	5.89	6.677	5.463	Pass
	Conductivity µs/cm	182.775	204.275	201.0525	164.4975	Fail
	Turbidity NTU	7.8	8.825	8.58	7.02	Fail
	Dissolved oxygen % saturation	53.525	61.05	58.8775	48.1725	Pass

Table 3-9 Control site water quality comparison between during construction and 2019 results

Site	Water quality parameters	During Construction average (2016-2017)	During Construction average (2016-2017) Minus (-) 10%	During Construction average (2016-2017) Plus (+) 10%	2019 Post construction average	Pass/Fail
Control site 1	Temperature °C	16.56875	14.911875	18.225625	16.55	Pass
	pH	6.8625	6.17625	7.54875	6.8025	Pass
	Conductivity ms/cm	142.875	128.5875	157.1625	122.6	Fail
	Turbidity NTU	2.875	2.5875	3.1625	5.925	Fail
	Dissolved oxygen % saturation	65.72625	59.153625	72.298875	98.6	Pass
Control site 2	Temperature °C	17.415	15.6735	19.1565	16.825	Pass
	pH	6.786666667	6.108	7.465333333	6.51	Pass
	Conductivity ms/cm	151.8333333	136.65	167.0166667	137.05	Pass
	Turbidity NTU	0.683333333	0.615	0.751666667	7.75	Fail
	Dissolved oxygen % saturation	59.26166667	53.3355	65.18783333	87.43	Pass

Trendlines of each water quality parameter across all years of survey are presented in the figures below (Figure 3-11 to Figure 3-15).

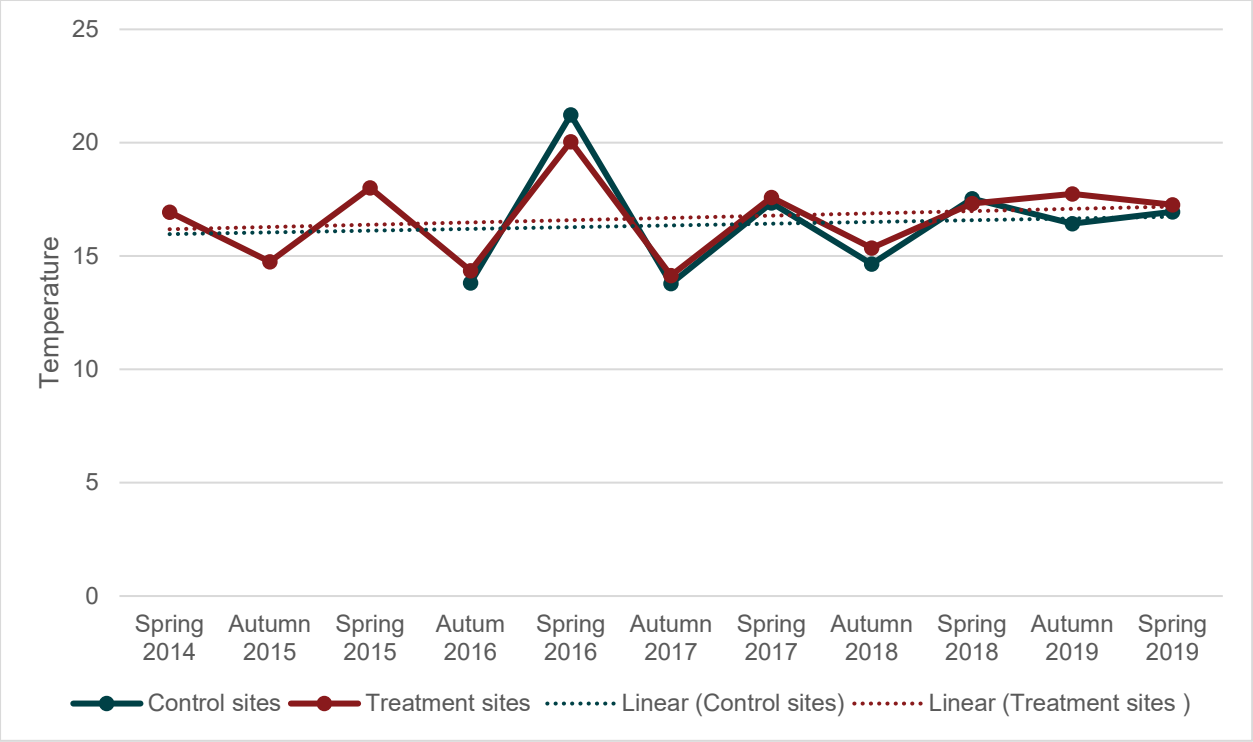

Figure 3-11 Water temperature across treatment and control sites between 2014 and 2019 surveys

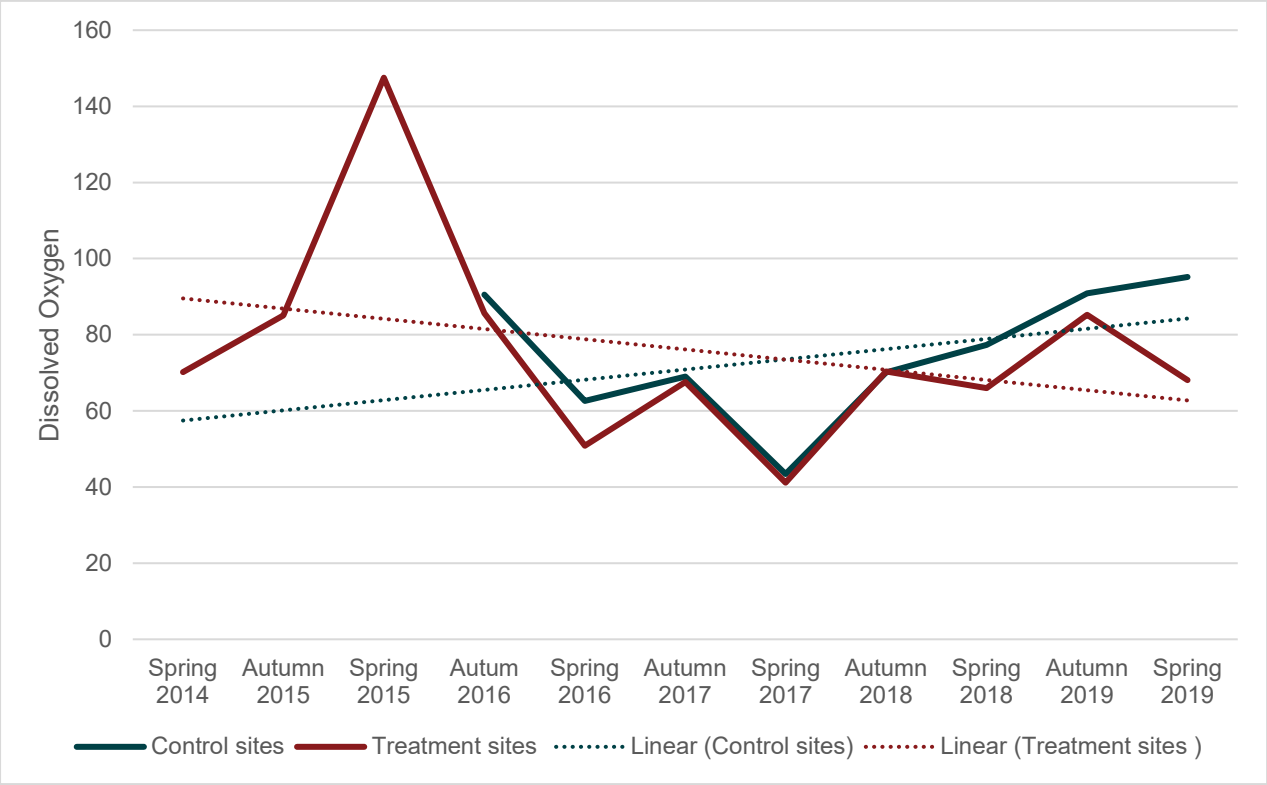

Figure 3-12 Water Dissolved Oxygen levels across treatment and control sites between 2014 and 2019 surveys

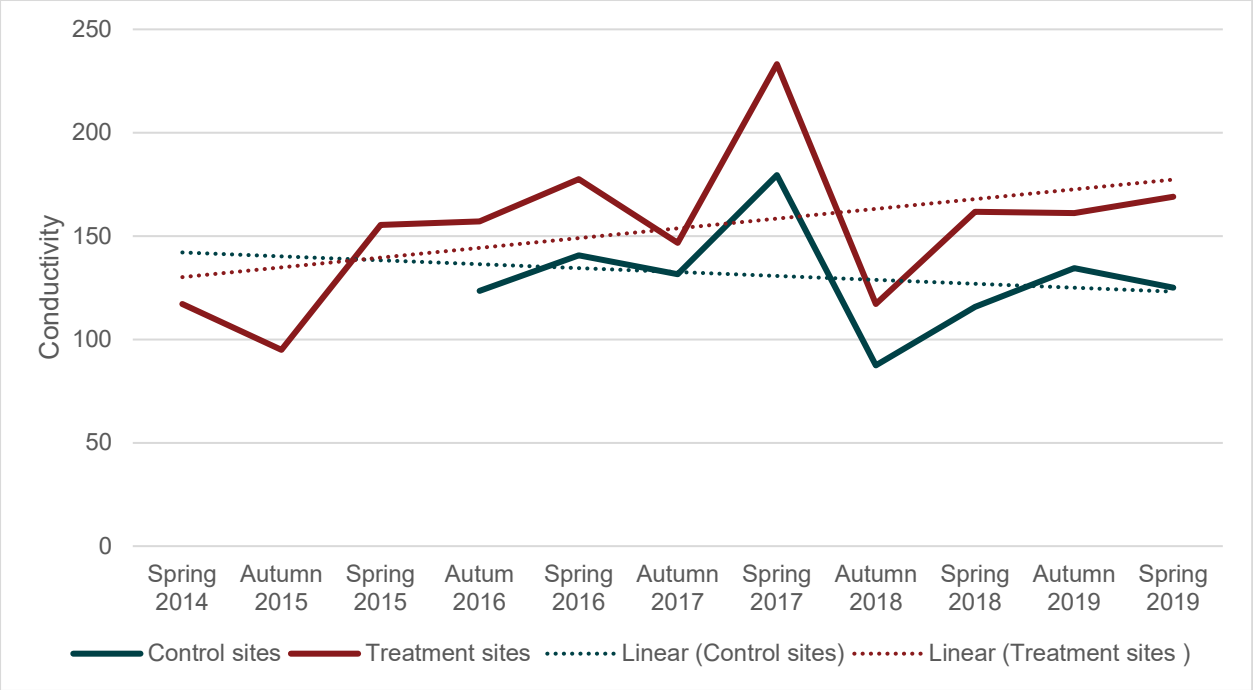

Figure 3-13 Water Conductivity across treatment and control sites between 2014 and 2019 surveys

Figure 3-14 pH levels across treatment and control sites between 2014 and 2019 surveys

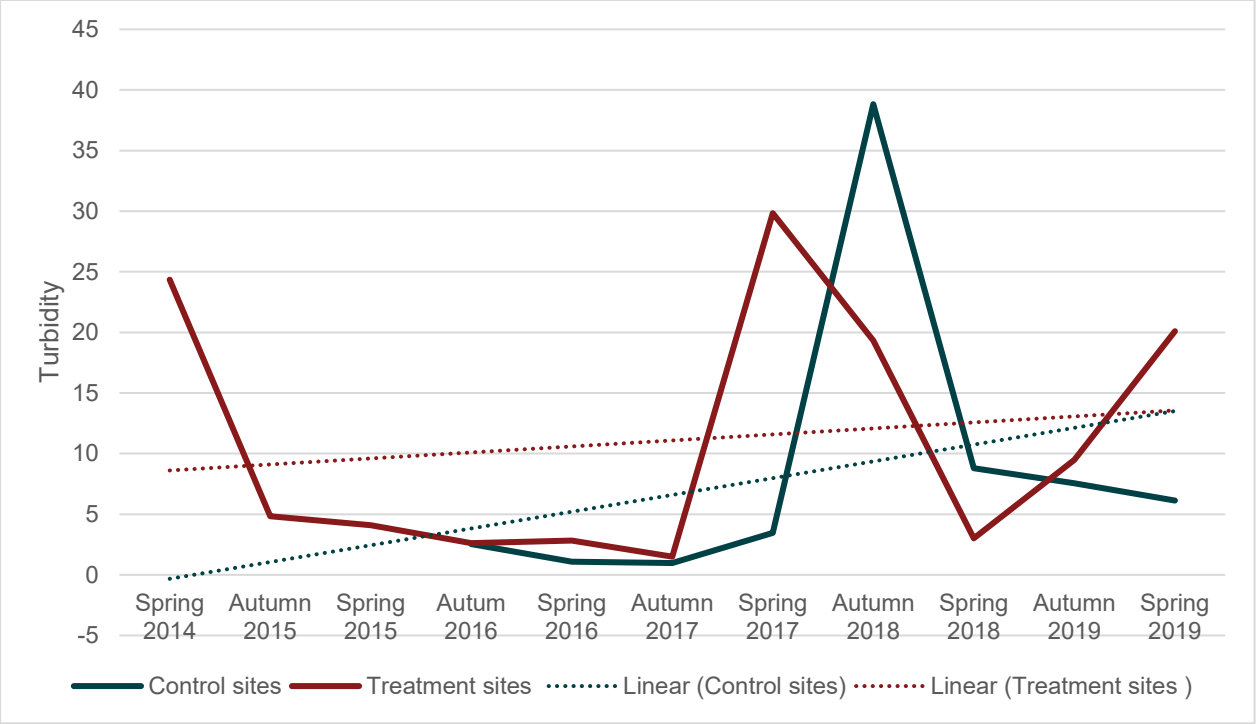

Figure 3-15 Water Turbidity levels across treatment and control sites between 2014 and 2019 surveys

3.2.3. Macrophyte and Emergent vegetation

The following presents the macrophyte and emergent vegetation of each site during 2019 as collected within the fixed quadrats.

Table 3-10 Macrophyte and emergent vegetation of each site in Autumn Session 1 2019 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2).

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Persicaria hydropiper **Water pepper**	2	0	0	1	0	2	3	2
Baumea articulata **Jointed rush**	0	0	0	0	0	0	2	2
Sagittaria platyphylla* **Sagittaria**	0	1	0	0	2	0	2	2
Elodea canadensis* **Elodia**	0	0	0	0	3	0	3	0
Colocasia **sp. *** **Taro**	1	0	1	0	0	0	0	1
Colocasia **sp.*** **Elephants ear**	1	0	1	0	0	0	0	0
Juncus usitatus **Common rush**	2	1	2	0	0	0	0	0

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Cyperus Eragrostis* **Umbrella Sedge**	0	0	2	2	0	0	0	0
Alternanthera philoxeroides* **Alligator weed**	0	0	0	1	0	1	0	0

Table 3-11 Macrophyte and emergent vegetation of each site in Autumn Session 2 2019 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2).

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Persicaria hydropiper **Water pepper**	2	0	1	2	0	0	2	1
Baumea articulata **Jointed rush**	0	0	0	0	0	0	0	1
Sagittaria platyphylla* **Sagittaria**	0	2	0	0	2	0	2	1
Elodea canadensis* **Elodia**	0	0	0	0	3	0	4	0
Colocasia sp.* **Taro**	1	0	1	0	0	0	0	1
Colocasia sp.* **Elephants ear**	1	0	1	0	0	0	0	0
Juncus usitatus **Common rush**	2	2	0	0	0	0	0	0
Cyperus eragrostis* **Umbrella Sedge**	0	1	1	3	0	0	2	1
Alternanthera philoxeroides* **Alligator weed**	0	0	0	1	0	0	0	0

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Rorippa nasturtium-aquaticum* **Watercress**	1	0	0	0	0	2	0	1
Ageratina riparia* **Mistflower**	0	0	0	0	0	0	0	1

Table 3-12 Macrophyte and emergent vegetation of each site in Spring Session 1 2019 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2).

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Persicaria hydropiper **Water pepper**	0	0	0	0	2	0	3	0
Baumea articulata **Jointed rush**	0	0	0	0	0	0	2	2
Sagittaria platyphylla* **Sagittaria**	0	0	0	0	2	0	2	3
Elodea canadensis* **Elodia**	0	0	0	0	3	0	4	0
Colocasia* sp. **Taro**	0	0	1	0	0	0	0	1
Colocasia* sp. **Elephants ear**	1	0	1	0	0	0	0	1

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Juncus usitatus **Common rush**	2	0	0	0	0	1	0	0
Cyperus Eragrostis* **Umbrella Sedge**	0	3	0	3	0	0	0	0
Alternanthera philoxeroides* **Alligator weed**	0	0	0	0	0	1	0	0
***Rorippa nasturtium-aquaticum** **Watercress**	2	0				1	0	2
Ludwigia peploides **Water primrose**	0	0	0	1	0	0	0	0
Rumex crispus* **Curly dock**	1	0	0	1	0	0	0	0
Cypress gracilis **Slender flat sedge**	0	0	1	0	0	0	0	0

Table 3-13 Macrophyte and emergent vegetation of each site in Spring Session 2 2019 according to the Braun-Blanquet 6-point scale (refer to section 2.4.2).

Species	Site 13	Site 16	Site 17	Site 22	Site 25	Site 27	CS1	CS2
Persicaria hydropiper **Water pepper**	1	0	0	0	2	2	3	0
Baumea articulata **Jointed rush**	0	0	0	0	0	0	2	2
Sagittaria platyphylla* **Sagittaria**	0	0	0	0	2	0	2	2
Elodea canadensis * **Elodia**	0	0	0	0	3	0	4	0
Colocasia sp. * **Taro**	0	0	1	0	0	0	0	0
Colocasia sp.* **Elephants ear**	1	0	1	0	0	0	0	1
Juncus usitatus **Common rush**	2	2	2	0	0	0	0	0
Cyperus eragrostis* **Umbrella Sedge**	2	2	2	3	0	1	0	2
Alternanthera philoxeroides* **Alligator weed**	0	0	0	0	0	1	0	0
Rorippa nasturtium-aquaticum **Watercress**	0	0	0	0	0	1	0	1

Ludwigia peploides **Water primrose**	0	0	0	1	0	1	0	0
Rumex crispus* **Curly dock**	0	0	0	1	0	1	0	1
Cypress gracilis **Slender flat sedge**	0	0	1	0	0	0	0	0

3.2.4. Macroinvertebrates

The following tables summarise the Macroinvertebrate survey results for each site in 2019. Signal and EPT scores have been given (refer to 2.3.5 for guidelines).

Table 3-14 Summary of 2019 Macroinvertebrate data for treatment sites

Site 13				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	4.97	4.52	5.46	5.91
EPT Score	6	6	7	7
Number of Taxa	24	13	21	22
Site 16				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	5.17	5.59	5.14	4.51
EPT Score	5	6	8	6
Number of Taxa	25	21	25	15
Site 17				

	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	4.21	4.22	4.54	4.26
EPT Score	5	4	5	4
Number of Taxa	12	15	15	13
Site 22				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	3.35	2.93	3.42	2.97
EPT Score	2	1	1	3
Number of Taxa	16	6	10	13
Site 25				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	5.17	4.26	5.08	5.08
EPT Score	1	1	4	4
Number of Taxa	11	11	21	21
Site 27				

	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	5.57	4.1	5.47	4.63
EPT Score	3	2	3	2
Number of Taxa	17	10	19	21

Table 3-15 Summary of 2019 Macroinvertebrate data for Control Sites

Control Site 1				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	5.39	5.16	4.53	4.54
EPT Score	4	5	4	4
Number of Taxa	21	20	13	18
Control Site 2				
	Autumn 2019		Spring 2019	
	Session 1	Session 2	Session 1	Session 2
Signal Score	5.31	5.1	4.51	4.5
EPT Score	3	5	5	5
Number of Taxa	11	16	22	22

Results from previous years can be found in Appendix E.

3.2.5. Aquatic Fauna Assessment

A small number of fish (4) were collected/observed from two common fish species throughout 2019 (see Figure 3-16). The only other aquatic species observed in 2019 were three (3) Short-finned Eels observed at Control site 1 (Autumn session 1), Site 16 (Spring Session 2), and Site 17 (Spring Session 2).

No new aquatic species were recorded in 2019 surveys.

Previous years data can be seen in Appendix C.

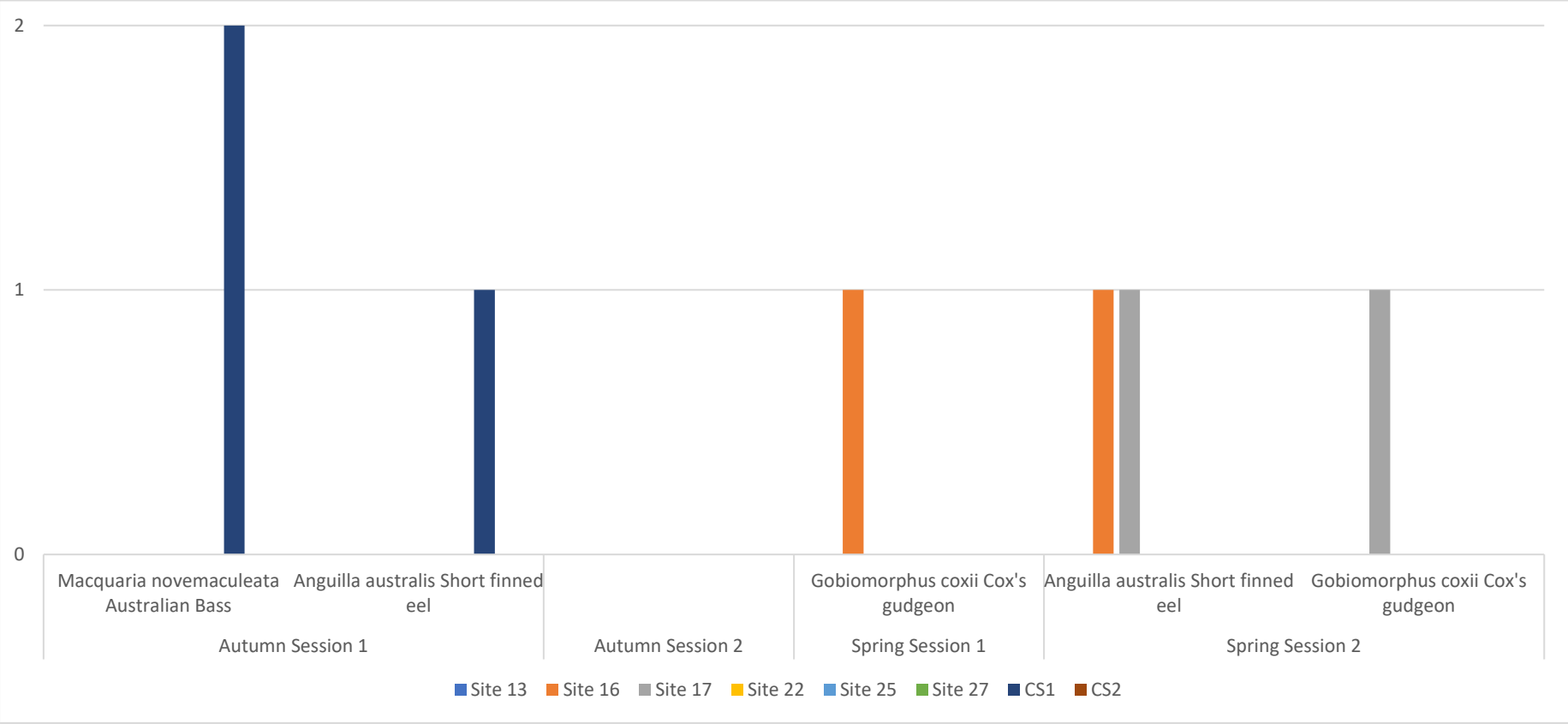

Figure 3-16 Aquatic fauna species observed across all sites and sessions in 2019

Aquatic fauna diversity at control sites (abundance 3, diversity 2) was slightly higher than 2018 (abundance 3, diversity 1) but abundances were the same (Figure 3-17). These figures remain lower than control site surveys in 2017 (abundance 6, diversity 3). Treatment sites in 2019 had a lower abundance of aquatic fauna (4) and lower diversity (2) when compared to 2018 surveys (abundance 13, diversity 4). Overall, there has been a dramatic decline in the abundance of aquatic fauna species since 2016. This is likely due to a change in methodology. In 2016 fyke nets were left out overnight, but due to the presence of platypus, for ethical reasons this was changed to daytime fish trapping only. In 2018, an ethical decision was made in consultation with TfNSW to discontinue use of fyke nets during aquatic surveys due to the presence of platypus. Therefore, the results of monitoring from 2016 to 2019 are not directly comparable.

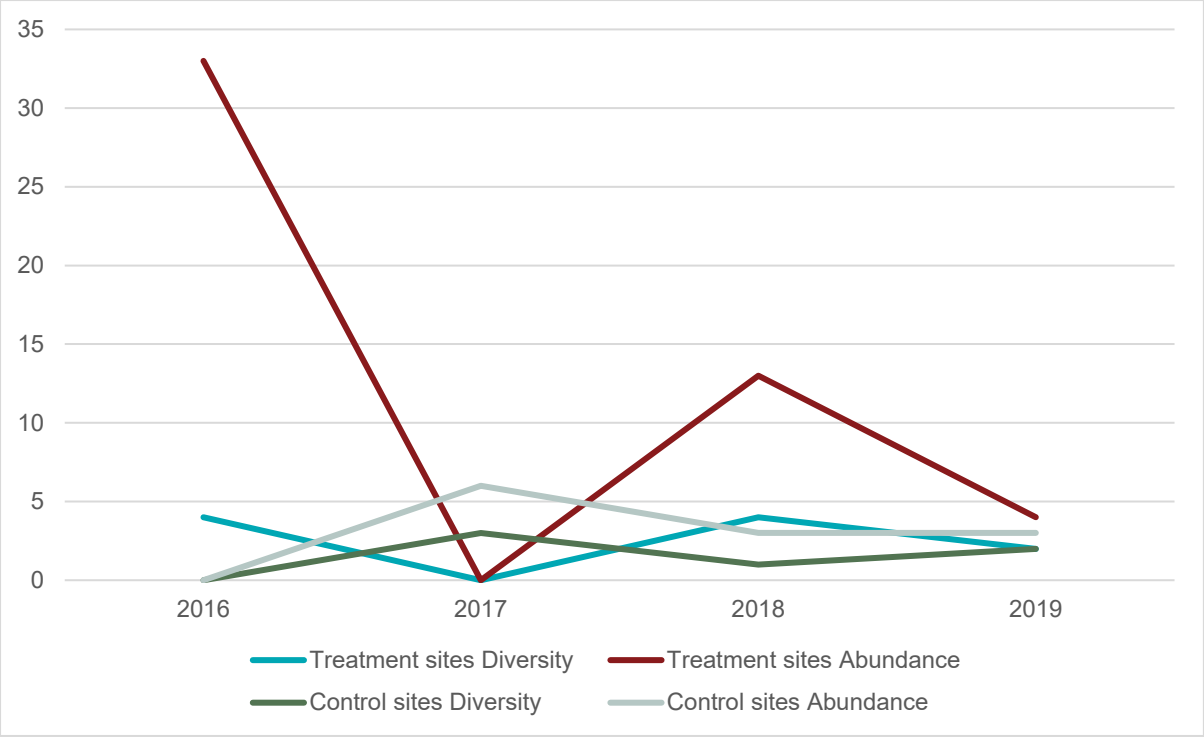

Figure 3-17 Diversity and abundance of aquatic fauna species (2016-2019)

3.3. WEED MONITORING

3.3.1. Weed species present

The 2019 Post-construction weed monitoring of the 49 chainages identified 39 exotic weed species within the Foxground and Berry Bypass project area. Four (4) species are listed as Priority Weeds under the *Biosecurity Act 2015.* Table 3-17 summarises the species identified and the Priority Weed Duty according to the Biosecurity Act.

Table 3-16 Priority and environmental weed species identified during 2019 weed monitoring

Weed Species	Common name	Environmental Weed	Priority Weed Duty (Biosecurity Act)
Ageratina adenophora	Crofton weed	x	
Andropogon virginicus	Whisky Grass	x	
Araujia sericifera	Moth Vine	x	
Avena fatua	Common Wild Oat	x	
Bidens pilosa	Cobbler's Pegs	x	
Brassica oleracea	Mustard	x	
Briza maxima	Quaking Grass	x	
Cenchrus clandestinus	Kikuyu	x	
Centaurea melitensis	Maltese star-thistle	x	
Cirsium vulgare	Spear Thistle	x	
Conyza bonariensis	Fleabane	x	
Cynodon dactylon	Common Couch	x	
Cyperus eragrostis	Tall flatsedge	x	
Erythrina sykesii	Coral Tree	x	
Foeniculum vulgare	Fennel	x	
Gomphocarpus physocarpus	Cottonbush	x	
Grevillea robusta	Silky Oak	x	
Hypochaeris radicata	Cat's Ear	x	
Lantana camara	Lantana		Prohibition on dealings
Ligustrum sinense	Small-leaved privet	x	
Malva parviflora	Mallow	x	
Medicago sativa	Alfalfa	x	
Morus alba	White Mulberry	x	
Paspalum dilatatum	Paspalum	x	
Phalaris aquatica	Phalaris	x	
Phytolacca octandra	Inkweed	x	
Plantago lanceolata	Ribwort Plantain	x	
Rubus fruticosus	Blackberry		Prohibition on dealings

Weed Species	Common name	Environmental Weed	Priority Weed Duty (Biosecurity Act)
Rumex obtusifolius	Curly Dock	x	
Senecio madagascariensis	Fireweed		Regional Recommended Measure
Setaria parviflora	Pigeon Grass	x	
Sida rhombifolia	Paddy's Lucerne	x	
Solanum mauritianum	Wild Tobacco	x	
Solanum nigrum	Blackberry nightshade	x	
Sonchus oleraceus	Sow Thistle	x	
Sporobolus fertilis	Giant Paramatta grass		Regional Recommended Measure
Tagetes minuta	Stinking Roger	x	
Trifolium repens	White Clover	x	
Verbena bonariensis	Purpletop	x	

Priority Weed Duty – as listed under the Biosecurity Act for the South-east Region

3.3.2. Cover and abundances

Table 3-18 presents the weed species and relative abundance at each of the weed monitoring sites. Relative abundance is given by a cover abundance scale (modified Braun-Blanquet):

1. 1 to a few individuals present, less than 5% cover
2. many individuals present, but still less than 5% cover
3. 5 - < 20% cover
4. 20 - < 50% cover
5. 50 - < 75% cover
6. 75 - 100% cover

Table 3-17 Description of each survey location, dominant weeds and relative abundance

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
15	297055	6152294	North of Toolijooa Rd	Batter	Mustard *Brassica oleracea* - 2 Kikuyu *Cenchrus clandestinus* - 4 Purpletop *Verbena bonariensis* - 2 Fleabane *Conyza bonariensis* - 2 Cobbler's Pegs Bidens p*ilosa* - 3 Paddy's Lucerne *Sida rhombifolia* - 2 Lantana *Lantana camara* – 1 Paspalum *Paspalum dilatatum* – 3 Fennel *Foeniculum vulgare* - 3 Fireweed *Senecio madagascariensis* - 1	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
14	296835	6152244	Near turn around bay south of Toolijooa Rd	Construction area, with bare soil areas	Kikuyu *Cenchrus clandestinus* - 4 Cobbler's Pegs *Bidens pilosa* – 2 Purpletop *Verbena bonariensis* - 1 Mustard *Brassica oleracea* - 2 Fireweed *Senecio madagascariensis* – 2 Paspalum *Paspalum dilatatum* – 5 Phalaris *Phalaris aquatica*-2 Fennel *Foeniculum vulgare* - 3 White Clover *Trifolium repens* - 2 Cat's ear *Hypochaeris radicata*- 2 Paddy's Lucerne *Sida rhombifolia* – 2	
16	296799	615239	South of Toolijooa Rd	Roadside area	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* – 5 Purpletop *Verbena bonariensis* - 2 Cobbler's Pegs *Bidens pilosa* – 2 Sow thistle *Sonchus oleraceus* 2 Fireweed *Senecio madagascariensis* - 2 Paddy's Lucerne *Sida rhombifolia* - 2 Common Wild Oat *Avena fatua*- 2 Cottonbush *Gomphocarpus physocarpus* – 2 Mallow *Malva parviflora* – 2 Maltese star-thistle *Centaurea melitensis*- 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
17	296675	6152401	South of Toolijooa Rd	Roadside batter	Cobbler's Pegs *Bidens pilosa* -2 Fireweed *Senecio madagascariensis* - 2 Purpletop *Verbena bonariensis* - 3 Paddy's Lucerne *Sida rhombifolia* - 3 Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 4 Wild tobacco *Solanum mauritianum* -1 Sow thistle *Sonchus oleraceus* 2 Moth vine Araujia sericifera -2	
18	296523	6152549	South of Toolijooa Rd	Roadside batter	Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 5 Cobbler's Pegs *Bidens pilosa* -3 Paddy's Lucerne *Sida rhombifolia* - 4 Fireweed *Senecio madagascariensis* - 3 Purpletop *Verbena bonariensis* - 2 Fleabane *Conyza bonariensis* – 3 Moth vine Araujia sericifera -1 Fennel *Foeniculum vulgare* - 1	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
19	296251	6152744	Between BC1 and Toolijooa Rd	Roadside embankment	Lantana *Lantana camara*- 5 Kikuyu *Cenchrus clandestinus* - 5 Fleabane *Conyza bonariensis* - 3 Cobbler's Pegs *Bidens pilosa* -3 Stinking Roger *Tagetes minuta* - 2 Purpletop *Verbena bonariensis* - 3 Fireweed *Senecio madagascariensis* - 2 Sow thistle *Sonchus oleraceus* 2 Spear Thistle *Cirsium vulgare* - 2 Common Wild Oat *Avena fatua*- 2 White Clover *Trifolium repens*- 2 Mallow *Malva parviflora* – 2 Paddy's Lucerne *Sida rhombifolia* – 2	
20	296157	6152704	Between BC1 and Toolijooa Rd	Access track between Toolijooa Rd and BC1	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* – 4 Paddy's Lucerne *Sida rhombifolia* - 4 Fireweed *Senecio madagascariensis* – 2 Purpletop *Verbena bonariensis* - 3 Stinking Roger *Tagetes minuta* - 2 Fleabane *Conyza bonariensis* - 2 Cottonbush *Gomphocarpus physocarpus* – 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
21	29593	6152819	Between BC1 and Toolijooa Rd	Top of cut	Kikuyu *Cenchrus clandestinus* - 5 Paddy's Lucerne *Sida rhombifolia* – 3 Lantana *Lantana camara*- 3 Purpletop *Verbena bonariensis* - 3 Fireweed *Senecio madagascariensis* – 2 Paspalum *Paspalum dilatatum* – 4 Cobbler's Pegs *Bidens pilosa* -3 Cottonbush *Gomphocarpus physocarpus* – 2	
22	295486	6152939	Between BC1 and Toolijooa Rd	Light vehicle track	Fireweed *Senecio madagascariensis* – 2 Kikuyu *Cenchrus clandestinus* - 6 Spear Thistle *Cirsium vulgare* - 2 Purpletop *Verbena bonariensis* – 2 Blackberry *Rubus fruiticosis*- 2 Paspalum *Paspalum dilatatum* – 3 Cobbler's Pegs *Bidens pilosa* -2 Paddy's Lucerne *Sida rhombifolia* – 4 Wild tobacco *Solanum mauritianum* - 1 Inkweed *Phytolacca octandra*- 2 Lantana *Lantana camara*- 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
24	295121	6152887	BC1	Adjacent to compound	Kikuyu *Cenchrus clandestinus* - 6 Cobbler's Pegs *Bidens pilosa* -2 Purpletop *Verbena bonariensis* – 3 Fireweed *Senecio madagascariensis* – 3 Stinking Roger *Tagetes minuta* – 2 Crofton weed *Ageratina adenophora* - 2 Paddy's Lucerne *Sida rhombifolia* - 2 Paspalum *Paspalum dilatatum* – 3	
31	295126	6152978	BC1	Roadside batter	Fireweed *Senecio madagascariensis* – 3 Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 4 Stinking Roger *Tagetes minuta* - 2 Paddy's Lucerne *Sida rhombifolia* - 3 Purpletop *Verbena bonariensis* – 3 Fleabane *Conyza bonariensis* - 2 Sow Thistle *Sonchus oleraceus* – 3 Alfalfa *Medicago sativa* - 1	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
25	294923	6152794	BC1	BC1	Fireweed *Senecio madagascariensis* – 3 Kikuyu *Cenchrus clandestinus* - 3 Cobbler's Pegs *Bidens Pilosa* - 2 Wild tobacco *Solanum mauritianum* - 3 Lantana *Lantana camara*- 4 Fleabane *Conyza bonariensis* - 2 Spear Thistle *Cirsium vulgare* - 3 Paspalum *Paspalum dilatatum* – 4 Paddy's Lucerne *Sida rhombifolia* - 4 Purpletop *Verbena bonariensis* – 4 Moth vine *Araujia sericifera* – 3	
26	294695	6152708	Between BC1 and BC2	Road side	Lantana *Lantana camara*- 5 Kikuyu *Cenchrus clandestinus* - 6 Sow thistle *Sonchus oleraceus* - 2 Wild tobacco *Solanum mauritianum* - 3 Fireweed *Senecio madagascariensis* – 1 Paspalum *Paspalum dilatatum* – 3 Fleabane *Conyza bonariensis* - 2 Purpletop *Verbena bonariensis* – 3 Moth vine *Araujia sericifera* - 3 Spear Thistle *Cirsium vulgare* - 1 Silky oak *Grevillea robusta* - 3 Cobbler's Pegs *Bidens pilosa* - 3 White Clover *Trifolium repens*- 2 Coral Tree *Erythrina sykesii* – 3 Quaking Grass *Briza maxima*- 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
27	294623	6152587	Between BC1 and BC2	Road side	Sow thistle *Sonchus oleraceus* - 2 Cobbler's Pegs *Bidens pilosa* - 4 Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 3 Paddy's Lucerne *Sida rhombifolia* - 3 Fireweed *Senecio madagascariensis* – 2 Purpletop *Verbena bonariensis* – 3 Alfalfa *Medicago sativa*- 2 Fleabane *Conyza bonariensis* - 3	
30	294583	6152452	Between BC1 and BC2	Road side	Kikuyu *Cenchrus clandestinus* - 5 Cobbler's Pegs *Bidens pilosa* - 3 Fireweed *Senecio madagascariensis* – 3 Purpletop *Verbena bonariensis* – 3 White Clover *Trifolium repens* - 3 Cat's Ear Hypochaeris radicata - 3 Fleabane *Conyza bonariensis* – 2 Crofton weed *Ageratina adenophora* - 1 Paddy's Lucerne *Sida rhombifolia* - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
28	294296	6152021	Between BC1 and BC2	Road side	White Clover *Trifolium repens* - 3 Cobbler's Pegs *Bidens pilosa* - 3 Purpletop *Verbena bonariensis* – 4 Kikuyu *Cenchrus clandestinus* - 4 Sow thistle *Sonchus oleraceus* - 3 Paspalum *Paspalum dilatatum* – 6 Fireweed *Senecio madagascariensis* – 2 Mustard *Brassica oleracea* - 2 Spear Thistle *Cirsium vulgare* – 3 Moth vine *Araujia sericifera* - 3 Paddy's Lucerne *Sida rhombifolia* - 4 Alfalfa *Medicago sativa* - 3	
29	294250	6151865	Between BC1 and BC2	Road side	Kikuyu *Cenchrus clandestinus* - 5 Fireweed *Senecio madagascariensis* – 2 Blackberry *Rubus fruiticosis* - 1 Lantana *Lantana camara*- 1 Paspalum *Paspalum dilatatum* – 3 Crofton weed *Ageratina adenophora* - 3 Moth vine *Araujia sericifera* - 3 Purpletop *Verbena bonariensis* – 3 Cobbler's Pegs *Bidens pilosa* - 3 Spear Thistle *Cirsium vulgare* – 2 Fleabane *Conyza bonariensis* – 3 Wild tobacco *Solanum mauritianum* -1 White Clover *Trifolium repens* - 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
32	294059	6151679	Between Austral Park compound and BC3	Access track	Fireweed *Senecio madagascariensis* – 2 Kikuyu *Cenchrus clandestinus* - 5 Paddy's Lucerne *Sida rhombifolia* - 2 Mallow *Malva parviflora* - 2 Stinking Roger *Tagetes minuta* - 2 Paspalum *Paspalum dilatatum* – 3 Whisky Grass *Andropogon virginicus* - 1 Fleabane *Conyza bonariensis* - 3 Common Couch *Cynodon dactylon* – 5 Quaking Grass *Briza maxima* – 1 Cobbler's Pegs *Bidens pilosa* – 2	
33	293916	6151611	Between Austral Park compound and BC3	Batter	Stinking Roger *Tagetes minuta* - 1 Fireweed *Senecio madagascariensis* – 2 Paspalum *Paspalum dilatatum* – 4 Paddy's Lucerne *Sida rhombifolia* - 5 Kikuyu *Cenchrus clandestinus* - 6 Purpletop *Verbena bonariensis* – 1 Cobbler's Pegs *Bidens pilosa* - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
34	293975	6151579	Between Austral Park compound and BC3	Batter	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* – 4 Fleabane *Conyza bonariensis* - 3 Sow Thistle *Sonchus oleraceus* - 3 Cobbler's Pegs *Bidens pilosa* - 3 Purpletop *Verbena bonariensis* – 3 Moth vine *Araujia sericifera* - 3	
35	293661	6151517	Between Austral Park compound and BC3	Batter	Stinking Roger *Tagetes minuta* - 3 Lantana *Lantana camara*- 4 Crofton weed *Ageratina adenophora* - 4 Fleabane *Conyza bonariensis* - 3 Kikuyu *Cenchrus clandestinus* - 4 Purpletop *Verbena bonariensis* – 2 Fireweed *Senecio madagascariensis* – 3 Inkweed *Phytolacca octandra* - 2 Spear thistle *Cirsium vulgare* – 2 Cobbler's Pegs *Bidens pilosa* - 3 Common Wild Oat *Avena fatua* - 3 Paspalum *Paspalum dilatatum* – 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
36	293699	6151420	Between Austral Park compound and BC3	Batter	Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 6 Purpletop *Verbena bonariensis* – 3 Fireweed *Senecio madagascariensis* – 3 Crofton weed *Ageratina adenophora* - 4 Fleabane *Conyza bonariensis* - 3 Inkweed *Phytolacca octandra* - 3 Spear thistle *Cirsium vulgare* – 2 Mallow *Malva parviflora* - 1 Cobbler's Pegs *Bidens pilosa* - 3 White Clover *Trifolium repens* – 2 Moth Vine *Araujia sericifera* – 3	
37	293391	6151342	Between Austral Park compound and BC3	Batter	Fireweed *Senecio madagascariensis* – 3 Inkweed *Phytolacca octandra* - 2 Purpletop *Verbena bonariensis* – 3 Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 5 Paddy's Lucerne *Sida rhombifolia* - 3 Stinking Roger *Tagetes minuta* - 1 Cobbler's Pegs *Bidens pilosa* – 2 Fleabane *Conyza bonariensis* - 2 Moth vine *Araujia sericifera* - 2 Crofton weed *Ageratina adenophora* – 1	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
13	293197	6151331	Austral Park	Western side Princess Hwy	Lantana *Lantana camara* - 3 Crofton weed *Ageratina adenophora* - 3 Blackberry *Rubus fruiticosis* -3 Moth vine *Araujia sericifera* - 3 Wild tobacco *Solanum mauritianum* - 1 Fireweed *Senecio madagascariensis* – 2 Inkweed *Phytolacca octandra* - 2 Purpletop *Verbena bonariensis* – 4 Kikuyu *Cenchrus clandestinus* - 6 Paspalum *Paspalum dilatatum* – 4 Paddy's Lucerne *Sida rhombifolia* - 4 Spear thistle *Cirsium vulgare* – 2 Fleabane *Conyza bonariensis* - 2 Whisky grass *Andropogon virginicus* – 2 Cobbler's Pegs *Bidens pilosa* – 2 Common Wild Oat *Avena fatua* – 2	
38	293143	6151252	Austral Park	Western side Princess Hwy	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* – 5 Cobbler's Pegs *Bidens pilosa* – 2 Paddy's Lucerne *Sida rhombifolia* - 2 Fireweed *Senecio madagascariensis* – 4 Lantana *Lantana camara* - 4 Blackberry *Rubus fruiticosis* -3 Crofton weed *Ageratina adenophora* - 3 Inkweed *Phytolacca octandra* - 2 Purpletop *Verbena bonariensis* – 4	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
					Fleabane *Conyza bonariensis* – 2 Moth Vine Araujia sericifera – 3 Wild Tobacco *Solanum mauritianum* – 3 White Mulberry *Morus alba* – 1 Spear Thistle *Cirsium vulgare* – 3	
12	293089	6151221	Austral Park	Western side Princess Hwy	Blackberry nightshade *Solanum nigrum* - 3 Fireweed *Senecio madagascariensis* – 3 Stinking Roger *Tagetes minuta* - 2 Paspalum *Paspalum dilatatum* – 5 Kikuyu *Cenchrus clandestinus* - 5 Paddy's Lucerne *Sida rhombifolia* - 4 Pigeon grass *Setaria parviflora* - 2 Inkweed *Phytolacca octandra* - 2 Wild tobacco *Solanum mauritianum* - 3 Purpletop *Verbena bonariensis* - 3 Lantana *Lantana camara* - 2 Spear Thistle *Cirsium vulgare* – 3 Moth Vine *Araujia sericifera* – 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
10	292987	6151220	Austral Park	Western side Princess Hwy	Fireweed *Senecio madagascariensis* – 2 Kikuyu *Cenchrus clandestinus* - 5 Purpletop *Verbena bonariensis* - 2 Paddy's Lucerne *Sida rhombifolia* - 3 Cobbler's Pegs *Bidens pilosa* – 3 Fennel *Foeniculum vulgare* - 3 Spear Thistle *Cirsium vulgare* - 3 Quaking Grass *Briza maxima*– 3 Fleabane *Conyza bonariensis* – 3 Sow Thistle *Sonchus oleraceus* – 3	
11	292977	6151168	Austral Park	Soil mound	Sow Thistle *Sonchus oleraceus* – 2 Cobbler's Pegs *Bidens Pilosa*- 3 Fennel *Foeniculum vulgare* - 2 Kikuyu *Cenchrus clandestinus* - 4 Purpletop *Verbena bonariensis* - 3 Fireweed *Senecio madagascariensis* – 2 Quaking Grass *Briza maxima* – 1 Spear Thistle Cirsium vulgare – 1 Patty's lucerne *Sida rhombifolia* - 2 Moth Vine *Araujia sericifera* – 1	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
9	292873	6151166	Austral Park	Batter	Sow Thistle *Sonchus oleraceus* - 1 Fireweed *Senecio madagascariensis* - 2 Lantana *Lantana Camara* - 3 Purpletop *Verbena bonariensis* - 4 Paspalum *Paspalum dilatatum* - 4 Kikuyu *Cenchrus clandestinus* - 3 Fleabane *Conyza bonariensis* - 2 Cobbler's Pegs *Bidens pilosa* - 2 Patty's lucerne *Sida rhombifolia* - 2 White Clover *Trifolium repens* 3	
8	292746	6151115	Austral Park	Road side	Fireweed *Senecio madagascariensis* - 1 Wild tobacco *Solanum mauritianum* - 3 Purpletop *Verbena bonariensis* - 4 Paspalum *Paspalum dilatatum* - 3 Small-leaved privet *Ligustrum sin*ense - 2 Fleabane *Conyza bonariensis* - 3 Tall flatsedge *Cyperus eragrostis* - 3 Kikuyu *Cenchrus clandestinus* - 4 Inkweed *Phytolacca octandra* - 1 Patty's Lucerne *Sida rhombifolia* - 3 Sow Thistle *Sonchus oleraceus* - 3 Cobbler's Pegs *Bidens pilosa* - 3 Blackberry *Rubus fruiticosis* – 4	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
7	292355	6150882	Central zone	Road side	Inkweed *Phytolacca octandra* - 1 Fireweed *Senecio madagascariensis* - 3 Kikuyu *Cenchrus clandestinus* - 5 Lantana *Lantana camara* - 4 Purpletop *Verbena bonariensis* - 2 Stinking Roger *Tagetes minuta* - 2 Paspalum *Paspalum dilatatum* - 3 Ribwort Plantain *Plantago laceolata* - 3 Cobbler's Pegs *Bidens pilosa* – 3 Patty's lucerne *Sida rhombifolia* – 2 Fleabane *Conyza bonariensis* - 2 Spear Thistle *Cirsium vulgare* – 2	
6	291579	6150900	Tindell's Lane	Road side	Kikuyu *Cenchrus clandestinus* - 3 Blackberry *Rubus fruiticosis* - 2 Paspalum *Paspalum dilatatum* - 3 Lantana *Lantana camara* - 3 Purpletop *Verbena bonariensis* - 2 Common Wild Oat Avena fatua – 3 Moth Vine Araujia sericifera – 1 White Clover Trifolium repens – 2 Quaking Grass Briza maxima - 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
5	291578	6150845	Tindell's Lane	Batter	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* - 5 Patty's lucerne *Sida rhombifolia* - 4 Fireweed *Senecio madagascariensis* - 3 Moth vine *Araujia sericifera* - 2 Purpletop *Verbena bonariensis* - 2 Cobbler's Pegs *Bidens pilosa* - 2 Fleabane *Conyza bonariensis* - 2 Sow Thistle *Sonchus oleraceus* - 2 Spear Thistle *Cirsium vulgare* – 2 Quaking Grass *Briza Maxima* – 3	
4	291320	6150671	Central zone Cut 6	Batter	Kikuyu *Cenchrus clandestinus* - 6 Sow Thistle *Sonchus oleraceus* - 2 Cobbler's Pegs *Bidens pilosa* - 3 Purpletop *Verbena bonariensis* - 2 Paspalum *Paspalum dilatatum* - 4 Fleabane *Conyza bonariensis* - 3 Mallow *Malva parviflora* – 1 Patty's lucerne *Sida rhombifolia* - 2 Spear Thistle *Cirsium vulgare* – 3 Inkweed *Phytolacca octandra*- 1 Fennel *Foeniculum vulgare* - 1 Cat's Ear *Hypochaeris radicata* – 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
3	291317	6150605	Central zone Cut 6	Batter	Kikuyu *Cenchrus clandestinus*- 5 Paspalum *Paspalum dilatatum* - 4 Purpletop *Verbena bonariensis* - 2 Cobbler's Pegs *Bidens pilosa* - 3 Fireweed *Senecio madagascariensis* - 1 Patty's Lucerne *Sida rhombifolia* - 4 Fleabane *Conyza bonariensis* - 2 White Clover *Trifolium repens* - 2 Moth Vine *Araujia sericifera* - 3	
2	291251	6150619	Central zone Cut 6	Batter	Kikuyu *Cenchrus clandestinus* - 5 Fireweed *Senecio madagascariensis* - 2 Cobbler's Pegs *Bidens pilosa* - 3 Fleabane *Conyza bonariensis* - 3 Purpletop *Verbena bonariensis* - 2 Patty's lucerne *Sida rhombifolia* – 3 Fennel *Foeniculum vulgare* - 1 Spear Thistle *Cirsium vulgare* - 1 Common Wild Oat *Avena fatua* - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
1	291130	6150523	Central zone Cut 6	Batter	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* - 5 Purpletop *Verbena bonariensis* - 3 Fireweed *Senecio madagascariensis* - 2 Crofton weed *Ageratina adenophora* - 2 Mallow *Malva parviflora* - 2 Sow Thistle *Sonchus oleraceus* - 2 Patty's Lucerne *Sida rhombifolia* – 3 Fleabane *Conyza bonariensis* - 2 Inkweed *Phytolacca octandra* - 2 White clover *Trifolium repens* – 2	
0	290920	6150386	Central zone	Batter	Kikuyu *Cenchrus clandestinus* - 3 Paspalum *Paspalum dilatatum* - 3 Patty's Lucerne *Sida rhombifolia* - 3 Fennel Foeniculum vulgare – 2 Common Wild Oat- Avena fatua – 3 Spear Thistle Cirsium vulgare – 1 Purpletop Verbena bonariensis – 1 Moth Vine Araujia sericifera – 1 Quaking Grass Briza maxima – 3 Fleabane Conyza bonariensis - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
39	290499	6150097	Southern zone	Batter	Kikuyu *Cenchrus clandestinus* - 5 Paspalum *Paspalum dilatatum* - 5 Fireweed *Senecio madagascariensis* - 2 Patty's Lucerne *Sida rhombifolia* - 4 Crofton weed *Ageratina adenophora* – 2 Lantana Lantana *camara* - 2 Giant paramatta grass *Sporobolus fertilis* - 1 Purpletop *Verbena bonariensis* - 2 Fleabane *Conyza bonariensis* - 3 Cobbler's Pegs *Bidens pilosa* – 2 Blackberry *Rubus fruticosus* – 2 Moth Vine *Araujia sericifera* – 3 Wild Tobacco *Solanum mauritianum* – 1 Spear Thistle *Cirsium vulgare* – 1	
41	290384	6150131	Southern zone	Batter	Mallow *Malva parviflora* - 1 Fireweed *Senecio madagascariensis* - 2 Kikuyu *Cenchrus clandestinus* - 3 Purpletop *Verbena bonariensis* - 2 Paspalum *Paspalum dilatatum* - 4 Sow Thistle *Sonchus oleraceus* - 2 Cobbler's Pegs *Bidens pilosa* - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
40	290237	6150006	Southern zone	Embankment	Kikuyu *Cenchrus clandestinus* - 3 Fireweed *Senecio madagascariensis* - 2 Sow Thistle *Sonchus oleraceus* - 2 Cobbler's Pegs *Bidens pilosa* - 2 Mallow *Malva parviflora* – 2 Fleabane Conyza bonariensis – 2 Paspalum *Paspalum dilatatum* - 2	
42	289262	6149761	Southern zone	Batter	White Clover *Trifolium repens* - 2 Sow Thistle *Sonchus oleraceus* - 2 Mallow *Malva parviflora* - 2 Cobbler's Pegs *Bidens pilosa* - 2 Pigeon Grass Setaria parviflora – 1 Paspalum *Paspalum dilatatum* - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
43	288808	6149755	Southern zone	Batter	Paspalum *Paspalum dilatatum* - 5 Fireweed *Senecio madagascariensis* - 2 Fleabane *Conyza bonariensis* - 3 White Clover *Trifolium repens* – 2 Ribwort Plantain *Plantago lanceolata* – 4 Cat's Ear *Hypochaeris radicata* – 2 Purpletop *Verbena bonariensis* – 1 Cobbler's Pegs Bidens *pilosa* – 1 Mallow *Malva parviflora* - 2	
49	288598	6149960	Southern zone	Town Creek Diversion, Rawling's Lane	Lantana *Lantana camara* - 3 Fireweed *Senecio madagascariensis* - 2 Patty's lucerne *Sida rhombifolia* - 3 Kikuyu *Cenchrus clandestinus* - 5 Curly Dock *Rumex obtusifolius* - 3 Paspalum *Paspalum dilatatum* – 3 Purpletop Verbena bonariensis – 2 Curly Dock *Rumex obtusifolius* – *3* White Clover Trifolium repens - 2	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
44	288407	6149644	Southern zone	Noise mound	Cobbler's Pegs *Bidens pilosa* - 3 Sow Thistle *Sonchus oleraceus* – 3 Paspalum *Paspalum dilatatum* – 2 Fireweed *Senecio madagascariensis* – 1 Purpletop Verbena bonariensis – 1 Fleabane *Conyza bonariensis* - 1 Blackberry nightshade *Solanum nigrum* – 1 Mustard *Brassica oleracea* - 1	
45	288031	6149263	Southern zone	Roadside	Fireweed *Senecio madagascariensis* - 2 Kikuyu *Cenchrus clandestinus* - 5 Blackberry nightshade *Solanum nigrum* - 3 Moth vine *Araujia sericifera* - 2 Patty's lucerne *Sida rhombifolia* - 3 Fleabane *Conyza bonariensis* - 3 Cobbler's Pegs *Bidens pilosa* - 3 Sow Thistle *Sonchus oleraceus* - 2 Blackberry *Rubus fruiticosis* - 3 Lantana *Lantana camara* – 3 Inkweed *Phytolacca octandra* - 2 Purpletop *Verbena bonariensis* – 2 Crofton weed *Ageratina adenophora* – 3 Paspalum *Paspalum dilatatum* – 3	

Way point	Easting	Northing	General Location	Site Description	Weeds and abundances	Photograph
48	287971	6149266	Southern zone	Roadside	Kikuyu *Cenchrus clandestinus* - 4 Purpletop *Verbena bonariensis* - 3 Fireweed *Senecio madagascariensis* - 2 Patty's lucerne *Sida rhombifolia* - 3 Cobbler's Pegs *Bidens pilosa* – 3 Paspalum *Paspalum dilatatum* - 3 Sow Thistle *Sonchus oleraceus* - 3 White Clover Trifolium repens - 2 Fleabane *Conyza bonariensis* - 3	
47	287054	6147773	Southern zone	Roadside	Could not survey due to Berry to Bomaderry Construction	Could not survey due to Berry to Bomaderry Construction
46	286918	6147524	Southern zone	Roadside	Lantana *Lantana camara* - 2 Kikuyu *Cenchrus clandestinus* - 4 Paspalum *Paspalum dilatatum* - 4 Patty's lucerne *Sida rhombifolia* - 4 Cobbler's Pegs *Bidens pilosa* – 2 Ribwort Plantain *Plantago laceolata* – 3 Quaking Grass *Briza maxima* – 3 Common Wild Oat *Avena fatua* - 2	

3.3.3. Landscape Maintenance Works

Works undertaken in accordance with the Landscape Maintenance Plan for the Foxground and Berry Bypass Project 2017 (LMP) include priority weed control as part of required maintenance activities. The following summarises the weed inspection requirements:

- All areas
    - Priority Weed Control – monthly inspections
- Grassland Areas
    - Weed control in Grassland – monthly inspections
- Landscape Bed Plantings
    - Weed garden beds prior to weed setting flower – yearly inspection
    - Removal/treatment of priority weeds – every 4 weeks.

A monthly and annual maintenance audit is completed by the Foxground and Berry Bypass Landscape Officer to ensure that landscape maintenance works are undertaken and recommendations for future maintenance works will be provided. The landscape officer should look at maintenance works records to ensure adequate works are being conducted in accordance with the timeframes outlined in the LMP.

4. DISCUSSION

4.1. ECOLOGICAL MONITORING

4.1.1. Camera Automated Detection

Comparison with pre-construction data

A direct comparison of the pre-construction and post-construction data (Figure 4-3) reveals that more terrestrial and arboreal individuals have been detected during both years of post-construction monitoring. However, the placement of cameras during the pre-construction phase was quite different, as no crossing structures were present at the time of initial monitoring. As such, some terrestrial species were recorded in initial monitoring which would not be recorded during post-construction monitoring of structures such as rope bridges. Six species were detected during the pre-construction phase and in 2018, whereas 12 species were recorded during 2019. In 2019 Common Ringtail Possums were detected using rope bridges at five camera sites, and Sugar Gliders (*Petaurus breviceps)* were recorded using a rope bridge at one camera site. During both 2018 and 2019 there has been an absence of Common or Mountain Brushtail Possums which indicates that they are not readily utilising the crossing structures yet. It may take longer for certain species to acclimatise to the crossing structures. Table 4-1 below provides a comparison of results pre and post construction at each crossing site for terrestrial and arboreal species only (birds have been excluded).

A number of fauna underpasses contain fauna “furniture” in form of timber attached along the side of underpasses, however these poles are relatively isolated from adjacent vegetation, potentially reducing their efficacy for arboreal species that are less likely to move along the ground. In 2018 it was recommended that any revegetation efforts should target these areas to create vegetative connectivity to the crossings. The 2019 monitoring only detected limited evidence of revegetation work.

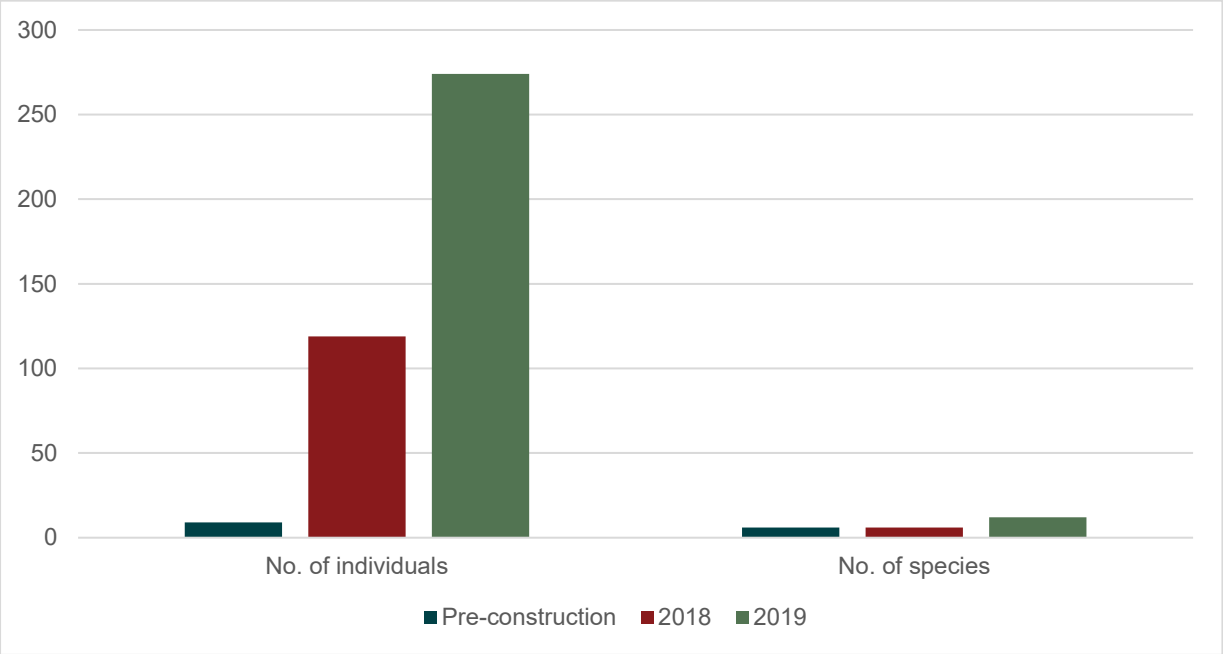

Figure 4-1 Pre-construction vs post-construction camera survey fauna results

Table 4-1 Terrestrial and arboreal fauna recorded during camera surveys during pre-construction and post-construction

Fauna mitigation structure locations	Structure code and type (PB 2015)	Fauna crossing main orientation	[1]Pre-construction		[1]2018		[1]2019	
			North or east	South or west	North or east	South or west	North or east	South or west
Toolijooa ridge 1 CH 8450	TR1 Fauna underpass and fencing	North-South	Common Wombat Swamp Wallaby	-	-	Common Wombat	-	Common Ringtail Possum
Toolijooa ridge 2 CH 8500	TR2 Rope bridge	North-South	Common Brushtail Possum	-	-	none	-	none
Broughton Creek 1 CH 9950 - CH 9990	BCB1 Bridge		-	Short-beaked Echidna	-	-	-	-
	BCC1 Rope bridge		-	-	none	none	none	none
Broughton Creek 2 CH 10700	BCB2 Bridge	East-West	Mountain Brushtail Possum	Eastern Water Skink	-	-	-	-
	BCC2 Rope bridge				Common Ringtail Possum	Common Ringtail Possum	Common Ringtail Possum, Sugar Glider, Peron's Tree Frog	Common Ringtail Possum
Broughton Creek 3 CH 11200	BCB3 Bridge	North-South	-	none	-	-	-	-
	BCC3 Rope bridge				Common Ringtail Possum	Common Ringtail Possum	none	Common Ringtail Possum
Princes Highway CH 12770	PH1 Fauna underpass and fencing	North-South	-	Swamp Wallaby	-	Black Rat, Red Fox	-	Black Rat, Red Fox, Cat
Princes Highway CH 13320	PH2 Fauna underpass	North-South	Swamp Wallaby	-	none	-	Short-beaked Echidna, Red Fox	-

Fauna mitigation structure locations	Structure code and type (PB 2015)	Fauna crossing main orientation	[1]Pre-construction		[1]2018		[1]2019	
			North or east	South or west	North or east	South or west	North or east	South or west
	and fencing							
Princes Highway CH 13360	PH3 Rope bridge	North-South	-	none	-	none	-	none
Princes Highway CH 13680	PH4 Fauna underpass and fencing	North-South	-	Swamp Wallaby	none	-	Black Rat	-
Princes Highway CH 13700	PH5 Rope bridge	North-South	none	-	Possum?	-	none	-
Broughton Mill Creek CH 15900	BMC Rope bridge	North-South	none	-	none	-	Common Ringtail Possum	-
Bridge at Berry CH 16000	BAB Bridge	North-South	-	-	-	-	-	-
Bundewallah Creek (Connollys Creek) CH 16250	BCCC Rope bridge	North-South			none	-	none	-

*[1] ˜none" indicates that no species were recorded. ˜- " indicates that no camera was placed in this location due to monitoring program design

4.1.2. Transect Surveys

Comparison with pre-construction data

From Figure 4-2 it is evident that more individuals and more species have been detected during post-construction spotlighting surveys. While fewer individuals were detected in 2019 compared to 2018, there was a greater number of species recorded. The number of individuals detected through scats, tracks and signs searches was similar from pre-construction to 2018, with an increase in 2019. More species traces have been detected during post-construction surveys, with very similar results between 2018 and 2019. Herpetological surveys found a higher number of individuals and species during the pre-construction phase, possibly attributed to the conditions at the time of the survey which may have been more favourable for reptiles.

No new mammal species were detected during 2019, however a Long-nosed Bandicoot was observed during spotlighting which had not been recorded since the pre-construction surveys. Overall, 10 native mammal species were detected during the pre-construction surveys, 11 native mammal species during 2018, and 11 in 2019.

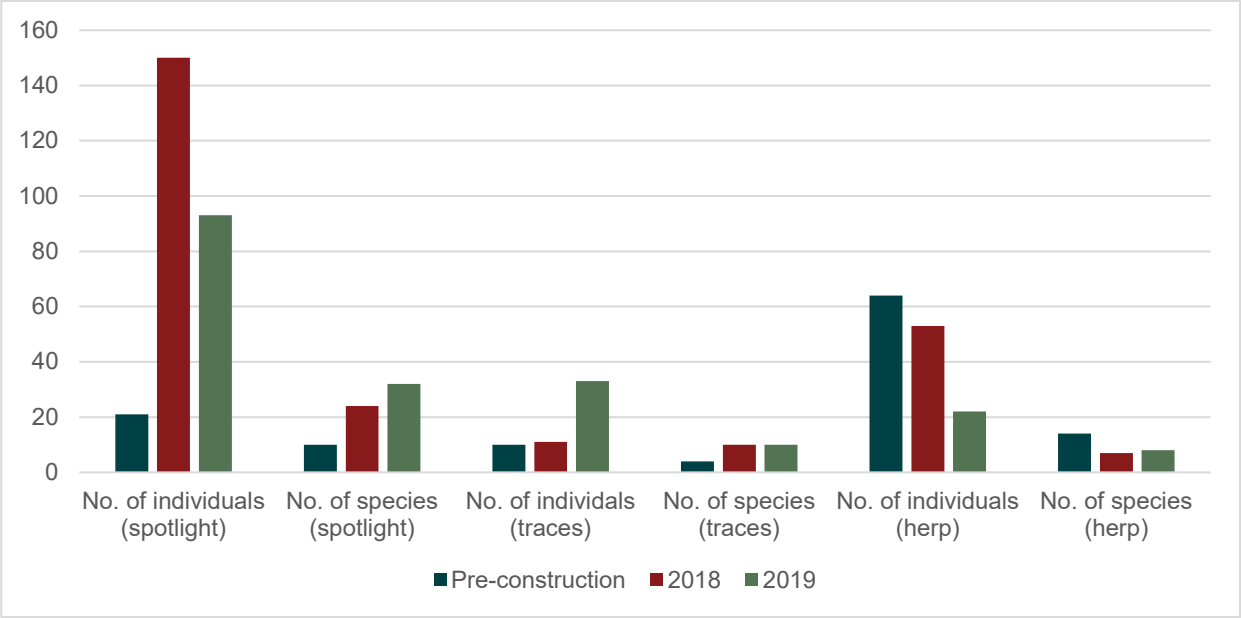

Figure 4-2 Pre-construction vs post-construction (2018 and 2019) count and species diversity transect data

4.1.3. Ecological Monitoring- Performance Criteria Comparison

Table 4-2 Performance Criteria Comparison

Mitigation measure	Performance criteria	Performance target and timeframe	Are performance criteria being met?
Targeted GGBF surveys	If any Green and Golden Bell Frogs (GGBF) are detected during the pre-clearing surveys further investigations and reporting would be required (such as a GGBF Management Plan). This would identify the appropriate performance criteria. Generally, this would be likely to focus on the presence of GGBF continuing at the same or higher population levels	GGBF persist in areas identified during the life of the monitoring program.	Yes. No GGBFs were detected during pre-clearing surveys, therefore no further targeted surveys were required during the post-construction period. No GGBFs were recorded during the transect surveys or call playback surveys conducted in February 2018 and 2019.
Connectivity mitigation measures (fauna exclusion fencing, underpasses and arboreal rope crossing)	Low fauna mortality or injury due to road kill	Road kill rates similar or lower than rates recorded pre- construction on existing highway, during the life of the monitoring program.	No. Road kill rates were 64 per cent higher during the post-construction period, when pre and post construction monitoring periods (March to November) are directly compared. No road kill monitoring was required during 2019.
	Evidence of use of by arboreal, cover-dependent species with low mobility, dispersing (juvenile) or different age cohorts.	Demonstrated use of structure by native targeted fauna species within 3 years of start of operation phase	Yes. Common Ringtail Possums and Sugar Gliders have been confirmed using the rope bridges.
	High rates of native fauna movement and species diversity using structures.	Majority of structures show several native species using the structure within 3 years of start of operation phase	Yes. A total of 12 different terrestrial and arboreal species were recorded using the rope bridges and fauna underpasses (100% increase since 2018). The cameras recorded 274 terrestrial and arboreal individuals using the crossing structures in 2019 (a 130% increase since 2018).

Mitigation measure	Performance criteria	Performance target and timeframe	Are performance criteria being met?
Habitat Use	Mammal species present within retained habitat is at similar levels to pre-construction	Mammal diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program.	Yes. Native mammal diversity was 10% higher during both post-construction monitoring sessions when compared to pre-construction monitoring.
	Reptile species similar diversity as pre-construction	Reptile diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program.	No. Fourteen reptile species were recorded during pre-construction surveys. Seven reptile species were recorded during 2018 and eight reptile species during 2019 post-construction surveys. This is a 50% (2018) and 43% (2019) decrease in reptile diversity when compared to pre-construction monitoring. Survey conditions may be a factor, and further monitoring may detect additional species. One additional reptile species was recorded from camera monitoring; Fence skink (*Cryptoblepharus virgatus*). An increase in exotic predators may also be impacting reptile abundance. Foxes were recorded along three of the nocturnal transects, and a number of fox scats and burrows were detected opportunistically.
	Amphibians species similar diversity as pre- construction	Amphibians diversity of monitoring areas within 20% of pre-construction data during the life of the monitoring program.	Yes. Seven species of frog were recorded during pre-construction surveys. Five species of frog were identified during 2018 (29% decrease) and six species in 2019 (14% decrease). 2019 results show similar amphibian diversity compared to pre-construction surveys that are within the performance target range.

4.2. AQUATIC MONITORING

4.2.1. Habitat Assessment

The substrate of a stream influences the type of organisms that are likely to occur there. It is unlikely to vary greatly in healthy streams, however it is a valuable tool to detect changes such as siltation, which is a possibility in a rural/agricultural environment. An increase in the presence of bedrock, gravel, sand, silt and clay represents a decrease in habitat availability for aquatic organisms at a site. Substrate proportions in upstream control sites were similar to the downstream treatment sites. There was an increase in silt at the treatment sites since pre-construction, with a decrease at control sites since both 2018 and pre-construction. A possible explanation is that barriers and water catchment structures built during the installation of the bypass may be preventing some waterflow to downstream sites and therefore the potential substrates that may be dislodged during high flow events. An increased trend in cobble and boulder at treatment sites since pre-construction is an indication that habitat availability, while variable, has improved. Trendlines for cobble and boulder at the control sites are much less variable but this may be due to the comparison of only two control sites with six treatment sites.

High proportion of cobble at both treatment sites and control sites, with an increase compared to 2018 results and is likely to be impacted by water levels at the time of the surveys. Cobble at treatment sites remains less than pre—construction monitoring between 2015 to 2017. Pebble, Bedrock, Boulder, Sand and Silt substrates at treatment sites showed a small degree of variability in 2019 when compared to 2018 results. At control sites there appeared to be a decrease in Silt and Boulder, with an increase in Bedrock.

When compared to pre-construction data, there has been a downward trend of algae at all control sites and treatment sites, except for Site 27. There has been an increase in percentage cover of macrophytes at both control sites and Sites 13, 16, 17 and 27 since pre-construction. There have been no obvious changes since pre-construction at Site 22, and Site 25 shows a minor downward trend in macrophytes. Macrophytes provide habitat for aquatic fauna, reduce bank erosion, may improve water clarity, and may limit spread of invasive species. However, extensive macrophyte coverage also has the potential to limit stream flow. The highest percentage cover of macrophytes in 2019 was at Control Site 1 with 35%. There has been very little change in moss cover since pre-construction, except at Site 17 which has a downward trend. Moss can provide good habitat for aquatic invertebrates.

4.2.2. Water Quality

Water quality parameters that varied more than 10% when compared to pre-construction values were conductivity (Sites 16, 17, 25, 27 and CS1), temperature (Site 17), and turbidity (Sites 22, 25, 27, CS1 and CS2). All other parameters passed the water quality performance criteria (See Table 3-8 and Table 3-9).

There is a slight increase in both water temperature at treatment sites and control sites, which may create adverse conditions for invertebrates and fish. Similarly, pH levels increased slightly at control sites however, a larger increase was seen in the treatment sites. pH is a measure of acidity, and with increasingly acid waters, numbers of species and individuals of aquatic organisms decrease. A pH reading of 6.5 to 7.5 is optimal. Ph levels were below 6.5 at all treatment sites and are an indication of high photosynthetic growth. Dissolved Oxygen is seen to decrease over time in treatment sites, while an increase has been observed at control sites. Dissolved oxygen is the volume of oxygen contained in the water, and extreme levels (low and high) can have negative impacts on organisms. Dissolved oxygen was low at all treatment sites, whereas the Control sites had levels that were within the recommended range (ANZECC 2000). Conductivity is seen to increase over time at treatment sites

however has decreased slightly over time at the control sites. Conductivity is a measure of the total ionic strength of the water and is used as an indication of the level of enrichment (i.e. nutrient content) of the water. There were no high readings of conductivity which could indicate unsuitable water quality. An increase in turbidity may inhibit plant growth. Slight increases in turbidity have been observed at both the treatment sites and control sites. Turbidity can be caused by soil erosion, waste discharge, urban runoff, algal growth and other disturbances in the water channel (Sydney Water 2010).

4.2.3. Macrophyte and Emergent Vegetation

In Autumn Session 1 2019, Water pepper *Persicaria hydropiper* was the most common macrophyte observed, found in 5 sites; treatment sites 13, 22, and 27, and control sites 1 and 2. Elodea *Elodea canadensis* was found in the highest proportions of any macrophyte, with a reading of 3 (according to the Braun-Blanquet 6-point scale, refer to section 2.4.2) on two (2) occasions. Site 17 had the highest number of exotic species recorded (3) during Autumn Session 1.

In Autumn Session 2 2019, Water pepper *Persicaria hydropiper* and Umbrella sedge *Cyperus eragrostis* were the most common macrophytes observed, found in 5 sites each. Elodea *Elodea canadensis* was found in the highest proportions of any macrophyte, with a reading of 4 and 3 according to the Braun-Blanquet 6-point scale, on one occasion each (refer to section 2.4.2). Control site 2 and Site 13 had the highest number of exotic species recorded (4) during Autumn Session 2.

In Spring Session 1 2019, Sagittaria *Sagittaria platyphylla,* Elephants ear *Colocasia sp,* and Watercress *Rorippa nasturtium-aquaticum* were the most common macrophytes observed, found in three sites each. Elodea *Elodea canadensis* was found in the highest proportions of any macrophyte, with a reading of 4 and 3 according to the Braun-Blanquet 6-point scale, on one occasion each (refer to section 2.4.2). Control site 2 had the highest number of exotic species recorded (4) during Spring session 1.

In Spring Session 2 2019, Umbrella sedge *Cyperus eragrostis* was the most common macrophyte observed, found in 6 sites: treatment sites 13, 16, 17, 22, and 27, and control site 2. Elodea *Elodea canadensis* was found in the highest proportions of any macrophyte, with a reading of 4 and 3 according to the Braun-Blanquet 6-point scale, on one occasion each (refer to section 2.4.2). Control site 2 had the highest number of exotic species recorded (5) in Spring session 2.

Data from previous years can be found in Appendix B.

4.2.4. Macroinvertebrates

All SIGNAL scores indicated moderate to mild pollution, except Site 22 which resulted in scores below 4 indicating severe pollution.

EPT scores indicate poor stream health at all sites. There was some variation at Site 13 and 16, which had slightly better scores during spring indicating fair stream health.

Despite some seasonal and yearly variation, these scores are similar to previous years. Overall, SIGNAL scores have improved since pre-construction with far fewer ‘severe’ indicators.

A comparison of macroinvertebrate data with pre-construction averages and post-construction averages reveals that all sites have seen either an increase or a decrease within 20% of pre-construction scores in both SIGNAL scores and number of taxa (Table 4-3). Three sites (16, 22, Control Site 1) failed the performance criteria with lower average EPT scores during post-construction.

Table 4-3 Pre and Post construction Signal, EPT Scores and Taxa Number comparison

	Parameter	Pre-Construction Average	Pre-Construction Average minus (-20%	Post-Construction Average	PASS/FAIL
Site 13	SIGNAL score	3.75	3	5.1	PASS
	EPT score	6	4.8	6	PASS
	Number of taxa	6	4.8	17.75	PASS
Site 16	SIGNAL score	3.55	2.84	4.9	PASS
	EPT score	1.5	1.2	7.25	PASS
	Number of taxa	6	4.8	21.9	PASS
Site 17	SIGNAL score	2.9	2.32	4.3	PASS
	EPT score	7	5.6	5.13	FAIL
	Number of taxa	No Data	No Data	17	NA
Site 22	SIGNAL score	3.6	2.88	3.37	PASS
	EPT score	3	2.4	2.25	FAIL
	Number of taxa	6	4.8	13.5	PASS

	Parameter	Pre-Construction Average	Pre-Construction Average minus (-20%	Post-Construction Average	PASS/FAIL
Site 25	SIGNAL score	3.4	2.72	4.8	PASS
	EPT score	2.5	2	3.6	PASS
	Number of taxa	8.5	6.8	17.25	PASS
Site 27	SIGNAL score	3.25	2.6	4.7	PASS
	EPT score	1	0.8	3	PASS
	Number of taxa	5.5	4.4	18.5	PASS
Control Site 1	SIGNAL score	5.285	4.228	4.5	PASS
	EPT score	5	4	3.75	FAIL
	Number of taxa	16.5	13.2	19	PASS
Control Site 2	SIGNAL score	No Data	No Data	4.7	NA
	EPT score	No Data	No Data	5	NA
	Number of taxa	No Data	No Data	17.1	NA

4.2.5. Aquatic Fauna Assessment

There was a reduction in species diversity and abundance recorded in 2019 at treatment sites compared to previous years. This trend was also observed in control site surveys between 2017 and 2019. This may indicate that factors that affecting species diversity and abundance are not necessarily a result of construction activities, but may be attributed to conditions of this generally disturbed aquatic ecosystem. Factors that typically influence aquatic ecosystems include water supply, water quality, turbidity, pollution and alien species.

4.2.6. Aquatic Monitoring – Performance Criteria Comparison

The following performance criteria relevant to aquatic monitoring are taken from the EcMP (PB 2014). It should be noted that these do not relate specifically to the post-construction period monitoring rather they relate to the lifetime of the monitoring program, including post construction.

Of note is the fact that the water quality varies across sites between surveys by more than 10% in some years. Examples of this include turbidity changing from approximately 25 NTU to 5 NTU between 2014 Spring and 2015 Autumn, and Dissolved Oxygen changing from approximately 70 to 130 between Spring 2014 and Spring 2015. As such, the comparison of pre and post construction values may not be informative about the relative impact of the project, as the quality values of the whole waterway may change by more than 10% in any given season. The comparison to control sites allows for comparison upstream and downstream of the project, and it is suggested that this measure is more informative about the impacts of the project than comparison with conditions over time.

As can be seen from Table 3-8 and Table 3-9, conductivity is the only measure where control sites have consistently better values than treatment sites. It is suggested that this may be as a result of the importation of fill and rocks for the construction of the project, and potentially from inorganic compounds resulting from the construction and use of the road.

Table 4-4 Performance criteria Comparison

Measure	Performance criteria	Performance target	Comment
Aquatic and riparian monitoring	Water quality maintained between impact sites and control sites as a result of the Project's operations	Water quality is maintained at preconstruction data levels, or increases. Any decrease in water quality does not exceed 10% difference when compared to preconstruction data levels.	The performance criteria and performance target in this case vary. The performance target should not solely be used as a guideline on the overall water quality assessment of the project. Rather, it should additionally include the comparison between control and treatment site data. This comparison would assess whether trends are consistent between treatment and control sites. We could suggest that although downstream treatment sites have decreased in water quality, if this is similarly seen in upstream control sites, disturbance would not be a result of the bypass' construction and use. A discussion of the water quality analysis is given below. The treatment sites are highly disturbed as a result of surrounding land uses. The water quality values at all the sites generally fell outside the ANZECC/ARMCANZ Guideline levels (ANZECC 2000) for disturbed aquatic ecosystems. This occurred during both preconstruction surveys and during construction and is therefore likely a reflection of the agricultural land uses in the catchment rather than the bypass' construction.

Measure	Performance criteria	Performance target	Comment
			An analysis (Table 3-8 and Table 3-9) has been conducted to assess whether the performance target of water quality has been met, which is summarised below. • Site 13: PASS in all water quality parameters • Site 16: FAIL for Conductivity • Site 17: FAIL for Temperature and Conductivity • Site 22: FAIL for Turbidity • Site 25: Fail for Conductivity and Turbidity • Site 27: Fail for Conductivity and Turbidity • Control Site 1: FAIL for Conductivity and Turbidity (no pre-construction data – compared to 2016-2017 data) • Control Site 2: FAIL for Turbidity (no pre-construction data – compared to 2016-2017 data) Although no control site data was obtained pre-construction, a comparison has been made between control site data during construction and post-construction (above). As mentioned above, this performance target should not solely be used as a determining factor of the overall water quality assessment of the project. Rather, trends between treatment sites and control sites additionally need to be compared before overall conclusions can be made. Temperature: Only failed at Site 17. Figure 3-11 shows a very similar trend between treatment sites and control sites between surveys. pH: Passed in both control and treatment sites. Figure 3-14 shows an upward trend in pH at treatment sites since pre-construction, and little change at control sites, despite seasonal /yearly variations. Conductivity: Passed in both control sites, failed in site 16, 17, 25, 27 and CS1. Figure 3-13 shows a similar trend in control and treatment sites. However, treatment sites always had a higher recorded conductivity than control sites throughout the survey times. Important to note, average trendlines in the graph are different to actual trendlines as treatment sites included pre-construction data, where none was recorded for control sites. Turbidity: Failed in sites 22, 25, 27, and both control sites. Figure 3-15 shows a similar trend line except for Spring 2017 where a much higher

Measure	Performance criteria	Performance target	Comment
			turbidity was recorded in treatment sites than control sites. This change was not permanent as from Autumn 2018 trend lines restored to similar levels. Spring 2019 recorded higher turbidity levels at treatment sites than control sites. Overall, changes cannot be attributed to construction activities or operation when compared to pre-construction data. Dissolved oxygen: Passed for all sites. Figure 3-12 shows a downward trend for treatment sites and an upward trend at control sites since pre-construction. There is a similar trendline between treatment and control sites across surveys.
	No emergent vegetation or macrophyte dieback	None observed during the life of the monitoring program.	The overall abundance was similar across survey years, with a total number of 14 different species recorded in 2019 across all sites and seasons compared to 11 species in 2018, 13 in 2017, 10 species in 2016, and 14 species during 2015. Overall, emergent vegetation and macrophytes were at pre-construction levels during 2019. Some sites experience some dieback with some species disappearing and reappearing and/or other species appearing. This could be due to natural temporal variations. Seven exotic species were detected during 2019. The most abundant species at any one site was *Elodea canadensis* at Control Site 1. Control Site 1 had the largest recorded abundance of any exotic macrophyte identified, *Elodea canadensis* 4 (20- <50% modified Braun-Blanquet 6-point scale). A total of eight species, including five exotic species, were recorded at the control sites in 2019. *Cyperus eragrostis* Umbrella sedge was extremely abundant in Spring 2019, recorded at six of the eight sites. As upstream control sites also contained similar abundance and richness of macrophytes to the downstream sites, this suggests results may not necessarily be construction caused.
	Macroinvertebrates maintained	Macroinvertebrates are maintained at preconstruction data levels or increase during the life of the monitoring program. Any decrease in macroinvertebrates does not exceed 20% difference when compared to preconstruction data levels.	Table 4-2 and Table 4-3 shows the comparison between EPT and SIGNAL scores and number of macroinvertebrate taxa observed between pre-construction data and post construction data. A column for Pre-construction averages minus 20% has been included to specifically address performance targets/indicators. Furthermore, a PASS/FAIL column has been added. PASS: Signal Scores at all sites passed. No data was recorded for number of taxa site 17 pre-construction which means no comparison can be made.

Measure	Performance criteria	Performance target	Comment
			FAIL: Thee sites (16, 22, Control Site 1) had average EPT scores which had decreased by more than 20% since pre-construction. EPT scores passed for treatment sites 13, 17, 25, and 27 between pre and post construction. That is, the EPT score either increased since, or decreased by less than 20% of the pre-construction recordings. As a decrease in average EPT scores was recorded at Control Site 1, this indicates that decreases observed at treatment sites are unlikely to be related to the construction of the bypass. PASS: Average number of taxa at all sites passed.
	Native fish species diversity maintained	Fish species diversity is maintained at preconstruction data levels, or increases during the life of the monitoring program. Any decrease in fish species diversity does not exceed 20% difference when compared to preconstruction data levels.	A small number of fish (7) were collected/observed from three (3) common fish species throughout 2019. Species diversity was four (4) during pre-construction monitoring. FAIL: There is a 25% difference in species diversity for 2019 when compared to pre-construction data, however fyke nets were no longer used in 2019 for ethical reasons; the risks to fauna, primarily the platypus were too high despite the implementation of safeguards. The change in technique is a likely cause for this reduction, and not a true reflection of fish diversity when compared to previous years.

4.3. WEED MONITORING

4.3.1. Comparison with 2018 Monitoring

The 2019 annual weed monitoring identified a total of 39 weed species across the 49 survey locations, including 35 environmental weeds, and four (4) species listed as Priority Weeds for the South-East region under the Biosecurity Act. An additional eight (8) environmental weed species were identified in 2019 that were not recorded in 2017 or 2018 (red in Table 4-4). Three species observed in 2017 and/or 2018 were not recorded in 2019 (blue in Table 4-4).

Average cover abundance in 2019 was 2.74 compared to 2.78 in 2018, which indicates the spread of weeds has been controlled, but weed abundance has not been greatly reduced.

Table 4-5 Priority weeds and environmental weed species recorded in the project area: 2017-2019 comparison

Weed Species	Common name	Weed listing	Detected during 2017 surveys	Detected during 2018 surveys	Detected during 2019 surveys
Ageratina adenophora	Crofton Weed	Environmental	X	X	X
Andropogon virginicus	Whiskey Grass	Environmental	X	X	X
Araujia sericifera	Moth Vine	Environmental		X	X
Aster subulatus	Wild Aster	Environmental	X		
Avena fatua	Wild Oats	Environmental	X		X
Bidens pilosa	Cobbler's Pegs	Environmental	X	X	X
Brassica oleracea	Mustard	Environmental		X	X
Briza maxima	Quaking Grass	Environmental			X
Cenchrus clandestinus	Kikuyu Grass	Environmental	X	X	X
Centaurea melitensis	Maltese star-thistle	Environmental			X
Cirsium vulgare	Spear Thistle	Environmental	X	X	X
Conyza bonariensis	Fleabane	Environmental	X	X	X
Cynodon dactylon	Common Couch	Environmental			X
Cyperus eragrostis	Tall flatsedge	Environmental		X	X
Erythrina x sykesii	Coral Tree	Environmental	X		X
Foeniculum vulgare	Fennel	Environmental	X	X	X
Gomphocarpus physocarpus	Cottonbush	Environmental			X
Grevillea robusta	Silky Oak	Environmental		X	X
Hypochaeris radicata	Cat's Ear	Environmental			X
Lantana camara	Lantana	Priority Weed	X	X	X

Weed Species	Common name	Weed listing	Detected during 2017 surveys	Detected during 2018 surveys	Detected during 2019 surveys
Ligustrum lucidum	Large-leaved Privet	Environmental		X	
Ligustrum sinense	Small-leaved Privet	Environmental	X	X	X
Malva parviflora	Mallow	Environmental		X	X
Medicago sativa	Alfalfa	Environmental			X
Morus alba	White Mulberry	Environmental			X
Paspalum dilatatum	Paspalum	Environmental	X	X	X
Phalaris aquatica	Phalaris	Environmental			X
Phytolacca octandra	Inkweed	Environmental	X	X	X
Plantago lanceolata	Plantain	Environmental	X		X
Rubus fruticosus	Blackberry	Priority Weed	X	X	X
Rumex crispus	Curly Dock	Environmental	X	X	X
Senecio madagascariensis	Fireweed	Priority Weed	X	X	X
Setaria parviflora	Pigeon Grass	Environmental		X	X
Sida rhombifolia	Paddy's Lucerne	Environmental	X	X	X
Solanum mauritianum	Wild Tobacco	Environmental	X	X	X
Solanum nigrum	Deadly Nightshade	Environmental	X	X	X
Sonchus oleraceus	Sow Thistle	Environmental	X	X	X
Sporobolus fertilis	Giant Paramatta Grass	Priority Weed	X	X	X
Tagetes minuta	Stinking Roger	Environmental	X	X	X
Taraxacum officinale	Dandelion	Environmental	X	X	
Trifolium pratense	Pink Clover	Environmental	X		
Trifolium repens	White Clover	Environmental	X	X	X
Verbena bonariensis	Verbena	Environmental	X	X	X
Xanthium occidentale	Nagoora burr	Environmental		X	

Priority Weed- Listed as a Priority weed under the Biosecurity Act 2015 for the South-east region.
Environmental – Environmental weeds.
Blue shaded – Species present in 2017, absent in 2018 and/or 2019.
Red shaded – Species absent in 2017 and 2018, present in 2019.

There were no new Priority Weeds detected during 2019. Fireweed is the most prevalent priority weed, but it has been detected at fewer sites in 2019 compared to previous years; 42 sites in 2019 compared to 44 sites in 2018 (Figure 4-3). There has also been a decrease in average relative abundance of Fireweed across the project alignment (according to modified Braun-Blanquet) from 2.95 in 2018 to 2.17 in 2019 (Figure 4-4). An increase in both spread and abundance in Blackberry was found. Blackberry was observed at eight (8) sites in 2019 and seven (7) sites in the 2018 survey; and raised from an average relative abundance of 2.14 in 2018 to 2.5 in 2019. Similarly, Lantana increased in both abundance and spread, being observed in 18 sites in 2019 compared to 17 in 2018; and increased from an average relative abundance of 2.94 in 2018 to 3.06 in 2019. As Blackberry and Lantana are both dense monoculture species and are highly prevalent in the project's surrounds, spread amongst the project alignment is expected without appropriate control. Giant Parramatta Grass was observed at just one (1) site in this years' survey, compared to two (2) sites in 2018, with abundance also decreasing from 2.5 in 2018 to 1 in 2019. See Figure 4-3 and Figure 4-4 below.

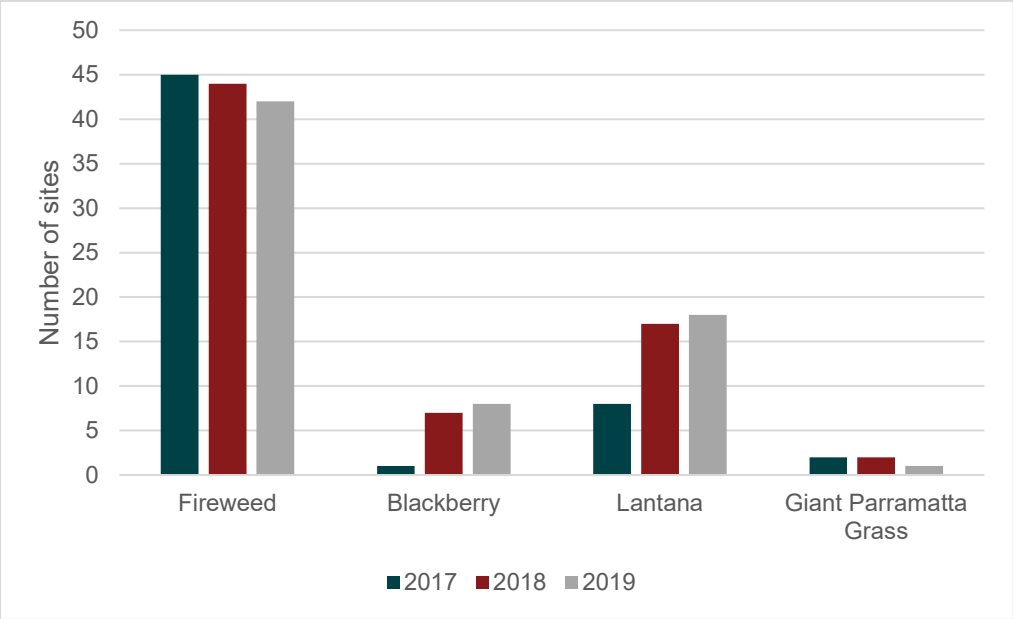

Figure 4-3 Priority weed occurrence 2017-2019

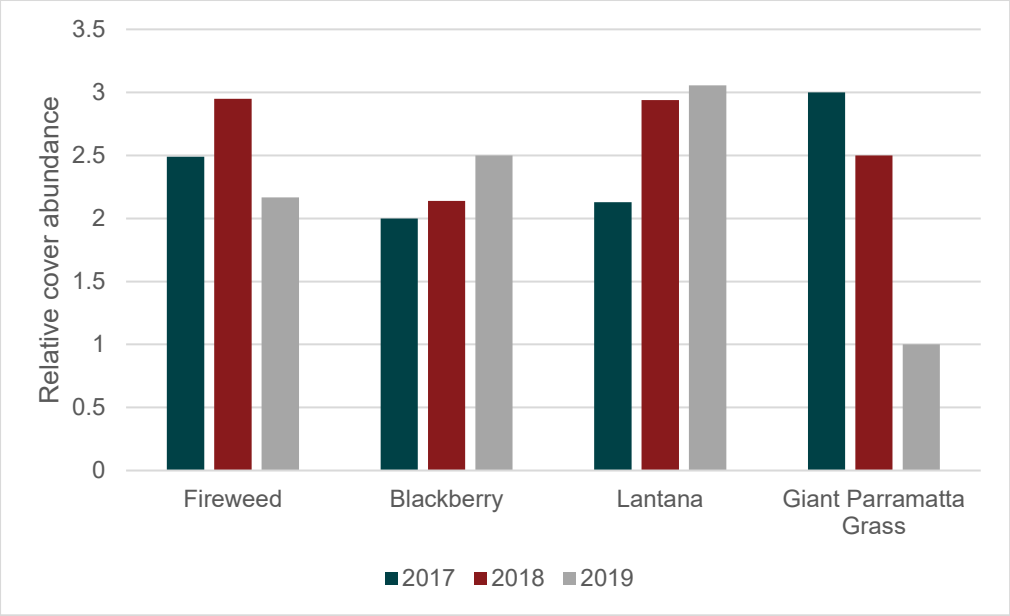

Figure 4-4 Priority Weeds relative cover abundance 2017 - 2019 comparison

Kikuyu and Paspalum were the most prevalent environmental weeds, observed in 45 and 43 sites respectively.

The 2019 survey recorded an average relative abundance of 4.82 for Kikuyu, compared to 4.59 in 2018. There was a reduction in Paspalum with a relative abundance of 3.84 in 2019 compared to 4.06 in 2018. Although we have observed little change in the spread and abundance of these two species, they can act as a good mechanism to supress other more invasive weed species.

Appendix A provides photographic comparisons between the 2018 and 2019 surveys.

4.3.2. Weed Monitoring- Performance Criteria Comparison

Table 4-6 Performance Criteria Comparison

Measure	Performance Criteria	Performance Target	2018 Assessment	2019 Assessment
Weed management	No evidence of weed invasion or spread to adjacent areas	No new weed species become problematic within 12 months post-construction	There has been an overall increase in the abundance and cover of weed species compared to the 2017 survey. There were an additional eight species identified in the project alignment. None of these weeds should be considered problematic as they are common environmental weeds. Areas with prevalent weed cover are those that have been highly disturbed and have limited revegetation successes. Mid storey species establishment has overall been a success, however grass and herbaceous weeds have colonised many areas. Two of the four priority weeds identified have spread to new areas. Weed control measures are recommended immediately to stop these weeds from spreading to more areas. Fireweed remains the most prevalent weed issue across the project alignment as it has been recorded as being widespread throughout the alignment. Fireweed is a Priority Weed for the South-east region under the Biosecurity Act. Fireweed is difficult to control due to its widespread presence in private lands surrounding the project alignment, placing more of an emphasis on control of spread to new areas than eradication.	There has been an increase in weed species diversity compared to previous years. An additional eight species were identified in the project alignment in 2019. None of these weeds should be considered problematic as they are common environmental weeds. Areas with prevalent weed cover are those that have been highly disturbed and have limited revegetation activities (e.g. roadsides). Mid storey species establishment has overall been a success, however grass and herbaceous weeds have colonised many areas. Two of the four priority weeds identified have spread to new areas since 2018; Blackberry and Lantana. Weed control measures are recommended immediately to stop these weeds from spreading to more areas. Fireweed remains the most prevalent weed issue across the project alignment. Despite a small decline in distribution and abundance, it is widespread throughout the alignment. Fireweed is a Priority Weed for the South-east region under the Biosecurity Act. Fireweed is difficult to control due to its widespread presence in private lands surrounding the project alignment, placing more of an emphasis on control of spread to new areas than eradication.

5. REVIEW OF MITIGATION MEASURES

5.1. ECOLOGICAL MONITORING

According to the results of ecological monitoring, only one mitigation measure is not meeting the performance criteria; twelve reptile species were recorded during pre-construction transect surveys, with seven reptile species in 2018 and eight reptile species during 2019. This is a 50% (2018) and 43% (2019) decrease in reptile diversity when compared to pre-construction monitoring. Survey weather conditions and an increase in predation may be factors. Further monitoring may detect additional species, but monitoring and potentially managing fox populations in the locality should be considered.

Road kill rates above the performance target were evident in 2018, but NGH Consulting was not contracted to undertake road kill monitoring in 2019.

5.2. AQUATIC MONITORING

The EcMP and the CFFMP, including the Weed Management Plan, include a number of mitigation measures and actions from the environmental assessment and Statement of Commitments to be undertaken to avoid and/or minimise water quality and aquatic biodiversity impacts during construction. These are detailed in Table 4-1 along with notes on whether these have been implemented.

Table 5-1 Mitigation measures

Mitigation measure	Implementation
EcMP	
Consider lopping or relocation of large woody debris in streams as a first priority before removal. Should removal of large woody debris be necessary, consider the introduction of engineered woody debris as compensation within the offset strategy for residual impacts.	Cut stump methodology has been used to retain root balls in situ around waterways. Coarse woody debris has been salvaged and has been re-introduced to the project during stream rehabilitation works.
Consult with the DPI (Fishing and Aquaculture) for input in relation to matters relevant to Fisheries, where appropriate	DPI and Fisheries attended the project four times in 2015 and on at least three occasions in 2016. They have also been consulted periodically via email and on the telephone for all creek works.
Where feasible use low hollow-core bridges or short lengths of pipe culverts for temporary crossings to maintain fish passage with reference to guidelines for the design and construction of waterway crossings to maintain fish passage.	Fish passage in the major creeks of the project has been maintained through the construction of temporary bridges. These bridges allow for full connectivity of upstream and downstream flows and have been installed at; Broughton Creek 1, Broughton Creek 2, Broughton Mill Creek, The other main creek on the project Bundewallah Creek had piped culverts installed below the waterline so passage for

Mitigation measure	Implementation
	fish is maintained. This crossing was approved by NSW DPI Fisheries. All other waterways on the project are ephemeral.
Manage weeds where identified	Weed management is ongoing across the site in accordance with the CFFMP and relevant legislation. In 2019 aquatic monitoring Site 13 showed evidence of midstorey weed removal along the riparian zone. Weed removal at other aquatic sites was not apparent.
Minimise impacts to water quality during operation of the project through the combination of swales, water quality basins and biofiltration.	The operational design includes the following water quality features: • Basins • Bioswales • Vegetated swales • Hard rock scour protection The effectiveness of these design features can be assessed during the operational phase of the project.
Implement erosion and scour protection in the design and construction of bridges and culverts. Manage erosion and sedimentation impacts and conduct surface water quality monitoring during construction of the project to monitor water quality	A PESCP has been prepared and implemented across the site. EWMS's have been prepared and implemented during works within and adjacent to waterways. All bridge structures have scour protection designed around them. Surface water quality monitoring completed throughout 2019 did not show any impacts on the receiving waterways which can be attributed to the operation of the bypass.
Design transverse drainage structures to allow unrestricted passage of most natural flows and allow for changes in the natural flow regime as a result of climate change. This would be achieved by designing bridges and culverts to provide flood immunity from the 100 year flood event and the 50 year flood event respectively.	This has been completed and is included in the design at Broughton Creek, Bundewallah Creek and Broughton Mill creek.
In areas close to or upstream from sensitive receiving waters, implement additional treatment measures to ensure no net increase in pollutant load from road runoff.	Pollution control basins and attenuation swales have been designed to manage long term road runoff pollutants.
Conduct regular water quality monitoring in accordance with the Foxground and Berry Bypass Water Quality Monitoring Program (GHD, 2014).	Ongoing. Monitoring completed to date.
Conduct aquatic ecology monitoring during the pre-construction, construction and operational periods.	Ongoing. Monitoring completed to date.
Periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the	Ongoing. Refer to this annual report and the 2015, 2016, 2017 and 2018 annual reports.

Mitigation measure	Implementation
monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity.	
CFFMP	
Periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity.	Additional controls will be put in place where monitoring shows they are required. Current results at this stage indicate that continued weed control is necessary.
Retain stumps in riparian zones and aquatic habitats where practicable to reduce the potential for bank erosion. Even dead stumps and root systems may act to reduce erosion during construction and operation periods.	Cut stump clearing has been undertaken across the project within 5 m of waterways as a minimum.
Subject to consultation with NOW and DPI (Fishing and Aquaculture), utilise trees removed as a consequence of the project for fish habitat and bank stability within the creeks of the project area.	Coarse woody debris has been salvaged and has been re-introduced to the project as part of the creek rehabilitation works. Riparian rehabilitation was carried out in consultation with DPI (fisheries) and NSW Office of Water.
For temporary water crossings over all Class 1 and 2 waterways install temporary bridge structures instead of box culverts to reduce the potential for scouring.	Temporary bridge structures were installed over Broughton Creek crossing one and two, and Broughton Mill creek.
Follow the relevant EWMS and PESCP for the construction of all temporary bridges to minimise the potential of erosion and sedimentation impacts.	Adhered to.
Locate all refuelling areas at least 50 metres away from waterways.	Refuelling of mobile plant was undertaken more than 50 m from a waterway. Cranes, pilling rigs and other less mobile plant was refuelled closer than 50 m to the waterway in accordance with the Fulton Hogan refuelling procedure.
Progressively revegetate batters and other disturbed areas with cover crop species to stabilise the soil and provide vegetation cover as a method to minimise sedimentation of waterways and impacts on fish. Use Rye Corn during the months of April to August or Japanese Millet during the months of September to March. Also refer to the UDLP where necessary.	Cover crops were applied to temporarily stabilise batters, design seed was applied as efficiently as construction allowed in all areas.

5.3. WEED MONITORING

There is one mitigation measure for Weed Management which states that there should be 'no evidence of weed invasion or spread to adjacent areas'. There has been an increase in weed species diversity since 2017. This mitigation measure has not been met, however during construction areas were stripped of vegetation, and continue to recolonise. Average weed cover abundance recorded across all sites in 2019 was 2.74 compared with 2.76 in 2018, which indicates little change. There were no new

priority weed species in 2019, and a decrease in Fireweed and Giant Parramatta Grass abundance. An increase in the distribution and abundance of Blackberry and Lantana is problematic.

6. RECOMMENDATIONS

6.1. ECOLOGICAL MONITORING

The CoA require the development of potential contingency measures that would be implemented if circumstances arise where there are changes in habitat usage patterns as a result of the construction or operation phase of the Project, or where performance criteria are not met.

Table 6-1 and Table 6-2 below provide a list of mitigation and contingency measures in response to the performance criteria results and in accordance with Section 5 of the EcMP.

Table 6-1 Mitigation measures and contingency measures

Area of concern	Recommendation/Mitigation Measure
Roadkill rates – fauna fencing	• A fauna fence assessment should be conducted along the project alignment, to assess the current level of damage to fauna fences, and determine if installation of new areas of fauna fencing is feasible. This assessment should also assess whether the installation of fauna escape features is feasible in fenced areas • Restore damaged fauna fencing • Replace severely damaged fauna fencing • Where feasible, install fauna fencing in areas where roadkill hotspots are high, and no fence is present. Installation areas should focus on the terrestrial roadkill hotspots identified in Section 4.1.1 and within figures 3-2 to 3-11

Roadkill rates - Landscape Maintenance	• Plant non-preferred clumping species or non-desirable species to reduce grazing potential for macropods near the roadside in areas with no fencing. Examples include:
	  • Spiny-head Mat-rush *Lomandra longifolia*
	  • Coastal Rosemary *Westringia fruticosa*
	• Mowing these areas will also reduce habitat for small rodents and reptiles, reducing the foraging habitat for birds of prey and owls.
	• Supplement the loss of foraging habitat by implementing Weed Management recommendations by creating more suitable locations for foraging further from the road.
	• Control fruit-bearing vegetation which may attract birds/Flying Foxes adjacent to the road.

Reptile species diversity	• Reptile species diversity continue to be reduced. Recommend implementing additional shelter structures in proximity to crossings. Fox control (baiting) is also recommended.

Two additional recommendations not triggered by the EcMP criteria are provided below.

Table 6-2 Additional measures

Area of concern	Recommendation/Mitigation Measure
Rope Bridges	Although data suggests that some rope bridges are being used by Ringtail Possums and roosting birds, there appears to be a lack of use by other mammals. The areas surrounding crossing structures would

Area of concern	Recommendation/Mitigation Measure
	benefit from additional vegetation. It is understood that replanting has been undertaken around these, thus additional time will be required before surrounding vegetation grows to the height of crossing structures.
Underpasses/ underpass bridges Wooden structures have been installed without connecting ropes	The areas surrounding crossing structures would benefit from additional vegetation. Ensure adequate connectivity of underpass structures to surrounding vegetation to enable use by fauna. It is understood that some revegetation has taken place surrounding structures, and this will take time to grow to a height useable by fauna. It will also enhance safety for native fauna to cross given the presence of exotic predators.

6.2. AQUATIC MONITORING

The safeguards detailed below should continue to be implemented. Additionally, regular and systematic aquatic weed control should commence immediately across all sites. Please refer to the below guidelines.

Mitigation Measure	Implementation
Control aquatic weeds in riparian zones and aquatic habitats to prevent further spread.	Undertake aquatic weed management in accordance with the DPI guidelines (2008; 2018) and the 2018 FBB Weed Monitoring Report recommendations, across the project. This includes: • Mechanically or physically removing plants when they first appear; • Treating any remnants with spot applications of a recommended herbicide; • Diverting nutrient run off away from the riparian zones as nutrient rich waters encourage aquatic weed growth; • Plant trees to shade the riparian zones and reduce available light to the weeds; • Use biological control agents if they are available and are suitable to the particular situation; • Strategic placement of barriers or booms to contain the weeds and to prevent them from spreading; • Continual weed monitoring of the sites.

Monitoring should continue in accordance with the Ecological monitoring program, total of three years post-construction (Parsons Brinkerhoff 2014).

6.3. WEED MONITORING

The 2019 weed monitoring recorded a slight decrease in average weed cover across all sites, which indicates that the spread of weeds has been controlled. However, an increase in weed species diversity in 2019 indicates that ongoing weed control remains a priority.

The following sites provide examples where revegetation attempts have been effective in the suppression of weed abundance and diversity across the project alignment:

- 5 – mid-storey revegetation has improved at this site since 2018
- 9 – mid-storey revegetation has improved at this site since 2018
- 15- mid-storey revegetation has improved at this site since 2018
- 32 – landscape plantings in this area have improved considerably since 2018 and are providing a good suppressant for weed establishment and spread
- 33 - landscape plantings in this area have improved considerably since 2018 and are providing a good suppressant for weed establishment and spread
- 40 - landscape plantings in this area are moderately to well established, and continue to provide a good suppressant for weed establishment and spread
- 43– landscape plantings in this area are moderately to well established, and continue to provide a good suppressant for weed establishment and spread
- 44 - landscape plantings in this area are moderately to well established, and continue to provide a good suppressant for weed establishment and spread

The overall revegetation attempts were not wholly successful, with empty tubes, stakes and mats with dead plant were observed in some areas. The LMP states that all dead or dying plant material would be removed during maintenance activities. Furthermore, that replacement planting would be conducted in failed or damaged plantings. It is important to note that species selection in revegetation attempts can considerably affect the success rate. Revegetation attempts should continue to further aid the prevention of spread and invasion of weed species. The TfNSW Landscape Officer should look at maintenance work records to ensure works are being completed and in accordance to the timeframes agreed upon in the LMP.

Suppression of Fireweed and other priority weeds is an ongoing issue. As Fireweed occurs throughout most of the project area and in the presence of various other weeds, targeted control measures are not yet required. Fireweed should be treated as routine weed control and conducted in all areas. Blackberry and Lantana have larger ecological impacts and should be controlled immediately across sites where present. TfNSW should consider engaging with land owners in the project surrounds to assist in overall weed control as they too have a General Biosecurity Duty under the Biosecurity Act 2015.

Areas of concern:

- 9 – Although mid storey revegetation attempts have been successful in this area, it is recommended that immediate weed control is conducted to reduce this risk of exotic vines suffocating native mid storey.
- 12 – Area was previously dominated by exotic grasses, now dominated by exotic thistles and mid storey species. Immediate weed control recommended to prevent the spread of these weeds. If left untreated, it poses a risk of invasion and establishment in other areas within the alignment.
- 13 - An area impacted by runoff. This area contained a large diversity of weeds. Immediate control is recommended for this area to reduce the risk of spread to neighbouring sites.
- 19 – An area on the fringe of wet sclerophyll forest and landscape grasses. It contains large native trees and is also a possum rope bridge access point. It is recommended that immediate weed control is implemented in this area; primarily on *L. camara* and

perennial grasses to better utilise the habitat available for possums, gliders, and birds. Native revegetation may assist in weed suppression.

- 35 – Revegetation attempts are yet to be successful in this area. More revegetation attempts are recommended. Due to the location in the landscape, ground covers including rushes and grasses are recommended to avoid line of sight issues for vehicles. These will also help supress exotic weeds from establishing and spreading.
- 36 – Although revegetation attempts with the mid storey have been effective in some part. Exotic groundcovers, and vines are becoming more prevalent in the area. Immediate weed control is recommended in this area to avoid the suffocation of native mid storey by exotic vines.

The hierarchy of weed control: Prevention, Eradication, Control, Asset protection; can be used as a guide to control infestations. As priority weeds are already present and are spread throughout multiple sites, controlling the spread of these species and invasion into other areas is the main mitigation method. Targeting these species during routine weed control in addition to educating weed control officers on these species will assist in their suppression. Avoiding their establishment in new areas is paramount in controlling them throughout the project alignment.

7. REFERENCES

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APPENDIX A WEED MONITORING PHOTO COMPARSION 2018/2019

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
15	297055	6152294	North of Toolijooa Rd	Batter		
14	296835	6152244	Near turn around bay south of Toolijooa Rd	Construction area, with bare soil areas		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
16	296799	615239	South of Toolijooa Rd	Roadside area		
17	296675	6152401	South of Toolijooa Rd	Roadside batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
18	296523	6152549	South of Toolijooa Rd	Roadside batter		
19	296251	6152744	Between BC1 and Toolijooa Rd	Roadside embankment		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
20	296157	6152704	Between BC1 and Toolijooa Rd	Access track between Toolijooa Rd and BC1		
21	29593	6152819	Between BC1 and Toolijooa Rd	Top of cut		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
22	295486	6152939	Between BC1 and Toolijooa Rd	Light vehicle track		
24	295121	6152887	BC1	Adjacent to compound		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
31	295126	6152978	BC1	Roadside batter		
25	294923	6152794	BC1	BC1		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
26	294695	6152708	Between BC1 and BC2	Road side		
27	294623	6152587	Between BC1 and BC2	Road side		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
30	294583	6152452	Between BC1 and BC2	Road side		
28	294296	6152021	Between BC2 and BC3	Road side		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
29	294250	6151865	Between BC2 and BC3	Road side		
32	294059	6151679	Between Austral Park compound and BC3	Access track		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
33	293916	6151611	Between Austral Park compound and BC3	Batter		
34	293975	6151579	Between Austral Park compound and BC3	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
35	293661	6151517	Between Austral Park compound and BC3	Batter		
36	293699	6151420	Between Austral Park compound and BC3	Batter		

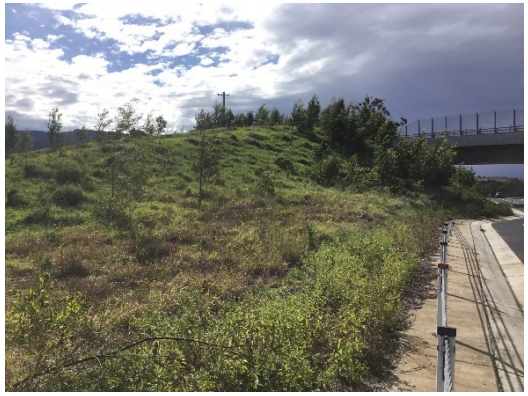
Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
37	293391	6151342	Between Austral Park compound and BC3	Batter		
13	293197	6151331	Austral Park	Western side Princess Hwy		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
38	293143	6151252	Austral Park	Western side Princess Hwy		
12	293089	6151221	Austral Park	Western side Princess Hwy		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
10	292987	6151220	Austral Park	Western side Princess Hwy		
11	292977	6151168	Austral Park	Soil mound		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
9	292873	6151166	Austral Park	Batter		
8	292746	6151115	Austral Park	Road side		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
7	292355	6150882	Central zone	Road side		
6	291579	6150900	Tindell's Lane	Road side		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
5	291578	6150845	Tindell's Lane	Batter		
4	291320	6150671	Central zone Cut 6	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
3	291317	6150605	Central zone Cut 6	Batter		
2	291251	6150619	Central zone Cut 6	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
1	291130	6150523	Central zone Cut 6	Batter		
0	290920	6150386	Central zone	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
39	290499	6150097	Southern zone	Batter		
41	290384	6150131	Southern zone	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
40	290237	6150006	Southern zone	Embankment		
42	289262	6149761	Southern zone	Batter		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
43	288808	6149755	Southern zone	Batter		
49	288598	6149960	Southern zone	Town Creek Diversion, Rawling's Lane		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
44	288407	6149644	Southern zone	Noise mound		
45	288031	6149263	Southern zone	Roadside		

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
48	287971	6149266	Southern zone	Roadside		
47	287054	6147773	Southern zone	Roadside		Could not survey due to Berry to Bomaderry Construction

Way point	Eastings	Northings	General Location	Site Description	2018 Photograph	2019 Photograph
46	286918	6147524	Southern zone	Roadside		

APPENDIX B MACROPHYTE DATA 2016-2019

Site13 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Ottelia ovalifolia Swamp lily								1								
*Sagittaria platyphylla** Sagittaria								1								
*Colocasia sp.** Elephants ear													1	1	1	1
Lemna disperma Duckweed	1		1	2		1	1									
*Altenanthera philoxeroides** Aligator weed									2							
Cyperus eragrostis												2				2

Site13 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Umbrella Sedge																
Juncus usitatus Common rush												2	2	2	2	2
Persicaria hydropiper Water pepper													2	2		1
Colocasia sp.* Taro													1	1		
*Rorippa nasturtium-aquaticum** Watercress														1	2	
*Rumex crispus** Curly dock															1	

*Exotic

Site 16 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Persicaria hydropiper Water pepper																
Lemna disperma Duckweed		1														
*Sagittaria platyphylla** Sagittaria	1	1	1	2	2	1	1	1					1	2		
*Colocasia sp.** Elephants ear	1	1	1	1	1	1	1	1								
Damasonium minus Starfruit	1	1														
**Rorippa nasturtium-aquaticum* Watercress						1	1	1								

Site 16 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Juncus usitatus Common rush											3	2	1	2		2
**Cyperus eragrostis* Umbrella Sedge												2		1	3	2

*Exotic

Site 17 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Lemna disperma Duckweed			2	3		2										
Juncus usitatus Common rush							1	1				1	2			2
Maidenii rubra Maidenii	1		1	2		1		1								
*Sagittaria platyphylla** Sagittaria									2			1				
*Colocasia sp.** Elephants ear											1	1	1	1	1	1
**Myriophyllum aquaticum* Parrots feather											1					

Site 17 – Broughton Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
**Cyperus eragrostis* Umbrella Sedge												1	2	1		2
*Colocasia sp.** Taro													1	1	1	1
Persicaria hydropiper Water pepper														1		
Cypress gracilis Slender flat sedge															1	1

*Exotic

Site 22 – Bundewallah Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Persicaria hydropiper Water pepper													1	2		
Lemna disperma Duckweed	2	1	2	1		3	1									
Ludwigia peploides Water primrose															1	1
*Rorippa palustris** Marsh watercress		1														
Eleocharis acuta Common Spike Rush																
Vallisneria australis Ribbonweed		1	1	3	1	1	1									

Site 22 – Bundewallah Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
*Nasturtium officinale** Watercress																
Maidenii rubra Maidenii	1		1	1		1										
**Cyperus eragrostis* Umbrella Sedge												4	2	3	3	3
*Alternathera philoxeroides** Alligator weed													1	1		
*Rumex crispus** Curly dock															1	1

*Exotic

Site 25 – Broughton Mill Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Adundance
Ottelia ovalifolia Swamp lily	2	3	2	3	3	2	3	2								
*Sagittaria platyphylla** Sagittaria			2	3	3	3	3	3		3	3	2	2	2	2	2
*Glyceria maxima** Reed sweetgrass																
Potamogeton crispus Curly Pond Weed	3															
**Elodea canadensis* Elodea	3	2	3	5	4	4	2	2		2	2	3	3	3	3	3
Vallisneria australis Ribbonweed			3	2	2	2	2	1								

Site 25 – Broughton Mill Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
*Alternanthera philoxeroides** Alligator weed									2							
Persicaria hydropiper Water pepper															2	2

*Exotic

Site 27 – Bundewallah Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Persicaria despectans Slender knotweed																
Ludwigia peploides Water primrose																1
Lemna disperma Duckweed	1	2	1	2	2	1	1									
Juncus usitatus Common rush															1	
**Rorippa palustris* Marsh Watercress		1														

Site 27 – Bundewallah Creek																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
*Alternanthera philoxeroides** Alligator weed										1	1		1		1	1
Azolla pinnata Mosquito fern											3					
**Cyperus eragrostis* Umbrella Sedge												2				1
Persicaria hydropiper Water pepper													2			2
*Rorippa nasturtium-aquaticum** Watercress														2	1	1
*Rumex crispus** Curly dock																1

*exotic

Control Site 1																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
**Sagittaria platyphylla* Sagittaria	3	1	3	3	3	3	2	1	2	2	2	2	2	2	2	2
Persicaria strigose Knotweed	1	1	1	1	2	2	2	2								
Ottelia ovalifolia Swamp Lily	1	1														
Maidenii rubra Maidenii	1	1	1	1	1	1										
**Myriophyllum aquaticum* Parrots feather	1	1	1	1	1	1	1									
Vallisneria australis Ribbonweed	1	1	1	1	1	1	1	1		2						
Triglochin procerum Water ribbon	1	1														
Eleocharis acuta		3	2	2	2	2	2	1								

Control Site 1																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
Common Spike-rush																
**Elodea canadensis* Elodea									3		2		3	4	4	4
Baumea articulata *Jointed rush*									2		1	2	2		2	2
Persicaria hydropiper Water pepper													3	2	3	3
Cyperus eragrostis Umbrella Sedge														2		

*Exotic

Control Site 2																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
Species	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance	Session 1 Abundance	Session 2 Abundance
**Sagittaria platyphylla* Sagittaria			2	2	2	2	2	1	2	2	1	2	2	1	3	2
Eleocharis acuta Common Spike-rush			1													
Eleocharis sphacelata Tall Spike-rush				2		1	1	1								
**Colocasia sp.* Elephant's Ear				1					2		1				1	1
Ottelia ovalifolia Swamp Lily				3	2		1				1					
Baumea articulata *Jointed rush*									2				2	1	2	2
*Alternanthera philoxeroides** Alligator weed									2							
**Cyperus eragrostis* Umbrella Sedge												2		1		2
Persicaria hydropiper Water pepper													2	1		

Control Site 2																
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017		Autumn 2018		Spring 2018		Autumn 2019		Spring 2019	
*Colocasia sp.** Taro													1	1	1	
*Rorippa nasturtium-aquaticum** Watercress														1	2	1
*Ageratina riparia** Mistflower														1		
*Rumex crispus** Curly dock																1

*Exotic

APPENDIX C AQUATIC FAUNA ASSESSMENT RAW DATA 2016-2019

			2016						2017								2018								2019							
		Taxa	**Site 13**	**Site 16**	**Site 17**	**Site 22**	**Site 25**	**Site 27**	**Site 13**	**Site 16**	**Site 17**	**Site 22**	**Site 25**	**Site 27**	**CS 1**	**CS 2**	**Site 13**	**Site 16**	**Site 17**	**Site 22**	**Site 25**	**Site 27**	**CS 1**	**CS 2**	**Site 13**	**Site 16**	**Site 17**	**Site 22**	**Site 25**	**Site 27**	**CS 1**	**CS 2**
Preconstruction	Spring session 1	*Atherinosoma microstoma* Small-mouthed Hardyhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0																
		Gobiomorphus coxii	0	0	0	0	0	0							0	0																
		Cox's Gudgeon																														
		Hypseleotris galli	0	0	0	0	0	0							0	0																
		Firetail Gudgeon																														
		Macquaria novemaculeata	0	0	0	0	0	0							0	0																

		Australian Bass																																		
	Spring session 2	*Anguilla australis*	0	0	0	0	0	0								0	0																		
		Short-finned Eel																																		
		Atherinosoma microstoma	0	0	0	0	0	0								0	0																		
		Small-mouthed Hardyhead																																		
		Gobiomorphus coxii	0	0	0	0	0	0								0	0																		
		Cox's Gudgeon																																		
		Macquaria novemaculeata	0	0	0	0	0	0								0	0																		
		Australian Bass																																		
Construction	Autumn Session	*Macquaria novemaculeata*	0	0	0	0	3	0								0	0																		

		Australian bass																																		
		Gobiomorphus australis	0	0	1	2	1	1								0	0																		
		Striped gudgeon																																		
		Philypnodon grandiceps	0	0	0	0	0	0								0	0																		
	Autumn Session 2	Flathead gudgeon																																		
		Gobiomorphus australis	0	0	0	0	0	0								0	0																		
		Striped gudgeon																																		
		Macquaria novemaculeata	0	0	0	0	0	0								0	0																		
	Spring session 1	Australian bass																																		
		Gobiomorphus australis	0	0	0	2	0	3								0	0																		

		Striped gudgeon																														
		Philypnodon grandiceps	1	1	0	0	1	0							0	0																
		Flathead gudgeon																														
		Anguilla australis	0	0	0	0	0	1							1	1																
		Short finned eel																														
		Macquaria novemaculeata	0	0	2	0	2	0							1	0																
		Australian bass																														
		Gobiomorphus australis	3	0	1	2	1	1							1	0																
		Striped gudgeon																														
	Spring session 2	*Anguilla australis*	0	0	0	0	0	0							2	0																

		Short finned eel																																
		Gobiomorphus coxii	0	0	0	0	0	0							0	0																		
		Cox's Gudgeon																																
		Philypnodon grandiceps	0	1	1	0	1	0							0	0																		
		Flathead gudgeon																																
		Atherinosoma microstoma	0	0	0	0	0	1							0	0																		
		Small-mouthed Hardyhead																																
Post Construction	Autumn Session 1	Macquaria novemaculeata Australian Bass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0			
		Gobiomorphus coxii Cox's gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0			

		Anguilla australis Short finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
		Philypnodon grandiceps Flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
	Autumn Session 2	Philypnodon grandiceps Flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Anguilla australis Short finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Ornithorhynchus anatinus Platypus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Spring Session 1	Gobiomorphus coxii Cox's gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
		Anguilla australis Short finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

	Spring Session 2	Anguilla australis Short finned eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
		Gobiomorphus coxii Cox's gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
		Philypnodon grandiceps Flathead gudgeon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0

APPENDIX D MACROINVERTEBRATE RAW DATA

Appendix D to be provided in PDF format

APPENDIX E MACROINVERTEBRATE DATA 2014-2018

Table 7-1 Site 13 – Broughton Creek macroinvertebrates

Site13 – Broughton Creek														
	Preconstruction survey[1]		Autumn 2015		Spring 2015		Autumn 2016		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	Approx. 3.3 Severe	Approx. 4.2 Moderate	4.94 Moderate	4.75 Moderate	5.17 Mild	5.66 Mild	5.1 Mild	5.27 Mild	4.89 Moderate	4.49 Moderate	5.04 Mild	5.07 Mild	4.76 Moderate	5.13 Mild
EPT score	8 Fair	4 Poor	8 Fair	6 Poor	8 Fair	9 Fair	9 Fair	9 Fair	9 Fair	11 Fair	6 Poor	8 Fair	8 Fair	5 Poor
Number of taxa	6	6	21	18	25	20	22	24	31	29	23	23	26	23

Note 1 Site 13 during preconstruction was located upstream of 2015 surveys

Note 2 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site13 – Broughton Creek				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	5.09 Mild	3.5 Severe	4.26 Moderate	4.81 Moderate
EPT score	8 Fair	4 Poor	4 Poor	6 Poor
Number of taxa	20	20	12	10

Table 7-2 Site 16 – Broughton Creek macroinvertebrates

Site 16 – Broughton Creek														
	Preconstruction survey		Autumn 2015		Spring 2015		Autumn 2016		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL score[1]	Approx. 4.2 Moderate	Approx. 2.9 Severe	4.47 Moderate	4.99 Moderate	4.66 Moderate	4.55 Moderate	4.84 Moderate	5.30 Mild	4.58 Moderate	4.63 Moderate	5.07 Mild	5.18 Mild	5.37 Mild	4.72 Moderate
EPT score	3 Poor	0 Poor	8 Fair	11 Fair	9 Fair	6 Poor	8 Fair	9 Fair	11 Fair	9 Fair	8 Fair	8 Fair	8 Fair	6 Poor
Number of taxa	8	4	20	22	30	15	16	24	37	26	28	26	17	19

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site16 – Broughton Creek				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	4.43 Moderate	5.39 Mild	4.61 Moderate	4.42 Moderate
EPT score	9 Fair	9 Fair	7 Fair	8 Fair
Number of taxa	24	24	20	21

Table 7-3 Site 17 – Broughton Creek macroinvertebrates

Site 17 – Broughton Creek														
	Preconstruction survey		Autumn 2015		Spring 2015		Autumn 2016		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL score[1]	N/A	Approx.2.9 Severe	NA	5.28 Mild	4.88 Moderate	4.74 Moderate	4.96 Moderate	5.08 Mild	4.88 Moderate	4.24 Moderate	5.03 Mild	5.43 Mild	4.76 Moderate	4.86 Moderate
EPT score	N/A	7 Fair	NA	8 Fair	10 Fair	6 Poor	9 Fair	8 Fair	8 Fair	10 Fair	7 Fair	9 Fair	6 Poor	5 Poor
Number of taxa	N/A	N/A	NA	16	29	19	23	20	31	28	21	21	18	23

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site17 – Broughton Creek				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	4.18 Moderate	4.39 Moderate	4.11 Moderate	4.15 Moderate
EPT score	7 Fair	6 Poor	5 Poor	5 Poor
Number of taxa	25	17	23	19

Table 7-4 Site 22 – Bundewallah Creek macroinvertebrates

Site 22 – Bundewallah Creek														
	Preconstruction survey		Autumn 2015		Spring 2015		Autumn 2016		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL score[1]	Approx. 4.2 Moderate	Approx. 3 Severe	4.64 Moderate	4.26 Moderate	4.44 Moderate	3.71 Severe	5.27 Mild	4.23 Moderate	4.49 Moderate	3.63 Severe	4.05 Moderate	4.27 Moderate	3.82 Severe	3.11 Severe
EPT score	2 Poor	4 Poor	7 Fair	6 Poor	6 Poor	6 Poor	6 Poor	8 Fair	6 Poor	1 Poor	7 Fair	7 Fair	4 Poor	4 Poor
Number of taxa	4	8	24	17	27	17	21	25	28	10	23	22	17	17

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site22 – Bundewallah Creek				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	4.32 Moderate	3.83 Severe	3.08 Severe	3.06 Severe
EPT score	4 Poor	4 Poor	1 Poor	2 Poor
Number of taxa	19	21	6	17

Table 7-5 Site 25 – Broughton Mill Creek macroinvertebrates

Site 25 – Broughton Mill Creek							
	Preconstruction survey[1]	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016	Autumn 2017	Spring 2017

Site 25 – Broughton Mill Creek														
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	Approx. 3.5 Severe	Approx. 3.3 Severe	4.46 Moderate	4.93 Moderate	4.70 Moderate	3.57 Severe	4.96 Moderate	5.03 Mild	4.88 Moderate	4.53 Moderate	4.93 Moderate	5.19 Mild	4.05 Moderate	4.01 Moderate
EPT score	4 Poor	1 Poor	7 Fair	8 Fair	8 Fair	5 Poor	6 Poor	10 Fair	10 Fair	10 Fair	8 Fair	12 Fair	7 Fair	3 Poor
Number of taxa	13	4	22	22	25	20	15	28	33	31	29	32	28	24

Note 1 Site 25 during preconstruction was located upstream of 2015 surveys

Note 2 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site25 – Broughton Mill Creek				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	5.02 Mild	3.77 severe	5.24 Mild	4.8 Poor
EPT score	7 Fair	5 Poor	4 Poor	3 Poor
Number of taxa	28	14	15	17

Table 7-6 Site 27 – Bundewallah Creek macroinvertebrates

Site 27 – Bundewallah Creek							
	Preconstruction survey	Autumn 2015	Spring 2015	Autumn 2016	Spring 2016	Autumn 2017	Spring 2017

Site 27 – Bundewallah Creek														
	Session 1	**Session 2**	**Session 1**	**Session 2**	**Session 1**	**Session 2**	**Session 1**	**Session 2**	**Session 1**	**Session 2**	**Session 1**	**Session 2**	**Session 1**	**Session 2**
SIGNAL score[1]	Approx. 3.6 Severe	Approx. 2.9 Severe	4.96 Moderate	4.98 Moderate	4.79 Moderate	4.75 Moderate	4.98 Moderate	4.64 Moderate	4.63 Moderate	3.32 Severe	5.07 Mild	5.54 Mild	4.51 Moderate	4.61 Moderate
EPT score	2 Poor	0 Poor	9 Fair	8 Fair	9 Fair	6 Poor	5 Poor	9 Fair	8 Fair	3 Poor	9 Fair	10 Fair	6 Poor	5 Poor
Number of taxa	7	4	25	20	25	17	18	28	27	18	31	25	20	26

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores. 2015 results are SIGNAL scores

Site 27 – Bundewallah Creek				
	Autumn 2018		**Spring 2018**	
	Session 1	**Session 2**	**Session 1**	**Session 2**
SIGNAL score[2]	4.78 Moderate	4.10 Moderate	4.75 Moderate	4.22 Moderate
EPT score	7 Fair	3 Poor	1 Poor	3 Poor
Number of taxa	32	15	16	18

Table 7-7 Control Site 1 macroinvertebrates

Control Site 1								
	Autumn 2016		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2[2]	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL 2 score[1]	4.9 Moderate	5.67 Mild	4.95 Moderate	4.55 Moderate	4.63 Moderate	5.46 Mild	4.44 Moderate	4.71 Moderate
EPT score	3 Poor	7 Fair	10 Fair	9 Fair	6 Poor	11 Fair	7 Fair	6 Poor
Number of taxa	6	27	37	33	27	28	28	20

Note 1 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores

Control Site 1				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	4.08 Moderate	4.13 Moderate	4.11 Moderate	3.91 Severe
EPT score	2 Poor	4 Poor	4 Poor	3 Poor
Number of taxa	20	21	20	19

Table 7-8 Control Site 2 macroinvertebrates

Control Site 2								
	Autumn 2016[2]		Spring 2016		Autumn 2017		Spring 2017	
	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2	Session 1	Session 2
SIGNAL 2 score[1]	N/A	N/A	4.7 Moderate	4.3 Moderate	4.74 Moderate	5.25 Mild	5.03 Mild	4.56 Moderate
EPT score	N/A	N/A	8 Fair	9 Fair	8 Fair	8 Fair	8 Fair	5 Poor
Number of taxa	N/A	N/A	32	29	25	28	23	23

Note 1 Preconstruction, 2016 and 2017 results are SIGNAL2 scores

Note 2 Access to Control Site 2 was not granted until Spring 2016

Control Site 2				
	Autumn 2018		Spring 2018	
	Session 1	Session 2	Session 1	Session 2
SIGNAL score[2]	4.71 Moderate	4.19 Moderate	4.52 Moderate	4.58 Moderate
EPT score	6 Poor	4 Poor	7 Fair	5 Poor
Number of taxa	25	12	17	12

APPENDIX F AQUATIC MONITORING PHOTOS 2019

Appendix F to be provided in PDF.

Site 13

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Site 16

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Site 17

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Site 22

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Site 25

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Site 27

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Control Site 1

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2

Control Site 2

Autumn Session 1

Autumn Session 2

Spring Session 1

Spring Session 2