Woolgoolga to Ballina Pacific Highway upgrade

Construction and Operational Monitoring of In-situ Threatened Flora Species (non-rainforest)

Annual Report 2019

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In-situ Threatened Flora (non-rainforest flora) Annual Monitoring Report 2019

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Transport for NSW

Pacific Complete

Woolgoolga to Ballina Pacific Highway Upgrade

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Contents

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The sole purpose of this report and the associated services performed by Jacobs is to provide the results of flora monitoring for Transport for NSW in accordance with the scope of services set out in the contract between Jacobs and Transport for NSW. That scope of services, as described in this report, was developed with Transport for NSW and Pacific Complete.

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1. Introduction

1.1 Background and objectives

As part of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project, a Threatened Flora Management Plan (TFMP) was developed to meet approval of the NSW condition requirements of MCoA D8 and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Condition of Approval (CoA) 12. The TFMP identified potential impacts to threatened flora species listed under the EPBC Act and formerly under the Threatened Species Conservation Act 1995, now the Biodiversity Conservation Act 2016 (BC Act). Threatened plant species are being managed in two ways, 1) by the protection, monitoring and management of plants that remain in-situ adjacent to the W2B upgrade, and 2) by the translocation, monitoring and management of plants that are located within the road construction footprint. This report addresses the monitoring requirements for in-situ threatened plant species.

The in-situ threatened plant monitoring program documented in the TFMP outlines the methods and timing for targeted surveys of threatened plant species that are located in proximity to the project. The program aims to identify potential direct and indirect impacts during construction and the early stages of operation of the project by monitoring the performance of mitigation measures against management goals and implementing required corrective actions for adaptive management of the program.

The program commenced during the pre-construction phase in which (baseline) data was collected for a series of impact and control plots for each threatened species. Impact and control plots were monitored in the first year of construction in 2017 from two monitoring events for section 1 to 2 and four quarterly monitoring events (Q1-Q4) for sections 3 to 10 of the W2B upgrade (Jacobs 2018). Monitoring in 2018 was done in two (biannual) events in autumn and spring. This report outlines the methods, results and assessment of performance measures for the third year of construction in 2019. Monitoring during year 3 was conducted in a single spring event consistent with the program provided in the TFMP.

The report provides discussion on avoiding and minimising impacts to threatened plant species with reference to the goals in the TFMP. Suggestions for adaptive management and corrective actions is also provided where deemed to be required.

The in-situ threatened flora monitoring program is specific to 20 threatened plant species, these are listed in Table 1-1 along with their status and relevant project section.

Table 1-1 Threatened flora species targeted in the construction monitoring

Species	Common Name	Status		Project section for monitoring
		EPBC Act	BC Act	
Angophora robur	Sandstone Rough Barked Apple	V	V	3
Arthraxon hispidus	Hairy Joint Grass	V	V	8, 9, 10
Cyperus aquatilis	Water Nutgrass	-	E	1, 2, 3, 6, 7
Eleocharis tetraquetra	Square-stemmed Spike-rush	-	E	1, 2, 3
Endiandra muelleri subsp. bracteata	Green-leaved Rose Walnut	-	E	4
Eucalyptus tetrapleura	Square-fruited Ironbark	V	V	2
Grevillea quadricauda	Four-tailed Grevillea	V	V	3
Lindernia alsinoides	-	-	E	1, 2, 3
Lindsaea incisa	Slender Screw Fern	-	E	1, 2, 3, 6
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V	7, 8

Species	Common Name	Status		Project section for monitoring
		EPBC Act	BC Act	
Maundia triglochinoides	-	-	V	1, 2, 3, 6, 7
Melaleuca irbyana	Weeping Paperbark	-	E	7
Oberonia complanata	-	-	E	8
Oberonia titania	-	-	V	10
Persicaria elatior	Tall Knotweed	V	V	4, 5
Prostanthera cineolifera	Singleton Mint Bush	V	V	6
Quassia sp. Moonee Creek	Moonee Quassia	E	E	1, 3
Rotala tripartita	-	-	E	6
V=vulnerable, E=endangered				

1.2 Detailed design outcomes

A small number of the in-situ sites established during the pre-construction phase of the project, were inadvertently placed in areas that were subject to approved clearing associated from the detailed design. These sites, which were removed during Year 1 construction activities, were documented in the 2017 annual report (Jacobs 2018) and will be excluded from future annual reports. Details are provided in Appendix B. Following review of the detailed design and comparison with concept design the total number of remaining in-situ populations being monitored were reset across the whole project. Monitoring plots partially impacted in 2017 were continually monitored to examine any change post impact or from future direct or indirect impacts. Where possible, additional plots were established to monitor remaining populations adjacent to pre-existing impacted sites.

2. Methods

2.1 Timing and conditions

2.1.1 Survey timing

The timing of surveys followed in accordance with the monitoring program in the TFMP which prescribes that monitoring events be undertaken once a year for the third year of construction and one annual monitoring event for the operational phase (relevant to sections 1-2).

As different sections of the W2B upgrade are being constructed independently, the timing of monitoring events have occurred at different phases in 2018 and 2019. For 2019, this report documents monitoring data at Year 3 construction and Year 2 operation as follows:

- Section 1-2 – Year 2 operation (2019). Annual survey completed in spring.
- Section 3-11 – Year 3 construction (2019). Annual survey completed in spring.

This information is summarised in Table 2-1. Although construction for sections 10-11 was delayed by approximately 12 months, the monitoring program has maintained the same classification as sections 3-9 for the purposes of survey timing and reporting results.

Table 2-1Timing of data collection during different project phases in 2019

Project sections	Timing of data collection for Spring 2019
Section 1	O2
Section 2	O2
Sections 3-4	C3
Sections 5	C3
Section 6	C3
Sections 7, 8, 9	C3
Sections 10-11	C3
C3 = Construction Year 3, O2 = Operation Year 2	

2.1.2 Climatic conditions

Given the length of the project study area spanning over 160 km, localised climatic conditions and rainfall vary across this extent and it is important to identify these conditions in interpreting the data and trends in natural variation of plants and changes in their health, abundance and occurrence. This is particularly important for threatened flora that grow in wetland and riparian habitats and depend on rainfall.

Total annual rainfall for 2019 ranged from a high of 758.4 mm at Lower Bucca (Sections 1 and 2), to 300.8 mm at Grafton Research Station (Sections 3-5), and a lower mid-range of 341 mm at Woodburn (Sections 6-10).

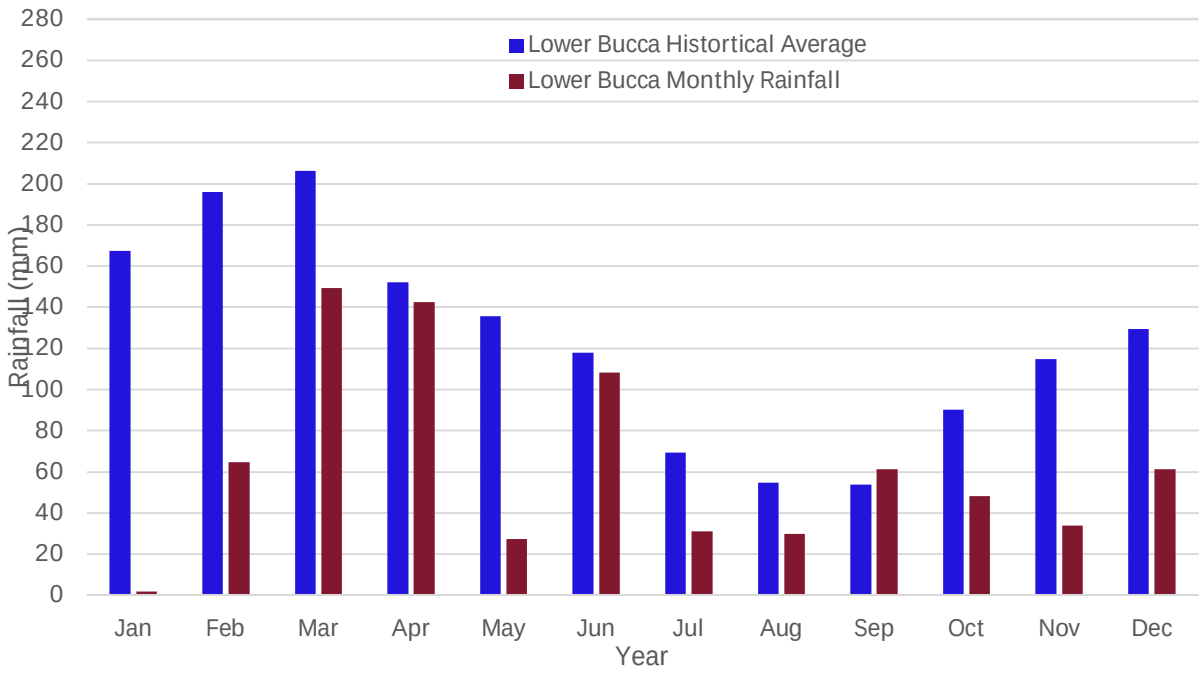

Figure 2-1 Monthly rainfall data and monthly historical average from Lower Bucca (059006) for 2019 (missing monthly data for December was complemented with data from nearby station Nana Glen 59139)

All sites received well below average annual rainfall (49-75 percent), with the greatest decrease at Woodburn which received just 0.2 mm of rain between May and December 2019. Monthly rainfall trends were variable across the whole region though generally always below average (refer to Figure 2-1,

Figure 2-2Monthly rainfall data and monthly historical average from Grafton Research Station (058077) for 2019

and Figure 2-3). Summer 2019 rainfall was very low across the region and spring was variable with above average rainfall in September in the Lower Bucca though below average everywhere else and no rain in Woodburn. Overall mean maximum and minimum temperatures were average for majority of months in 2019.

A summary of all monitoring events, survey timing and local weather conditions is presented in Tale 2-2, monthly rainfall data against historical averages is illustrated on Figure 2-1, Figure 2-2 and Figure 2-3 and a comparison of annual rainfall data against historical averages is illustrated in Figure 2-4.

Table 2-2 Survey timing and weather conditions experienced for each monitoring event in 2019

Season	Monitoring period 2019 (survey dates)			Total mean rainfall three months preceding survey (mm)*		
	Section 1-2	Section 3-5	Section 6-10	Lower Bucca	Grafton	Woodburn
Spring	Annual (1-2 Oct)	Annual (2-3 Oct)	Annual (15-18 Oct)	122	32.6	0

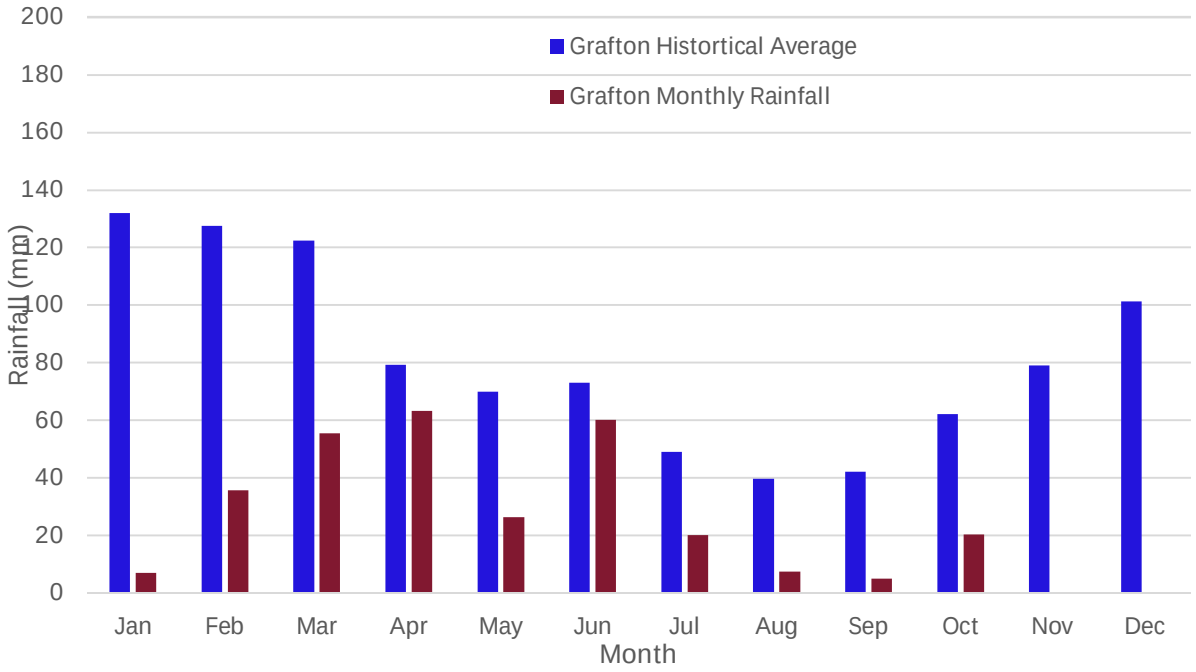

Figure 2-2Monthly rainfall data and monthly historical average from Grafton Research Station (058077) for 2019

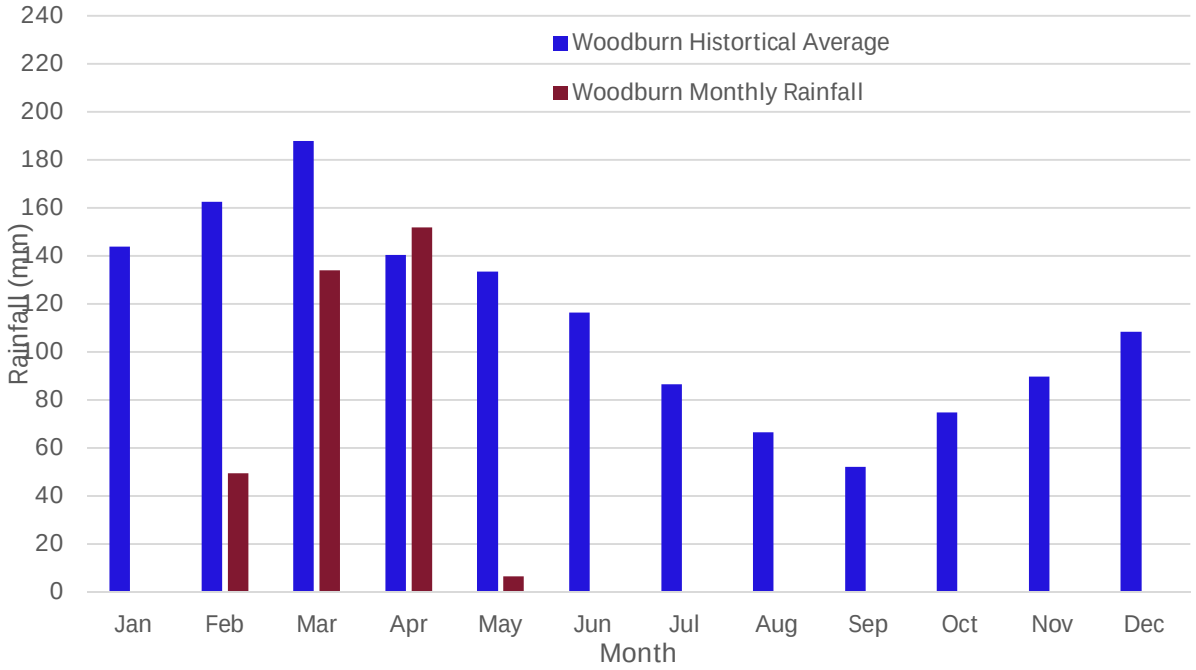

Figure 2-3 Monthly rainfall data and monthly historical average from Woodburn (058061) for 2019 (missing monthly data for December was complemented with data from nearby station Evans Head 058212)

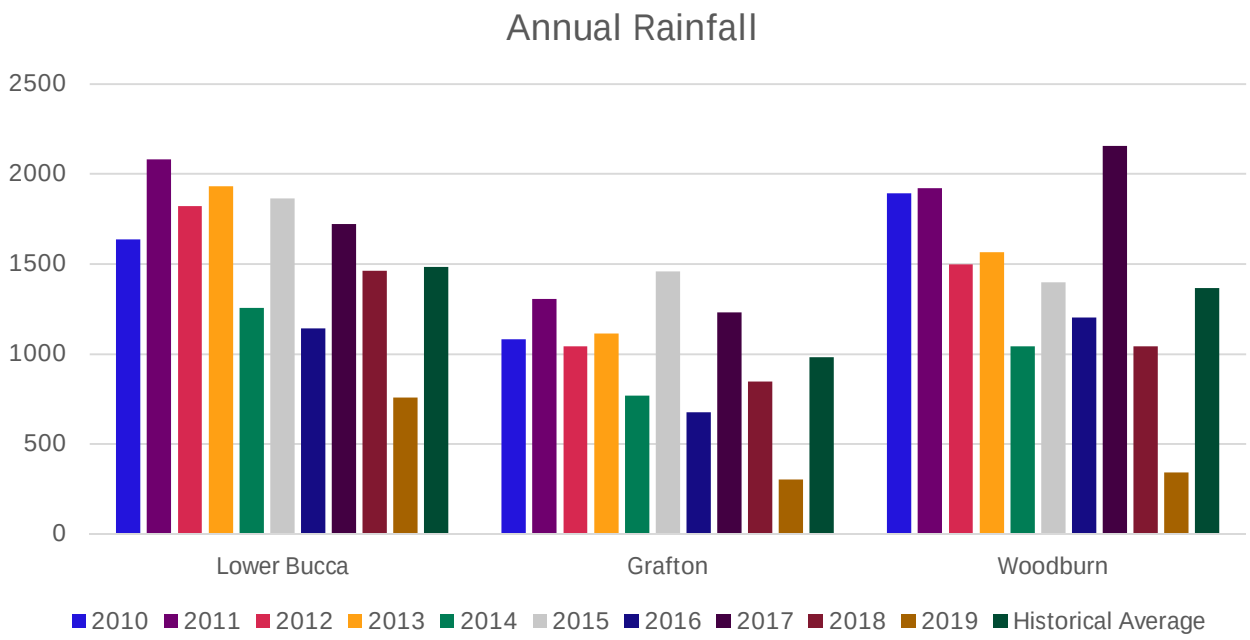

Figure 2-4 Annual and historical rainfall data from the Lower Bucca (059006), Grafton (058077) and Woodburn (058061) weather stations (missing annual data was complemented with data from nearby stations)

2.2 Monitoring sites

The pre-construction baseline surveys identified 93 threatened flora species occurrences (sites) as the basis of the in-situ monitoring program. This comprised 69 impact sites and 24 control sites (outside of the impact area). Two or three threatened flora species sites may occur in the same plot location. All sites monitored for pre-construction were established during the development of the project concept design.

During the 2019 construction/operation monitoring period some of the same sites could not be accessed from the first year of monitoring period due to continued landowner restrictions. The new control and impacts sites (added/replaced) established in 2017 were able to be accessed in 2019. This allowed for threatened species monitoring to continue. An additional site La-1.3a was established in 2018 to replace La-1.3 which hasn't been accessed since pre-construction. This was a result of new Lindernia alsinoides plants observed growing along the road verge adjacent to La-1.3. New L. alsinoides plants were also found in Elt-2.1, and a second site La-2.2 was established in 2018 to monitor these plants adjacent to the constructed highway.

A total of 81 sites are now monitored in the program comprising 62 impact and 19 control sites. Site locations are illustrated in Appendix A. Refer to the Construction Monitoring of In-situ Threatened Flora (non-rainforest flora) Annual Report 2017 for a description of replaced, removed or added sites from 2017.

2.2.1 Decommissioned monitoring sites

A total of 25 sites have been removed from the monitoring program due to continued access restrictions at 10 sites, loss of 10 sites impacted within the detailed design construction footprint and other reasons for five other sites. Some sites have been replaced or duplicated where possible and are referenced in the annual report 2017 (Jacobs). The list of sites removed is shown in Table 2-3.

Table 2-3 Sites removed from monitoring program

Site	Chainage	Reason/status	Site	Chainage	Reason/status
Elt-1.1	5700	Impact	Ar-3.10	66500	Impact
Elt-1.2	6200	Impact	Ar-3.11	67700	Impact
Elt-C1.1	6400	No access	Pe-4.2	80600	Impact
Elt-C1.2	6400	No access	Pe-5.1	83400	Impact
Elt-1.4	6700	No access	Emb-4.2	80700	Inadvertent impact
La-1.1	6200	Impact	Sp-4.1	80700	Not listed as threatened
La-C1.1	6400	No access	Sp-8.1	134900	Not listed as threatened
La-C1.2	6400	No access	Pc-6.2	101700	Impact
La-1.3	6700	No access	Pc-6.2a	101700	Monitored in translocation program
La-C1.3	6400	No access	Pc-C6.1	101700	Replaced with in-situ site
Mt-C1.1	4900	No access	Oc-8.1	132200	Impact
Mt-1.2	5700	Impact	Pa-9.1	144400	Calanthe triplicata - not listed as threatened
Mt-3.3	64300	No access	Ah-10.5	157600	Impact

2.3 Sampling methods

2.3.1 Targeted surveys and species detection

The sampling approach ensured that different plant life stages were targeted over at least two monitoring events per year during the initial two years of construction, which was reduced to a single annual survey in 2019. The surveys focused on monitoring the health and condition of known individuals as well as investigating plant recruitment. Detection of cryptic threatened flora was reliant on suitable climatic and seasonal conditions, particularly for Cyperus aquatilis and Rotala tripartita. Climate variability also has an effect on Lindernia alsinoides, Lindsaea incisa and Maundia triglochinoides, however these species were generally detected throughout the monitoring period under suitable conditions. Persicaria elatior and Arthraxon hispidus have an annual life cycle and were only detectable at certain times of the year. Persicaria elatior would generally show signs of natural dieback in late autumn with few plants remaining in winter and seedlings would appear in late spring. Arthraxon hispidus would dieback in winter and seedlings would appear in spring and begin to set seed in late autumn. Cyperus aquatilis and Rotala tripartita are also short-lived annuals and rely on wet summer periods. The below average rainfall in 2019 resulted in dry conditions that greatly impacted some of these species, particularly Lindsaea incisa, which was absent from many sites.

2.3.2 Sampling technique

A 20 x 20 metre plot with a central 20 metre transect was used at each site following the same techniques carried out in previous years and in line with the TFMP. Where possible, transects were aligned from north to south. At each monitoring event a photograph was taken at the northern end of the transect looking along the transect. Additional photographs were taken of the general habitat condition, individual plants and/or clusters of plants, and where insect attack and plant dieback were noted.

A tape measure was laid along the plot midline to record habitat condition (vegetation cover and structure) and used as a reference for plant locations. Vegetation condition was recorded along the transect with the canopy and midstorey (greater than one-metre high) cover recorded as percentage foliage cover every five metres (four points) along the transect and groundcover attributes were recorded at every metre (20 points) as either forb, grass, shrub (less than one-metre high), bare/water, litter or exotic. The central transect was also used to describe the distribution of threatened flora within the plot. Weed species and their cover abundance was recorded within the whole plot.

Habitat condition parameters and plant health indicators were recorded within the plot and the transect and associated with individuals in relation to threatened plants. This included but was not limited to:

- Genus, species and subspecies.
- Identifier – unique plant number.
- Location – location; easting, northing & description.
- General condition – score on a scale of 0 to 5, where 0 is dead and 5 is excellent.
- Leaf condition – healthy/unhealthy, colour, vigour.
- Flower/fruit – flower/fruit presence.
- Length of new shoots – average length of new shoots (estimate) and abundance of new shoots (counts or basic scale).
- Disease symptoms – evidence of disease (including presence / absence of Myrtle Rust, Cinnamon Fungus).
- Recruitment.
- Evidence of any other damage or disturbance.
- Plant community type.
- Canopy cover.
- Mid-storey cover.
- Ground-layer cover and composition.
- Weed cover of abundance and weed ground cover percentage.
- Recruitment of canopy and mid-storey species.
- Climatic events (e.g. drought, flood, unusually cold winter temperatures etc.).
- Maintenance carried out – when and what kind of maintenance carried out at the site since the last monitoring.
- Any other ecological impacts.

A quantitative measure of a subject plant's abundance and distribution within a plot was used for groundcover plants (and annuals) that are difficult to count and/or grow in large clusters. This method was adopted for C. aquatilis and R. tripartita. L. alsinoides, L. incisa and M. triglochinoides.

The technique involved the measurement of an area of occupancy (AoO) of subject plant's distribution within the plot and a series of 1x1 metre quadrats randomly placed within the AoO to either estimate percentage ground cover or count number of stems. Any plots with continual low abundances of individuals were directly counted. A measure of percentage cover was only used for M. triglochinoides. For A. hispidus, C. aquatilis, R. tripartita. L. alsinoides and L. incisa, stems (where present) were directly counted within specified patches or mean number of stems determined in 1 x 1m quadrats for larger occurrences.

To account for consistent temporal changes in site abundance and occupancy (i.e. increase/decline), a standard method of recording cover/abundance was applied across the entire plot for each monitoring event. This was

calculated by multiplying the mean percentage ground cover, or mean number of stems, by the division of the AoO over the plot size, i.e. (AoO ÷ 400m^2) x mean cover/stem count).

The remaining species of shrubs, trees and orchids were directly counted as per the TFMP. A summary of plant health and habitat condition factors was recorded based on observing leaf condition, any notable dieback or insect attack, plant height, width, diameter at breast height (DBH) for tree species, number of trunks and habitat conditions.

Weed cover was measured using a modified Braun-Blanquet cover abundance score (Braun Blanquet, 1928; Poore 1955), refer Table 2-4.

Table 2-4 Cover abundance score used for measuring weeds

Score	Description
1	Rare, few individuals present (three or less) and Cover <5%;
2	Common and cover <5%;
3	Very Abundant and Cover nearing 5% OR Cover from 5% to <25%;
4	Cover from 25% to less than 50%;
5	Cover from 50% to less than 75%;
6	Cover 75% or more

Other general information recorded at each plot included observations of the dominant flora species in each structural layer, prevailing site conditions (i.e. soil moisture, surface water levels and observed flow velocity for macrophyte species) and landscape parameters (i.e. landform, drainage, slope and aspect).

2.4 Performance thresholds and corrective actions

The TFMP details an adaptive management approach to achieve management goals and mitigate impacts to in-situ threatened flora. The data from the construction phase of the project has been analysed and interpreted to evaluate any impacts and the effectiveness of any management measures used. This is assessed in the context of the performance measures identified in the plan (refer to Table 4-2 and Table 4-3).

Specific goals for mitigating impacts using performance thresholds and corrective actions during construction management (relevant to Sections 3-10) for in-situ threatened plants are outlined in Table 2-5 and summarised from the TFMP.

The operational environmental planning measures for threatened flora species and corrective actions if the measure deviates from the performance criteria are outlined in

Table 2-6.

Table 2-5 Mitigation measures and corrective actions for threatened flora during construction (relevant to Sections 3-11)

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions
Zero mortality of threatened plants from in situ populations (from physical damage during construction) and no loss of threatened plants directly adjacent to the project.	Implementation of the Transport for NSW clearing protocol. Clearing areas identified and approved as required under the clearing protocol.	Clearing areas identified and approved prior to clearing activities being undertaken.	Clearing areas have not been marked out and approved prior to construction.	Delay construction until clearing areas have been marked out.
	Exclusion zones fenced off to protect in situ threatened plants. Induct all construction staff at the commencement of construction works. Induct new staff as appropriate	Exclusion zone fencing monitored at least weekly during construction. Faults rectified as soon as noticed.	Exclusion zone fencing is damaged or ineffective.	Stop construction in the area of the fencing breach until exclusion fencing has been repaired. Investigate why breach in fencing occurred and implement corrective actions as required to prevent reoccurrence.
	Monitor in-situ plants at established monitoring sites during construction.	Every three months during the first year of construction. Every six months during the second year of construction.	Any loss of retained in situ threatened plants.	Commence assessment of potential reasons for mortality, including seasonal fluctuations, natural events such as drought and fire within one month of trigger being identified. Compare with paired control site. Identify potential threats, implement corrective actions and modify monitoring as necessary.
No notable increase in the abundance of weeds within threatened plant habitat during monitoring of in situ populations.	Implementation of weed management as described in the CEMP and FFMP. Up to date Sensitive Area Plans.	Every three months during the first year of construction. Every six months during the second year of construction.	Noxious and environmental weeds reported in areas adjacent to threatened plants. Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities.	Review the weed management maintenance schedule and update as required. Implement appropriate weed measures as required within one month of the trigger for corrective action.

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions
Adequately planned translocation carried out such to maximise the chance of survival of the translocated plants.	Salvage and planting of identified plants for translocation undertaken prior to clearing, into suitable habitat, and using appropriate methods that maximise the chance of plant survival.	At the optimal time of year for species prior to clearing works commencing. Once salvaged, plants would need to be monitored throughout the construction phase at least three times a year (summer, autumn, spring).	All plants identified for translocation have not been translocated prior to commencement of construction.	Stop construction in vicinity of threatened plants. Investigate appropriate translocation activities. If translocation cannot be undertaken use reserves of species tube stock or seed to supplement and enhance populations.
The landscaping design includes details on revegetation requirements for areas adjacent to threatened plants and translocation/offset areas.	Revegetation and habitat management requirements included in the landscape design for areas adjacent to threatened plants. Specifically includes revegetation maintenance planned in consultation and implemented by experienced bush regenerators for areas adjacent to in situ populations.	Appropriate measures incorporated into the Urban Design and Landscape Plan.	Landscape design has not included specific revegetation requirements for areas adjacent to threatened plants and translocation/offset areas	Plan to be updated to include specific requirements prior to commencement of implementation of plan.
Dust managed in accordance with the CEMP.	Dust impacts would be managed in accordance with the CEMP including dust suppression measures.	Dust suppression would be implemented in accordance with the CEMP. Monitoring of dust on plants considered as part of plant health monitoring. Dust deposition is to be monitored monthly.	Dust exceedances recorded from dust monitoring within sections containing threatened plants.	Review dust suppression procedures to ensure adequate dust management. Where appropriate, shade cloth screening installed on edge of construction footprint to protect low growing threatened flora.
Water and soil quality managed in accordance with the CEMP.	Adequate soil and water quality controls installed surrounding retained threatened plants. Procedures for maintenance and monitoring of erosion and sediment controls included in the CEMP.	Erosion, sediment and water quality controls would be monitored weekly throughout the construction period and as soon as practical after storm events.	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Review adequacy of the erosion, sediment and water quality controls and implement appropriate corrective actions. Commence review of monitoring procedures for controls and implement appropriate corrective actions.

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions
Reduce impacts to threatened orchid species through illegal collection.	Restrict the availability of information identifying where orchids occur within the project area, and in close proximity to the project area. Limit site access to areas where orchids naturally occur and may be being managed in situ.	Threatened orchid populations will be regularly monitored during construction and post construction as part of the overall monitoring program.	There is evidence of public access to the orchid areas and/or evidence of illegal collection.	Discuss potential corrective measures with the regulatory authorities.

Table 2-6 Mitigation measures and corrective actions for threatened flora during operation (Sections 1-2)

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions
Zero mortality of retained in situ threatened plant populations during construction and for three consecutive monitoring periods post-construction. Post the above period 80 per cent survival of tree, shrub and herbaceous perennials after three years.	Clearly identify in situ populations and exclusion zones. Implementation of weed management measures throughout operational period.	Threatened plant health monitoring and weed monitoring to occur as per Sections 8. Monitoring to occur annually of in-situ monitoring sites and control sites. Monitoring will occur for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)).	Any mortality of in situ threatened plants for the first three consecutive monitoring periods post construction. Post the above timeframe more than a 20 per cent decline for an in situ threatened plant population over one monitoring event from the baseline (depending on species specific seasonal fluctuations).	Commence assessment of potential reasons for mortality, including natural events such as drought and fire within one month of trigger being identified. Review weed maintenance schedule within one month of trigger being identified. Identify potential threats, implement corrective actions and modify monitoring as necessary. Offset any additional threatened plant impacts that have occurred as a result of the Project.

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions
At least 90 per cent of the plants planted as part of the revegetated areas have survived after the first year and 80 per cent after three consecutive monitoring events.	Regular maintenance activities such as watering, mulching, weed control and supplementary plantings as required as per the landscape design.	For the first twelve months monitoring will be monthly. It will then go to every 6 months for two years. Monitoring will occur in Spring/Summer to evaluate the success of revegetation against performance objectives.	Monitoring and maintenance activities not being undertaken. More than 10 per cent of plants have died after year one, and more than 20% have died after three consecutive monitoring events.	Within one month of the trigger review and update maintenance methods as required. Identify any other potential threats and implement corrective actions as required. Any failed areas to be reseeded within 6 weeks of trigger. Ongoing monitoring and maintenance undertaken until plant health and/or ecological condition of habitat has been maintained at 80% survival after three consecutive monitoring events.
Less than five per cent weed cover at retained in situ threatened flora sites (end of monitoring program).	Implementation of weed management measures throughout operational period.	Threatened plant health monitoring and weed monitoring to occur as per Sections 8. Weeds will be monitored in proximity to in situ flora populations annually. Monitoring will occur for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)).	Weed cover increases by 10% from the baseline cover in areas surrounding in situ populations. More than 30% weed coverage in revegetation areas.	Review weed maintenance program within one month of trigger being identified and update as required.

3. Results and discussion

3.1 Operational Year 2 monitoring (Section 1 and 2)

3.1.1 Square-stemmed Spike-rush (Eleocharis tetraquetra)

Searches for E. tetraquetra at sites Elt-1.1a (chainage: 5700), Elt-1.3 (chainage: 6600) and Elt-2.1 (chainage:14700) were undertaken on 2 and 3 October 2019. No plants were identified at any of the three plots during in 2019. Refer to Figure 3-1.

The number of plants observed at these sites over the years has varied considerably in response to water levels. The current apparent absence of E. tetraquetra is likely to be directly related to the drought conditions (approx. 50 percent of annual average) experienced in the region since the end of 2018.

Sediment transport through the adjacent culvert has ceased considerably at site Elt-2.1 since 2017 and numerous native shrubs have established. The mean mid-storey cover has continually increased over the years and a reduction in weed cover abundance has been observed. The basin within site Elt-1.3 continues to hold sediment run-off from exposed soils, however the flow of sediment did not appear to be transported into habitat for threatened plants. Native macrophyte vegetation has re-established at the site and is capable of filtering sediment deposition. Weed cover abundance continues to remain low.

No plants have been observed at Elt1.1a since its establishment in 2017 due to the original Elt1.1 being set up during baseline monitoring within the approved clearing boundary. An increase in grass cover (40 percent) and decrease in reed cover (30 percent) since 2017 was observed at site Elt-1.1a, possibly due to lower water levels. Sitting water was a grey colour, possibly leached from introduced rock situated around adjacent basin.

Figure 3-1 Number of clumps Eleocharis tetraquetra observed over five survey periods at three active in-situ monitoring sites (Elt-1.1a, Elt-1.3 and Elt-2.1). No baseline data exists for Elt-1.1a as the original site (Elt-1.1) was located within the approved construction boundary.

3.1.2 Square fruited Ironbark (Eucalyptus tetrapleura)

All sites were searched on 1, 2 and 3 October 2019. All sites (chainage:9200-28400) demonstrated no change from 2018. Et-2.1 and Et-2.3 Reasons for previous observations of mortality at some of the sites in 2018 (Et-2.1, Et-2.2 and Et-2.3) are unknown and unlikely related to the project, however dieback of both small and large branches, and one trunk, was detected in winter 2016 monitoring period as well as small branch dieback at site Et-2.1 in the baseline monitoring event. E. tetrapleura recruitment has been evident at control site Et-C2.1, with two seedlings occurring since baseline monitoring in 2014, though recorded mortality of one in 2018. Refer to Figure 3-2 for changes in tree abundance over seven monitoring events.

Run-off is affecting site Et-2.3 (also observed during construction phase) and continues to wash away top soil within the plot. The drainage pipe initially diverting water to site during construction has been removed, however flow of water from the constructed embankment adjacent to the site is evident during high rainfall. The loss of top soil may impact on the success of seedlings to establish.

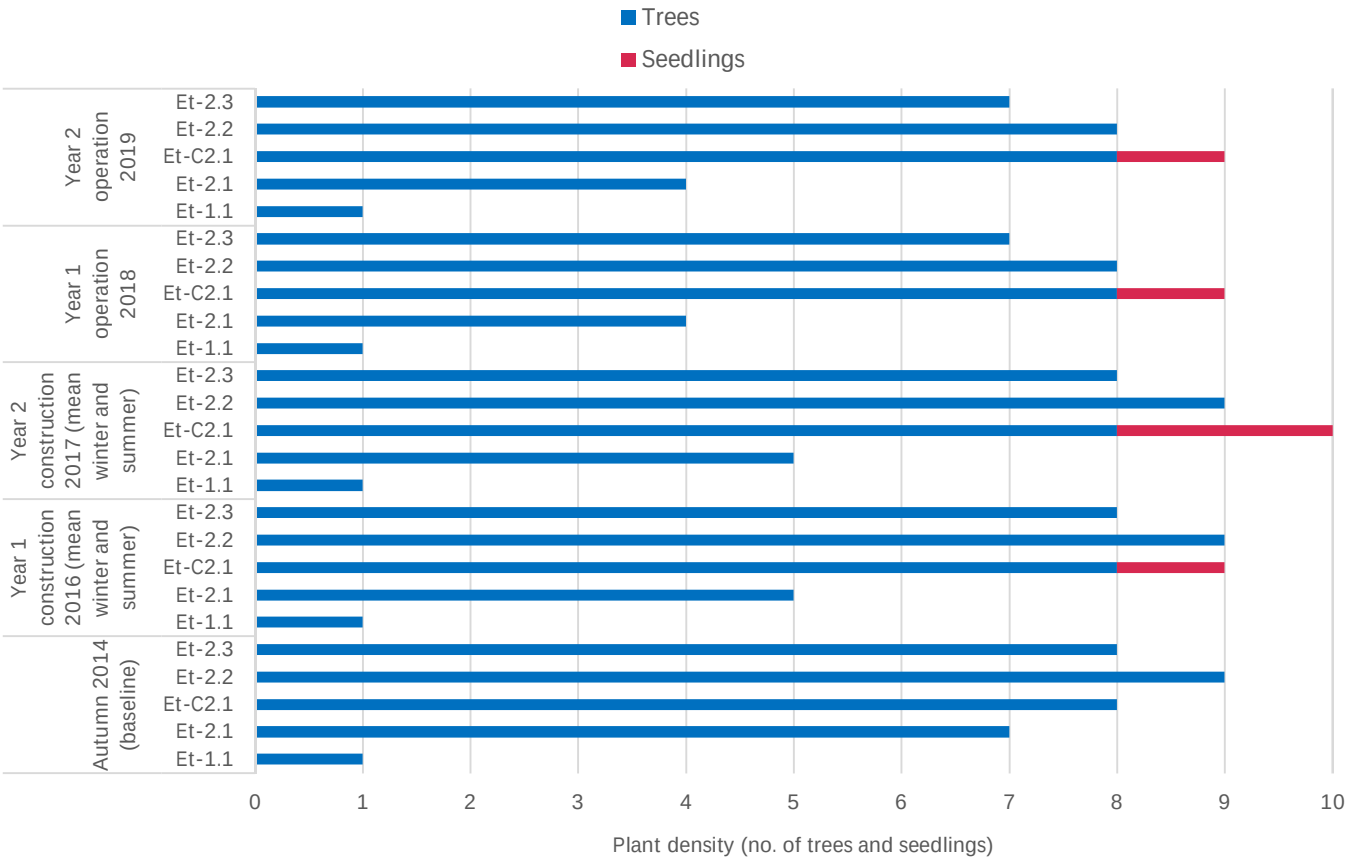

Figure 3-2 Number of Eucalyptus tetrapleura trees and seedlings observed over seven monitoring events (mean results for 2016 (n=2) and 2017(n=2)) at four in-situ sites and one control site.

3.1.3 Noah's False Chickweed (Lindernia alsinoides)

All accessible Lindernia alsinoides sites; La-1.2 (chainage:6600), La-2.1 (chainage:22400) and La-C1.3a, were searched on 2 and 3 October 2019. Plants were only recorded at La-2.1, with no large change from 2018 except for a possible slight reduction in the area of occupancy while maintaining the same number of plants (hence the increase in plant density shown in Figure 3-3).

The two sites added in 2018, La-1.3a (chainage:6700) and La-2.2 (chainage:14700), also did not have any plants during 2019 surveys. These monitoring sites were added in 2018 in response to opportunistic observations of plants that may have grown in response to rain. Dry conditions experienced in 2019 due to lower than average rainfall (approx. 50 percent of annual average recorded at Lower Bucca station) is likely the cause of the absence of plants at all these sites. No impacts from construction or operational activities were identified.

New individuals that were identified in 2018 along completed potions of section 1 (Corindi Beach) on seepage zones and on edge of constructed sedimentation basin near site La-1.2 were again observed alive during 2019 surveys. It is possible that soil in this location has better access to groundwater helping plants to persist.

Refer to Figure 3-3 for changes in plant density over five monitoring events.

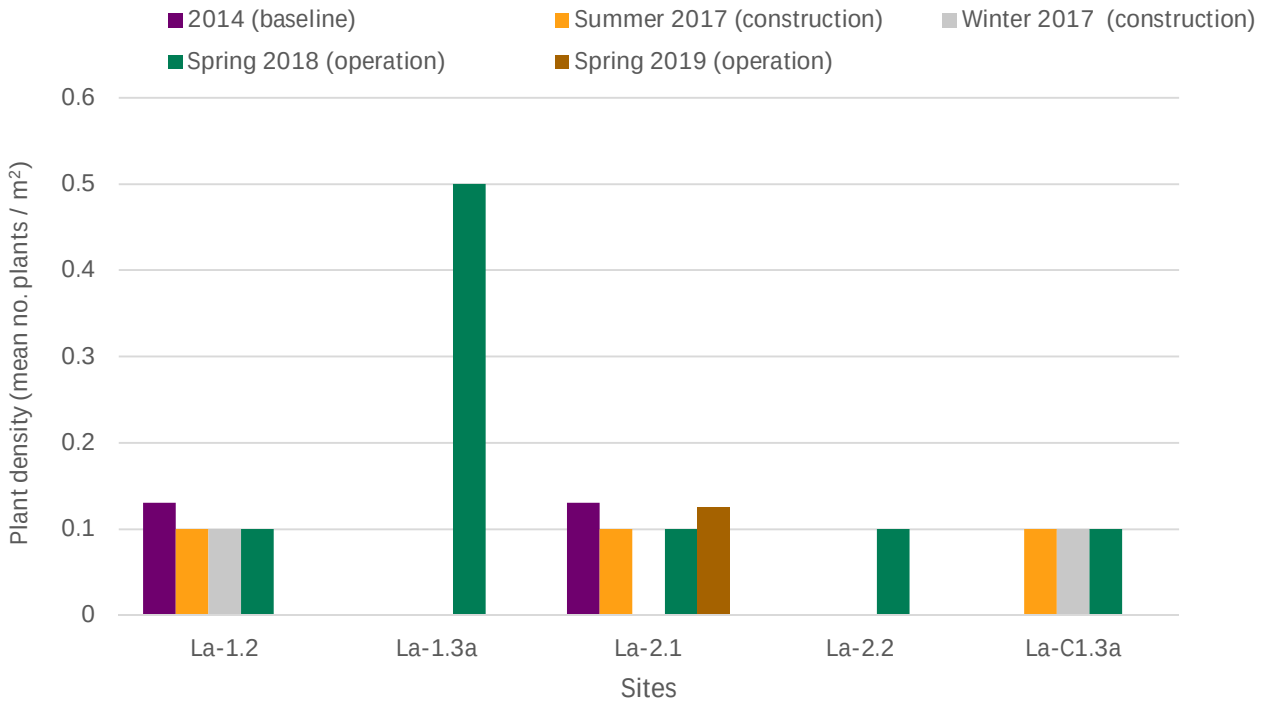

Figure 3-3 Density (mean number of plants / m2) of Lindernia alsinoides observed over five monitoring events at four in-situ sites and one control site. Data only exists for La-1.3a and La-2.2 from 2018 onwards when these sites were established.

Photograph 1: Lindernia alsinoides sub-population at new site La-1.3a established in 2018 along roadside drainage (Simmons Flat Road) adjacent to old Site La-1.3.

Photograph 2: New Lindernia alsinoides identified in 2018 on edge of constructed sedimentation pond on rocky substrate near site La-1.2 present during 2019 surveys

3.1.4 Slender Screw fern (Lindsaea incisa)

All active sites in Sections 1 and 2 (chainage:5000-17500) were surveyed during the operational phase on 2 and 3 October 2019. There were no large changes in L. incisa mean cover, though cover did increase slightly at all sites. All fern fronds were in mostly good health showing new growth, particularly at site Li-2.1 (refer to Photograph 3). Minor dieback (yellowing of fronds) and possible drought stress (wilting) of some L. incisa was observed across all sites. Figure 3-4 shows changes in plant density (mean percent cover) over the five monitoring events.

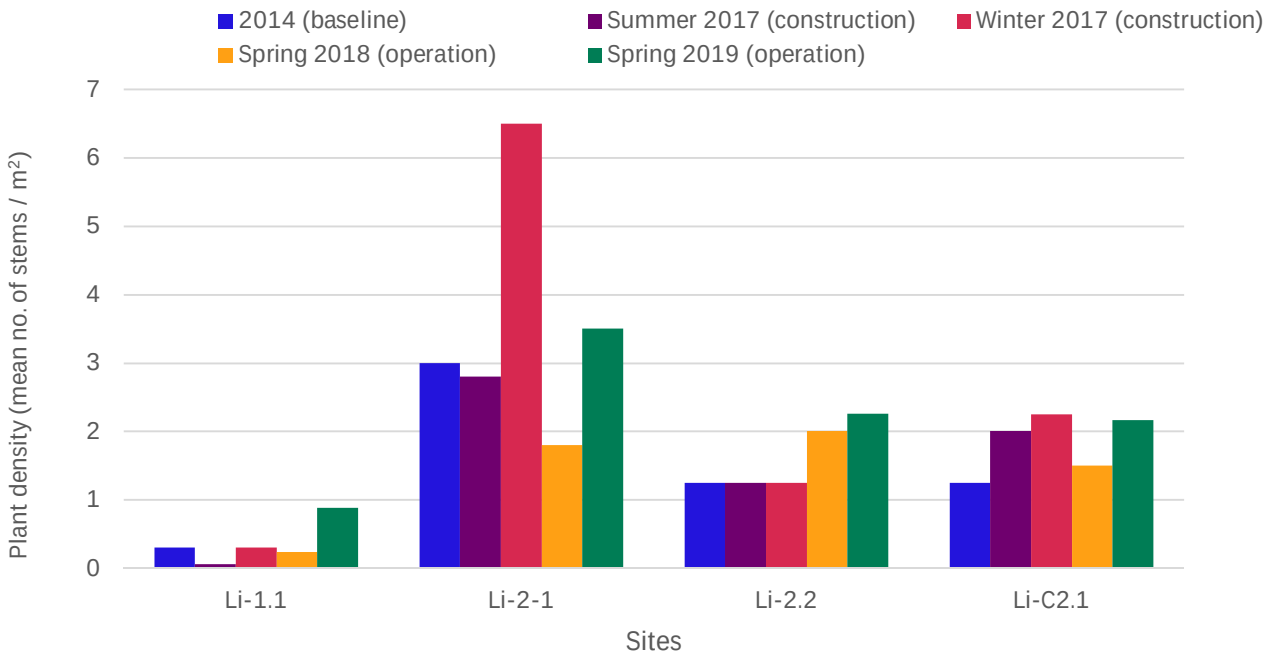

Figure 3-4 Density (mean no. of stems / m^2) of Lindsaea incisa observed over five monitoring events at three in-situ sites and one control site.

Photograph 3: Lindsaea incisa growing abundantly though showing some signs of wilting at site Li-2.1

Photograph 4: High cover of Lindsaea incisa observed at site Li-C2.1

3.1.5 Maundia triglochinoides

All active sites in Sections 1 and 2 (chainage:4900-22400) were surveyed during the operational phase on 2 and 3 October 2019. Rainfall was below average in most months preceding survey in 2019 that caused a reduction in water levels though all sites maintained low-moderate water levels, except Mt-1.1 (chainage:4900).

Plants were identified at all sites except Mt-1.1 (as per previous years) and Mt-2.1. Site Mt-1.1 continues to have no evidence of M. triglochinoides, even with broader searches beyond plot site. Cover of plants at Mt-2.1 was very low in 2018 (10 stems) with remaining plants growing on the outer edges of the creek. With dropping water levels this habitat has become unsuitable and the above-ground plant parts have died back. Presumably these plants continue to exist only as tubers in the soil.

Cover of M. triglochinoides at Mt-2.3 was very low in 2019, with just one plant identified. It is possible that Mt-2.3 will have no plants in following surveys. The largest decrease in cover was recorded at Mt-2.4, which doubled in cover between 2017 and 2018, though has now reduced by 80 percent. This is likely in response to dropping water levels associated with the drought, as cover of other threatened plants L. incisa and L. alsinoides (Li-2.2 and La-2.1) at this location saw little change.

Overall, mean cover at most sites changed little from 2018. Where plants persisted, health was generally very good. Some small increases in cover were recorded at Mt-C1.2a, Mt-2.2, Mt-C2.2 and Mt-2.3.

Grey sediment-laden water (possibly leached from introduced rock) observed in waterway during construction phase is still present during project operation at site Mt-1.2a but doesn't appear to be affecting M. triglochinoides plants.

Summary of mean percentage cover of M. triglochinoides is shown in Figure 3-5.

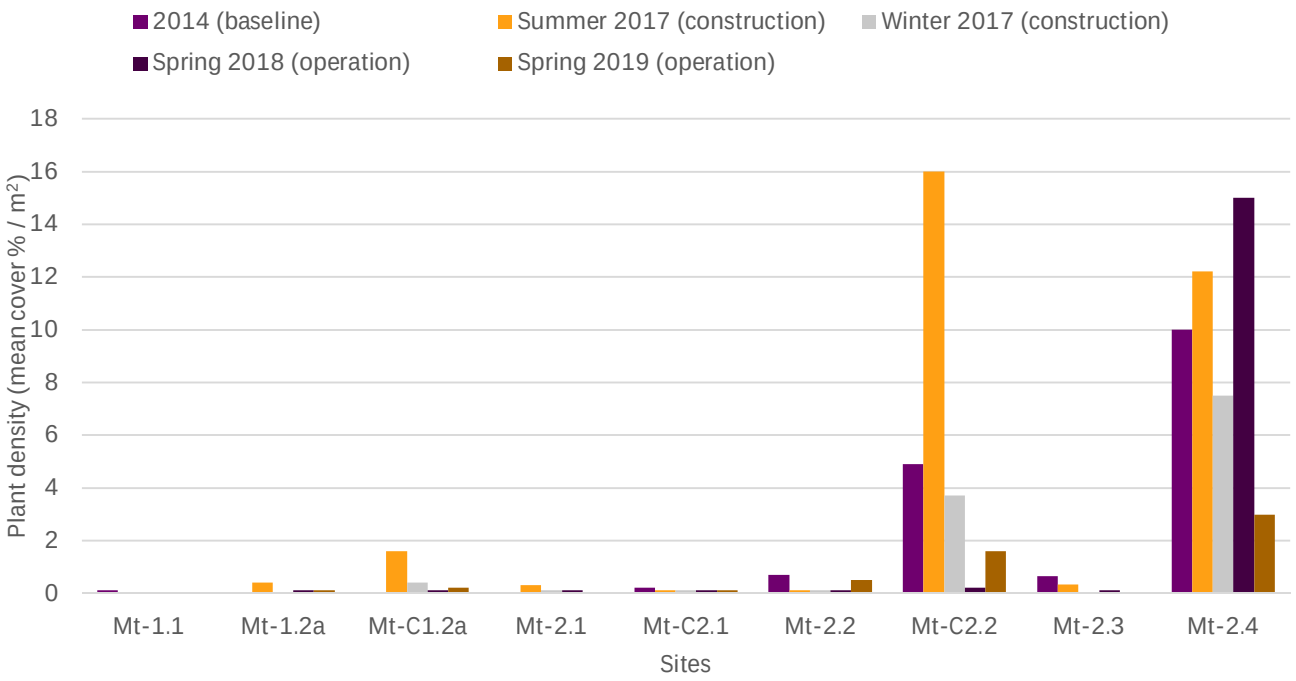

Figure 3-5 Density (mean cover % / m^2) of Maundia triglochinoides observed over five monitoring events at six in-situ sites and three control sites

3.1.6 Moonee Quassia (Quassia sp. Moonee Creek)

The two in-situ sites (Qm-2.1-Qm-2.2) and two control sites (Qm-C2.1-Qm-C2.2) (chainage:8000-8300) were surveyed on 3 October 2019.

The abundance of Quassia sp. Moonee Creek clumps and stems did not change from 2018 at sites, both in-situ and control. Most plants remain in very good health, though yellowing leaves and dieback were observed. Leaf dieback was particularly high at Mt-2.1, with plants exhibiting missing leaves, insect damage and a white coverage on the stems of some plants, possibly a fungus (see Picture 5 and 6). It is unknown if this is affecting the growth of the plants. However, the number of plants at Qm-2.1 remained the same at 93 stems. None of the plants had flower or fruit. The Quassia sp. seedlings observed in 2018 growing in mulch on the cleared edge up hill adjacent to in-situ site Qm-2.2 continued to grow healthily. Refer to Figure 3-6.for changes in tree abundance over six monitoring events.

Photograph 5: Quassia sp. Moonee plant at Qm-2.1 showing white fungus-like substance on the stem

Photograph 6: Quassia sp. Moonee plant at Qm-2.1 showing missing leaves and white fungus-like substance on the stem.

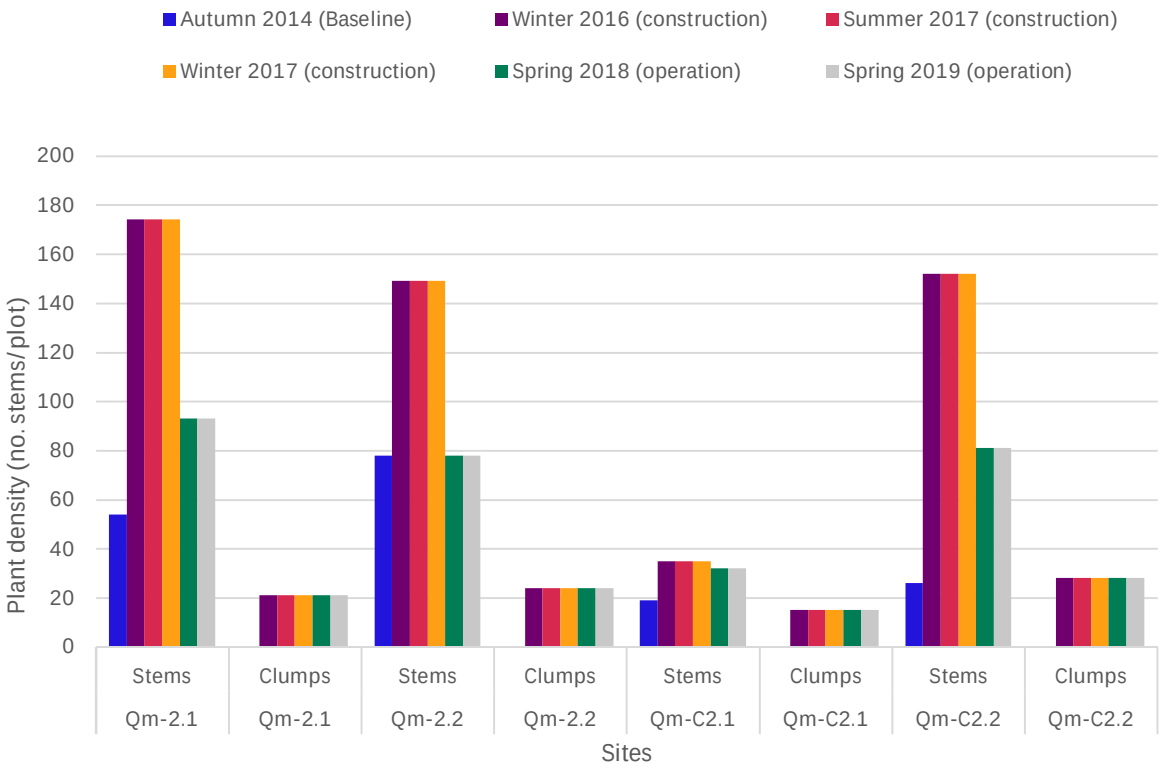

Figure 3-6 Clumps and stems counts of Quassia sp. Moonee Creek over six monitoring events (baseline, construction and operation) at two in-situ sites and two control sites. Only stem data was collected during baseline surveys.

3.2 Construction Year 3 monitoring (Section 3-10)

3.2.1 Sandstone Rough-barked Apple (Angophora robur)

All thirteen sites (in-situ and control) (chainage:44600-67700) were surveyed on 1 and 2 October 2019.

Year 3 construction monitoring of A. robur found no change in the abundance of mature trees and seedlings at both in-situ and control sites from spring 2018 surveys. Changes in the abundance of seedlings shown in Figure 3-7 from 2018 to 2019 are due to differences observed between autumn and spring surveys in 2018, which effected the annual average. Five sites (Ar-C3.2, Ar-3.3, Ar-3.4, Ar-3.9 and Ar-3.10a) were not able to be surveyed in spring 2019 due to access restrictions and construction activities. High boundary fencing is now in place round all these sites so the potential for direct impact is very unlikely. Considering the limited change observed at these sites in the past, no project-related indirect impacts are considered likely to have occurred.

Heat related plant stress and/or plant dieback continues to be evident (since Year 1 construction monitoring) at sites Ar-3.4 and Ar-3.7. Plant species affected include A. robur seedlings, Xanthorrhoea sp., Duboisia myoporoides, Banksia oblongifolia, Pteridium esculentum and Alphitonia excelsa. Dieback of Xanthorrhoea sp. and B. oblongifolia at Ar-3.7 is suspected to be caused by the epidemic infection of the root-rot fungus Cinnamon Fungus (Phytophthora cinnamomic), but this would need to be confirmed (refer to Photograph 7). Most sites with mature A. robur trees generally show some level of dieback in branches, and it is unknown whether minor tree dieback and seedling mortality at site Ar-3.7 is associated with the potential pathogen. Low average annual rainfall in the region has resulted in very dry conditions effecting many species (Photograph 7).

A summary of all in-situ and control A. robur sites is presented in

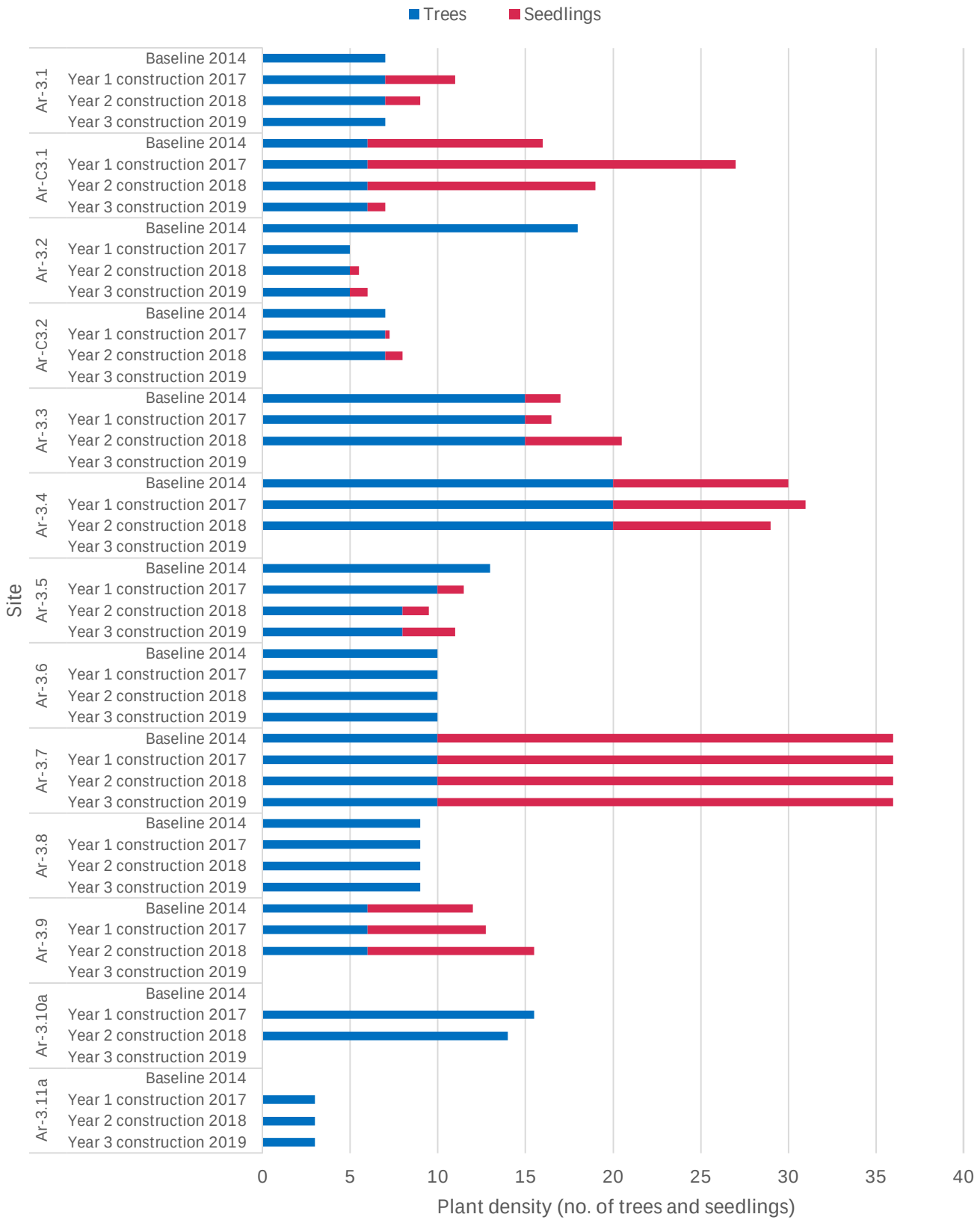

Figure 3-7.

Photograph 7: Xanthorrhoea sp. dieback at in-situ site Ar-3.7 in October 2019. The photo also shows lots of brown and yellow plants, a result of drought conditions in 2019.

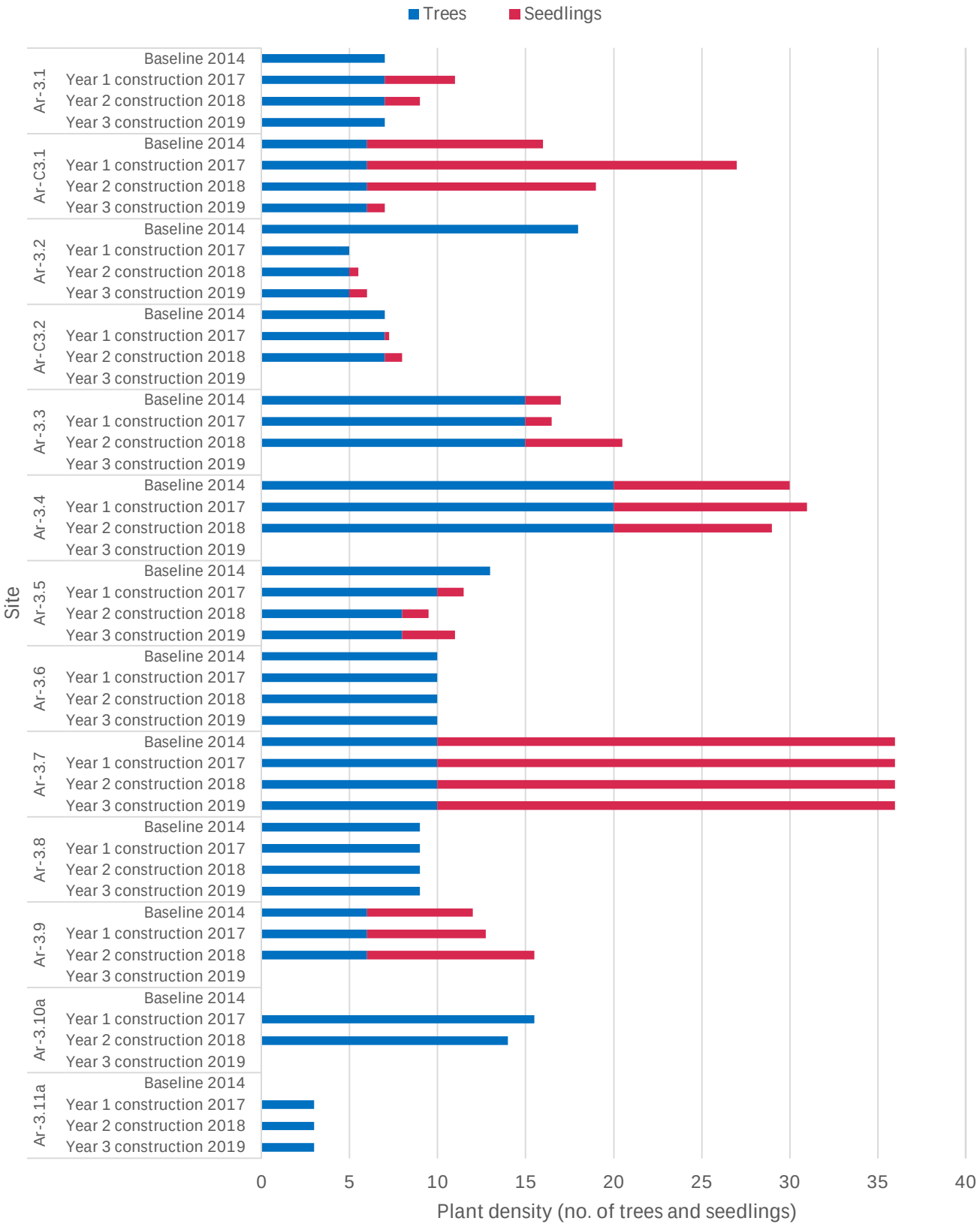

Figure 3-7 Number of A. robur trees and seedlings observed over eight monitoring events (2014 [n=1], mean results for 2017 [n=4], mean results for 2018 [n=2] and 2019 [n=1] at eleven in-situ sites and two control sites).

No baseline data exists for sites Ar-3.10a and Ar-3.11a that were established in 2017. Some sites were not able to be surveyed in 2019 due to access restrictions (high fencing) and construction activities.

3.2.2 Hairy-joint Grass (Arthraxon hispidus)

All six in-situ sites (chainage:129300-157900) and two control sites (chainage:157200-157500) were surveyed on 17 October 2019. This considers the removal of Ah-10.5 from the monitoring program as it was located within the detailed design boundary.

Arthraxon hispidus was detected at five sites and absent from four (Ah-10.4, Ah-10.5, Ah-C10.1, Ah-C10.2) from the 2019 surveys. The average number of stems per square metre in each plot was lower than 2018 at all sites where Arthraxon hispidus was present. All plants observed were small, mostly less than 5 cm, and appeared to have only just started shooting (see photograph 9). No flowering plants were observed. Large dead plants with seeds from the previous season were observed at some sites (Ah-C10.2) where it appeared that no plants had begun to grow yet in spring 2019. Arthraxon hispidus is an annual species that naturally dies back each year and the abundance of plants observed at the sites surveyed as part of this monitoring program have fluctuated since baseline surveys (refer

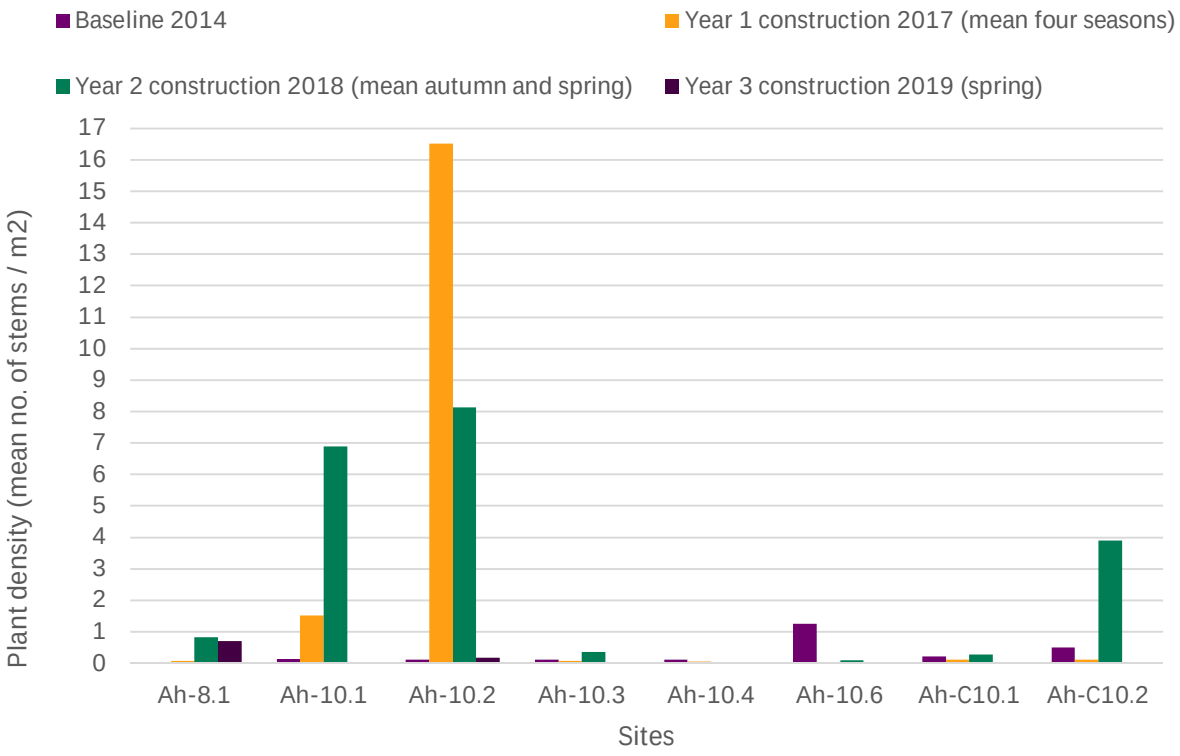

Figure 3-8). These observations in 2019 are considered primarily the result of drought conditions (Woodburn recorded 25 percent of the annual average in 2019 and only 0.2mm between May and December, refer Figure 2-3).

Competition with other plants continues to be a threat to Arthraxon hispidus. This is primarily by exotic species such as Ageratum houstonianum and Commelina benghalensis forming dense groundcover. This is particularly evident at sites Ah-C10.2 and Ah-10.4, where it appears Arthraxon hispidus plants are being out-competed. Similarly, this is also happening at Ah-C10.1 with the native grass Leersia hexandra. This is most likely occurring as the wetland around the upper reaches of Saltwater Creek is slowly drying out, a product of drought conditions in 2018-19. Though this problem may also be exacerbated by the removal of cattle from these properties, which have been previously managed through grazing. Cattle removal has occurred in some locations during the construction period. Table 3-1 shows the change in weed cover and number of weed species for all sites over all monitoring periods. This impact is not project related.

The only site that seemed unaffected by the dry conditions was Ah-8.1. Plants were healthy and up to 15cm, though mostly small and appeared to have just started shooting. However, this site was impacted by the construction of a new fence running north to south through the plot (see photographs 8 and 9). The concrete posts and associated clearing (approx. one metre either side) and disturbance has removed a large portion of the previous occurrence of Arthraxon hispidus in the plot (from 40 m^2 in 2018 to 9 m^2 in 2019).

Table 3-1 Comparison of pre-construction and construction (Year 1, Year 2, Year 3 and mean of all years) weed abundance (ground cover and richness) in Arthraxon hispidus habitat at in-situ and control sites

Site	Mean weed ground cover (%) / weed richness (No. spp.)					Change (%) in mean weed ground cover (baseline vs construction) (+/-)	Difference in number of weed species (+/-)	Detailed design impact
	Pre-construction	Construction Year 1	Construction Year 2	Construction Year 3	Construction mean			
Ah-8.1	100/1	67.5/8	82.5/8	100/8	83.3	-16.7	+7 spp.	No
Ah-10.1	100/2	99/10	100/10	100/11	99.7	-0.3	+4 spp.	No
Ah-C10.1	20/1	31.5/4	15/4	0/4	15.5	-4.5	+3 spp.	No
Ah-10.2	85/3	75/3	57.5/10	80/10	70.8	-14.2	+7 spp.	No
Ah-C10.2	20/3	35/8	40/8	95/8	56.7	+36.7	+5 spp.	No
Ah-10.3	65/3	82.5/11	77.5/11	80/11	80	+15	+8 spp.	No
Ah-10.4	75/6	64/9	65/5	65/9	64.7	-10.3	+3 spp.	No
Ah-10.6	65/2	96/9	100/9	100/9	98.7	+33.7	+7 spp.	No

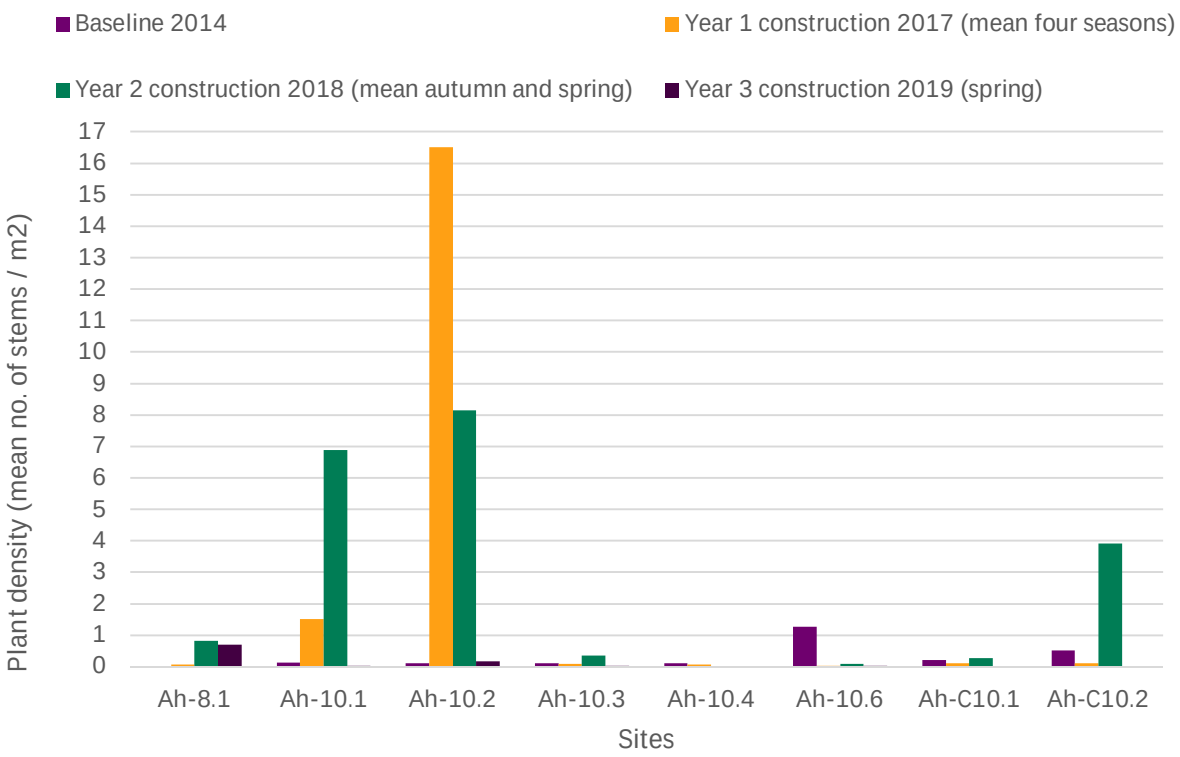

Figure 3-8 Mean number of stems / m2 in each plot over seven monitoring events for seven in-situ sites and two control sites

Photograph 8: New concrete post fence constructed through plot Ah-8.1.

Photograph 9: New Arthraxon hispidus shoots observed at most sites.

Photograph 10: Dense groudcover of Leersia hexandra at Ah-C10.1.

Photograph11: Exotic species such as Ageratum houstonianum and Commelina benghalensis forming a dense groudcover at Ah-10.4.

3.2.3 Water Nutgrass (Cyperus aquatilis)

No Cyperus aquatilis individuals were recorded at Ca-6.1 (chainage: 102900), on 16 October 2019 for Year 3 construction monitoring. This species is best detected during summer and autumn where climatic conditions are most suitable. Rainfall in the region was below the annual average (Woodburn recorded 25 percent of the annual average in 2019 and only 0.2mm between May and December, refer Figure 2-3) and is likely to have contributed to this species' absence from the site. However, Cyperus aquatilis has never been observed during this monitoring program and Ca-6.1 was added in 2017 due to the location of a record collected during surveys for the project impact assessment. Exotic groundcover increased from 30 percent to 80 percent in 2019 which is likely due to prevalent dry weather conditions and dieback of less resilient plant species.

3.2.4 Green-leaved Rose Walnut (Endiandra muelleri subsp. bracteata)

Both Emb-4.1 (chainage: 81700) and Emb-4.2 (chainage: 80700) were surveyed on 1 October 2019.

Site Emb-4.2 consisted of one mature Endiandra muelleri subsp. bracteata shrub, which was inadvertently removed by a construction contractor in January 2019. The contractor is required to implement a Remediation Plan to address corrective actions. Site Emb-4.2 has now been removed from the monitoring program.

The single individual E. muelleri subsp. bracteata at site Emb-4.1 is in good health with new apical meristem shoots and has maintained a height of 1.6 metres since Year 1 construction. Insect activity on shrub continues to be observed including caterpillar, moth, ant and aphids. A termite trail up the stem was observed in 2019 (refer photograph 11). Leaf insect damage has been noted but hasn't caused detrimental harm to plant. The E. muelleri shrub was observed in 2018 being smothered by Dutchmen's Pipe (Aristolochia elegans) climber weed, however weeds works have been undertaken and flagging has been re-established around the shrub (refer photograph 10). The amount of sunlight entering this site has increased from vegetation clearing during construction to the south (inside the project boundary) and dieback of Flooded Gum (Eucalyptus grandis) tree canopy, suspected to be caused by irregular roosting of Flying Foxes. The increased sunlight to the groundcover was potentially the cause of increases in weed cover. No recruitment of E. muelleri subsp. bracteata was observed.

Photograph 10: E. muelleri subsp. bracteata at in-situ site Emb-4.1 showing protective flagging.

Photograph 11: Termite trail on E. muelleri subsp. bracteata at in-situ site Emb-4.1.

3.2.5 Four-tailed Grevillea (Grevillea quadricauda)

Both in-situ site Gq-3.1 (chainage:59300) and control site Gq-C3.1 (chainage:59500) were surveyed on 1 October 2019.

In-situ site Gq-3.1 had four less adult G. quadricauda plants and one less juvenile plant in 2019. One dead plant was observed. Observations of plant recruitment, seed dispersal and seedling morality have varied over the years of monitoring. There were 24 seedlings counted in autumn 2018, 21 seedlings in November 2018 and 20 in October 2019. Interestingly, some seedlings have established over 20 metres from parent plants in disturbed areas with weeds close to the edge of the project. Seeds may have been dispersed via ant (or other animal), and Grevillea spp. are known to colonise on disturbed soil surfaces where there is little competition. Some seedlings showed dieback in leaves, perhaps because of dry conditions. The old track is becoming overgrown with Broad-leaved Paspalum (Paspalum mandiocanum) and native shrubs and Monterey Pine (Pinus radiata) have continued to increase the mid-storey and canopy cover on site.

Dieback was also recorded at Gq-C3.1, Previously Gq-C3.1 remained unchanged since November 2017 with 10 adults and five seedlings. During 2019 surveys only seven adult plants were identified. Cover of leaf litter was recorded at 65 percent, nearly three times previous measurements, giving evidence that many different species have died back in the dry conditions.

A summary of G. quadricauda plant numbers at monitoring sites is presented in Figure 3-9.

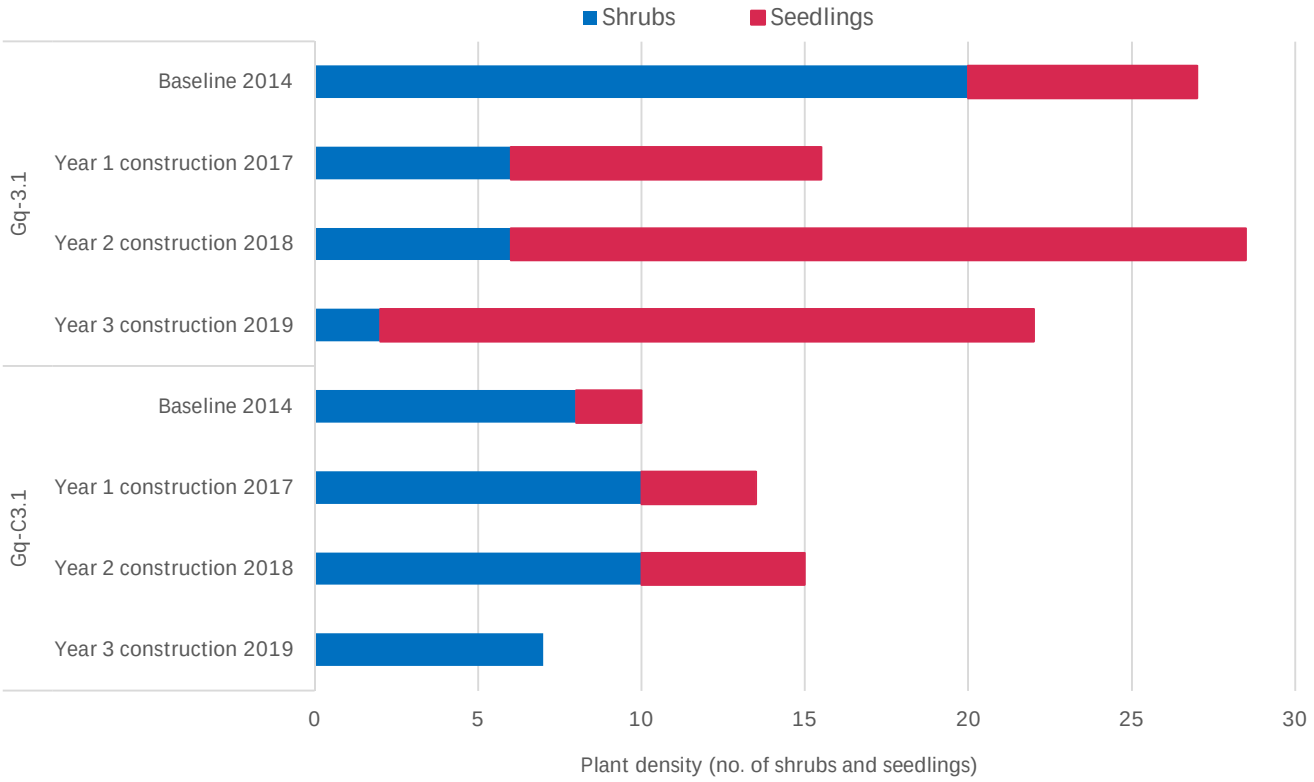

Figure 3-9 Number of G. quadricauda shrubs and seedlings observed over eight monitoring events (2014 [n=1], mean results for 2017 [n=4], mean results for 2018 [n=2] and 2019 [n=1] at in-situ and control site).

3.2.6 Slender Screw Fern (Lindsaea incisa)

Year 3 construction monitoring was undertaken on 1 October 2019 for in-situ sites li-3.1 and Li-3.2 (chainage:55800-60200) and, 15 October 2019 for in-situ sites Li-6.1, Li-6.2 and control site Li-C6.1 (chainage:98600-99300).

In-situ site Li-3.1 has continued to decline since 2018. This site was directly impacted by the approved detailed design work prior to autumn 2018 survey with the construction of a man-made drainage line in the middle of the site, which resulted in some loss of ferns, however many were observed in good health growing on edge of cleared space (refer to Photograph 12). The decrease in areas of occupancy to just 0.5 m^2 observed during 2019 surveys is possibly a result of a combination of this impact plus the dry conditions.

In-situ site Li-3.2 also had a decrease in the area of occupancy of L. incisa from 100 m^2 in 2018 to 10 m^2 in 2019, though the number of stems counted was higher which resulted in an increase in estimated cover within the plot from November 2018. L. incisa ferns were in excellent health during Year 3 construction.

No plants were observed at any of the monitoring locations in Section 6 during 2019 surveys. This follows from 2018 where L. incisa was absent at in-situ site Li-6.2 and control site Li-C6.1, and ferns were scarce and in bad health at in-situ site Li-6.1. These observations are expected to be a result of lower than average rainfall in the region in both 2018 and 2019. The dry and unfavourable conditions were evidenced by wilted and dying L. microphylla observed along the track near in-situ site Li-6.1 (refer to Photograph 13). During spring 2018 surveys, healthy L. incisa ferns were observed along edge of track adjacent to in-situ sites Li-6.1 and Li-6.2 where ferns are exposed to track runoff, however no plants were identified anywhere in habitat surrounding these sites in 2019. This species is likely to be sensitive to the very low rainfall trends and these observations are unlikely to be a project-related impact.

Summary of mean percent cover for all L. incisa sites is presented in Figure 3-10.

Photograph 12: Continue plant growth in 2019 at in-situ Site Li-3.1 despite extensive modification of the site in 2018 for a drainage line.

Photograph 13: Wilted and dying related Lindsaea microphylla observed along the track near in-situ site Li-6.1 evidence of the dry conditions likely responsible for the absence of plants in Section 6.

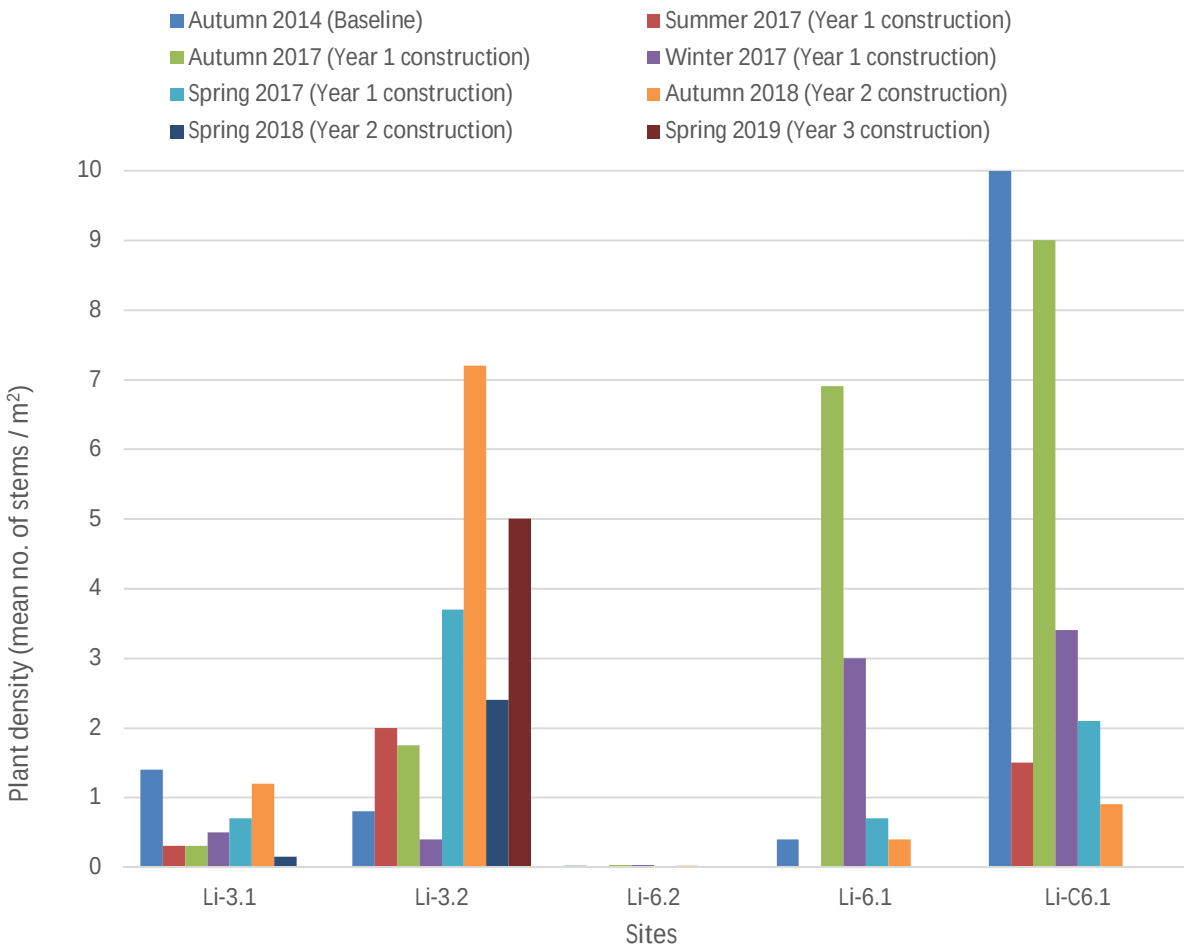

Figure 3-10 Density (mean no. of stems / m^2) of Lindsaea incisa observed over eight monitoring events at four in-situ sites and one control site.

3.2.7 Rough-shelled Bust Nut (Macadamia tetraphylla)

There was no notable change in health of the Macadamia tetraphylla tree or change in weed cover over the third-year construction phase at Site Mac-8.1 (chainage: 134700). The tree appeared to have just finished flowering before the survey, though no fruits were observed. New growth was evident. Weed cover remains high with 70% mean cover in the plot and a total of 13 weed species. Four weeds species have a high cover of abundance including Senecio madagascariensis, Cenchrus clandestinus, Bromus catharticus, Cirsium vulgare and Bidens pilosa.

3.2.8 Maundia triglochinoides

Year 3 construction monitoring was undertaken on 2 October 2019 for in-situ sites Mt-3.1, Mt-3.2 and control site Mt-C3.1, and on 16 October 2019 for in-situ sites Mt-7.1, Mt-7.2 and Mt-7.3.

Notable changes in mean cover and area of occupancy of M. triglochinoides occurred during the Year 3 construction phase at some sites, mostly related to climatic conditions.

No plants were found at in-situ sites Mt-3.1 and Mt-3.2 during 2019 surveys. Control site Mt-C3.1 had a large decrease in cover of M. triglochinoides from 150 m^2 area of occupancy in 2018 to 0.5 m^2 in 2019. All three sites were dry in 2019, a product of drought conditions during the monitoring period (Woodburn recorded 25 percent

of the annual average in 2019 and only 0.2mm between May and December, refer Figure 2-3). As above-ground plant parts of have dieback, presumably M. triglochinoides continue to exist only as tubers in the soil until sufficient water returns.

In-situ site Mt-7.1 nearly doubled in mean percent cover from 2018 to 2019. This is directly related to the dropping water level of the pond, which was observed throughout 2018 also. As the water level recedes, more suitable habitat is created (areas that were previously too deep) and plants now cover nearly the entire area of the pond. However, as the water level continues to drop, plants on the edges will dieback and the availability of habitat will begin to drop. Plants were generally very healthy with less than 5 percent in flower.

There was a large increase in mean percent cover of M. triglochinoides at in-situ site Mt-7.3 during Year 2 construction over the same area of occupancy (100 m^2) observed during Year 1 construction. This was also a result of decreasing water levels creating more suitable shallow habitat. In this time, a bridge with ballast was constructed over the population, and management measures were implemented to reduce impacts to the population such as sediment-fence/curtain. At this stage these measures have been successful at protecting the population from construction-related water quality impacts. However, the construction of the bridge was completed following Year 2 construction, which has now shaded a large portion of the plot that plants were occupying. As a result, the M. triglochinoides area of occupancy within the plot has decreased by almost 50 percent from November 2018. With dropping water levels, plants along the edges are susceptible to dieback. Most of the remaining population is healthy and a moderate proportion of plants were in flower in 2019.

The recovery of the M. triglochinoides population at in-situ site Mt-7.2 from inadvertent indirect impacts during Year 1 construction in 2017 has increased from 2018. Surveys in 2019 recorded an area of occupancy of 29 m^2 (over 300 percent increase from 2018) and the mean percent cover within the plot of 1.3 percent (over 200 percent increase). The increase in cover and abundance is possibly due to a continued increase is the amount of organic material occurring over the construction material that was deposited into the pond during the flood event in 2017. However, while the core of the population begins to recover, it is beginning to be threatened by dropping water levels as a natural event. The deposited bar of gravel from the 2017 flood has isolated a small pool on the edge of the pond. Maundia triglochinoides was most abundant in this small pool during the 2019 survey, however it is no longer connected to the main pond and will likely dry out quickly. The plants observed at Mt-7.2 in 2019 were mostly healthy though none were in flower.

Summary of mean percent cover for all M. triglochinoides sites is presented in Figure 3-11.

Photograph 14: Pre-construction phase at in-situ site Mt-7.2 showing healthy population of M. triglochinoides (May 2014)

Photograph 15: Year 3 construction phase at in-situ site Mt-7.2 showing gradual recovery of M. triglochinoides core population (October 2019)

Photograph 16: Year 3 construction phase at in-situ site Mt-7.2 showing gradual recovery of M. triglochinoides core population (October 2019). Photograph also shows how the sediment bar deposited during 2017 floods has isolated a pool of plants as the water level drops.

Photograph 17: Year 3 construction phase at in-situ site Mt-7.3 showing major dieback of M. triglochinoides under the bridge due to shading (October 2018)

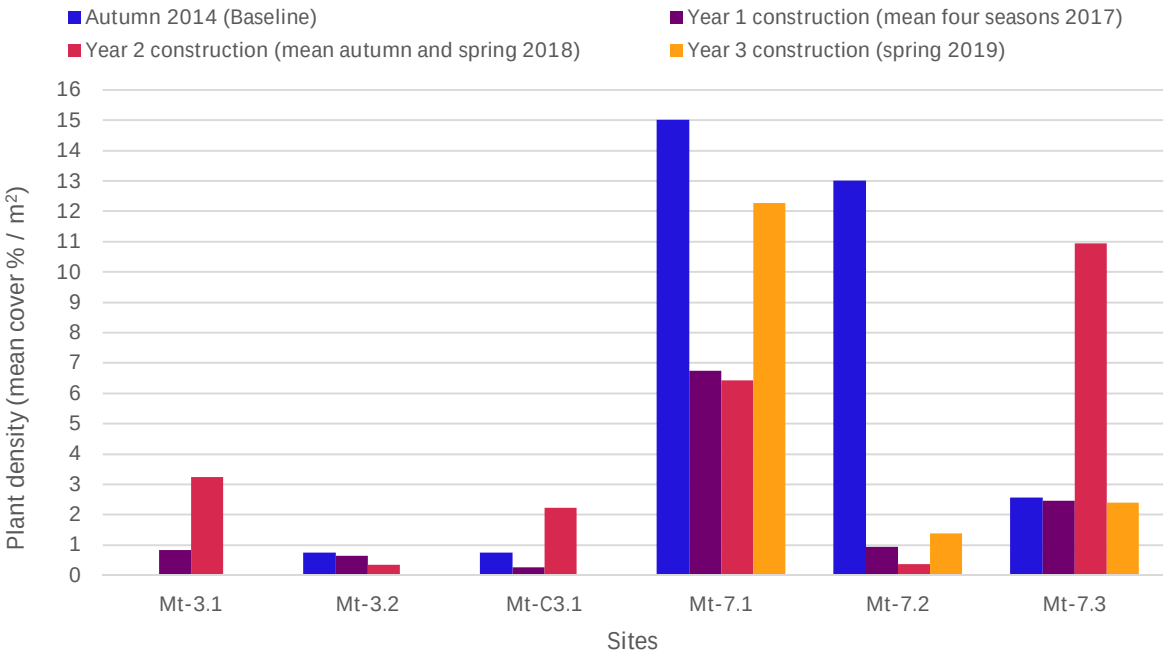

Figure 3-11 Density (mean cover % / m^2) of Maundia triglochinoides observed over eight monitoring events at five in-situ sites and one control site.

3.2.9 Swamp Tea-tree (Melaleuca irbyana)

All active sites for Melaleuca irbyana were surveyed on 16 October 2019. The abundance of M. irbyana at in-situ sites (Mi-7.1 and Mi-7.2, chainage:120800-120900) has remained unchanged. Plants damaged by falling trees during construction activities at in-situ sites Mi-7.1 and Mi-7.2 in April 2018 continue to recover with new growth. Dry conditions have resulted in an increase in leaf litter cover and a decrease in cover of some exotic species (Polygala paniculata not identified at Mt-C7.1). The control site Mi-C7.1 (chainage: 120800) generally remains unchanged.

3.2.10 King of Fairies (Oberonia titania)

Both in-situ site Ot-10.1 and control site Ot-C10.1 (chainage:152300) were surveyed on 18 October 2019. Conditions were very dry in the wet forest habitat for O. titania.

There have been slight increases in O. titania at both sites as new small plants continue to occur. It is difficult to count the number of individual plants high in trees, though some trunk patches appear to be increasing in density and spread. One small plant was observed at in-situ site Ot-C10.1 where plants had been previously overgrown by a large staghorn. Most plants were in good health though showed signs of the current dry conditions. Between 30-95 percent of plants on the different host trees showed evidence of having recently flowered.

3.2.11 Tall Knotweed (Persicaria elatior)

Data was collected for Persicaria elatior on 1 October 2019 for in-situ sites Pe-4.1, Pe-4.2a and Pe-5.1, and control site Pe-C4.1.

No P. elatior were recorded in Year 3 construction monitoring at any of the four sites. The abundance of plants at all sites has been in a general trend of decline over the monitoring program. The highest number of plants recorded at each site was during baseline surveys. All sites exhibited an increase in exotic species cover.

These changes are most likely directly related to the lower than average annual rainfall the region has experienced in three of the last five years, as opposed above average annual rainfall in the four years prior to baseline surveys (refer Figure 2-4). Particularly low rainfall in Year 3 construction monitoring (Grafton Research Station received 31 percent of the historical annual average in 2019 – refer Figure 2-2) resulted in the eventual drying out of standing water at all four monitoring sites.

These declines are not project related. Refer to Figure 3-12 for a summary of results.

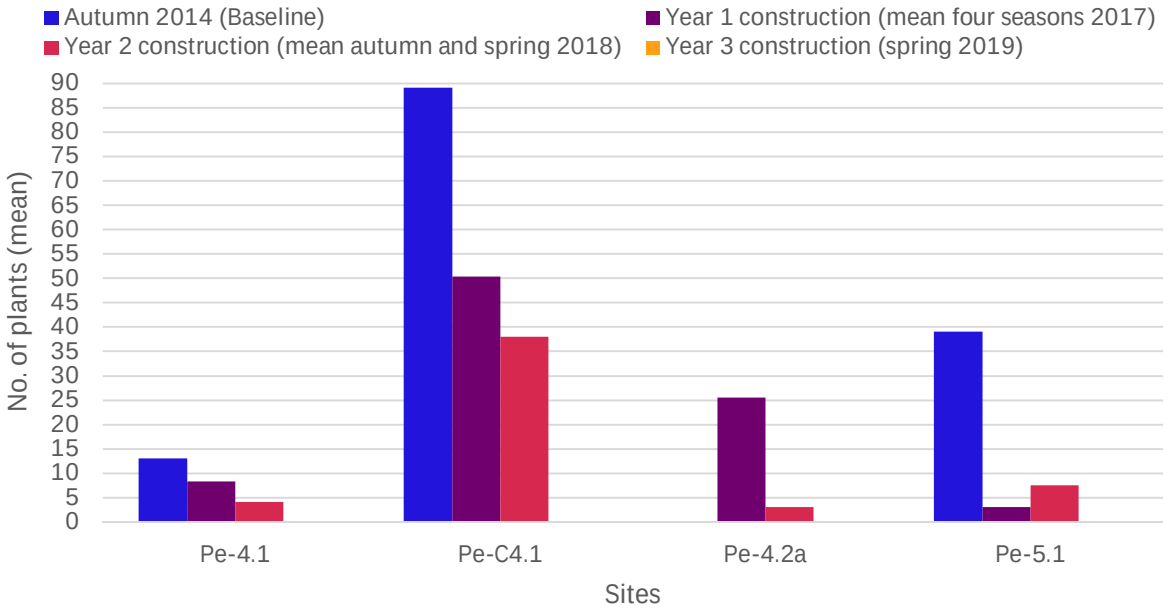

Figure 3-12 Mean number of Persicaria elatior plants over eight monitoring events (baseline and construction) at three in-situ sites and one control site. No baseline data exists for site Pe-4.2a as it was added in 2017.

3.2.12 Singleton Mintbush (Prostanthera cineolifera)

Both the in-situ (Pc-6.1) and control (Pc-C6.1a) (chainage: 101700) were surveyed on 16 October 2019. Plant abundance at Site Pc-6.1 has remained stable since winter 2017. Since Year 1 construction, there has been some minor natural plant mortalities but also seedling recruitment from mature plants. In October 2019, 62 plants were recorded, most in good health and around 40 percent in flower.

There were similar trends at control site Pc-C6.1a with minor fluctuations in plant abundance. In October 2019, there were 88 plants recorded in good health, with minor damages from fallen trees and branches, herbivory and insect attack. Since winter 2017, there has been a loss of 17 plants however many of these were seedlings that established during favourable conditions in 2017.

Wilting of the leaves of some P. cineolifera plants was observed at both sites. This is likely a response to the dry conditions across the region and at this site as the creek behind the sites was dry.

Lantana camara cover and abundance remains low at both sites. Cover of exotic species is generally low at both sites.

No construction-related impacts affecting P. cineolifera were identified.

3.2.13 Rotala tripartita

Both Rotala tripartita in-situ sites Rt-6.1 and Rt-6.2 were surveyed on 16 October 2019. No plants were recorded at either site. Both drainage lines were completely dry, and most wetland species had been replaced by pasture species. Plants have not been recorded since April 2018, when the last of the small population were observed at Rt-6.2. It is understood that individuals of this population were removed in 2017 as part of the project translocation program (Benwell 2019). This population likely exists most of the time in the soil seed-bank, only growing plant parts during periods of suitable rainfall. Weed groundcover remained high (90 percent at RT-6.1 and 100 percent at Rt-6.2). There has been no evidence of inadvertent construction-related impacts.

4. Evaluation of performance criteria, mitigation measures and impact thresholds

4.1 Amendments to the program and assessing impacts

As outlined in section 4.1 of the TFMP further pre-clearing flora surveys were undertaken by suitably qualified ecologists to reconfirm the distribution and abundance of threatened flora populations in proximity to the project prior to clearing for construction. Where additional populations of threatened flora were identified these were quantified and could be managed and translocated prior clearing. This has resulted in a revised baseline threatened flora layer and shown in the Appendix B as “Additional finds & GIS consolidation”.

Through the detailed design process, the project construction footprint was reduced. This resulted in a significant reduction to the overall impacts to threatened flora in situ compared to quantities reported in the approved EIS/SPIR. Where there was an increase this was contained within the project approval boundary and where feasible additional translocation efforts were undertaken.

The minor changes to the construction footprint affected the previous placement of some impact monitoring plots established in the early pre-construction phase. Replacement sites were established where there was opportunity to do this, which allowed for threatened species adjacent to the project boundary to be continually monitored and addressed the refinements of detailed design. Additionally, it was agreed with Transport for NSW to establish new control sites to allow for additional data to be collected where sites were on private land with access restrictions.

The updated clearing boundary as a result of the Detailed Design has changed the total number of threatened flora species and individuals expected to be impacted during construction and has reset the total remaining in-situ populations for following monitoring years.

Appendix B presents the updated threatened flora impact table for Year 3 construction 2019 for Sections 3-10, outlining the following:

1. EIS/SPIR boundary/impact – Expected impact on threatened flora based off the concept design boundary/EIS and outlined in the Threatened Flora Management Plan.

2. EIS/SPIR boundary/impact + Additional finds and GIS consolidation - Expected impact on threatened flora based off the Concept Design/EIS boundary using the revised threatened flora layer.

3. Current boundary/impact + Additional finds and GIS consolidation - Expected impact on threatened flora based off the current Detailed Design boundary using the revised threatened flora layer.

4. Net change – Comparison between the Concept Design EIS/SPIR boundary and the Detailed Design Clearing boundary using the revised threatened flora layer.

As noted in Section 2.3.2, the baseline methods for determining the abundance of threatened groundcover species was coarse and a percentage of mean cover over an area of occupancy for each relevant species was subsequently introduced into the method during the construction monitoring surveys to improve the detection of change. This allowed for an effective measure of change to be monitored over each season and identified typical trends in plant dieback in response to rainfall and other climatic factors. A percentage mean cover for relevant species from baseline data was estimated to provide indicative comparisons for measuring performance criteria. Therefore, this information has been viewed with consideration of other site observations and evidence when scrutinising data after each sampling event prior to making and assessment of impact.

4.2 Discussion of observed impacts and threats to threatened flora

A total of 81 sites were monitored in 2019 as part of the revised 2018 program comprising 62 impact and 19 control sites. All 37 threatened flora species sites for Section 1 and 2 were surveyed in spring 2019 for the Year 2 operational monitoring. The remaining 44 sites in Sections 3-10 were surveyed spring 2019 for the Year 3 construction monitoring.

No major changes or notable impacts were observed from the 2019 operational monitoring in Section 1 and 2 and most sites only experienced slight decreases in plant abundance considered a result of the low annual rainfall in 2019 compared to previous years. For example, aquatic species reliant on persistent surface water such as Eleocharis tetraquetra and Maundia triglochinoides were absent at some sites where water has completely dried up. These changes are considered natural variation and in response to climatic conditions and not a result of operational activities.

After revision of the 2019 results, there are now currently 79 sites comprising 60 in-situ and 19 control sites active for the ongoing future program. The single mature tree at Site Emb-4.2 was unintentionally removed by a construction contractor in January 2019 during construction activity. This site has subsequently been removed from the monitoring program as there are no longer any trees to monitor.

A small number of the in-situ sites monitored in Sections 3-10 in spring 2019 were observed to have direct and/or indirect impacts in Sections 3-10 either associated with the project or non-project related activities. Observed impacts include:

1. Loss of the single mature Endiandra muelleri subsp. bracteata shrub at site Emb-4.2 from unintentional clearing by a construction contractor in January 2019.

2. Continued dieback of Xanthorrhoea sp. and B. oblongifolia at Ar-3.7 (outside the project boundary) was observed and is potentially being caused by root-rot fungus Cinnamon Fungus but would need to be confirmed.

3. Changed hydrology and weed abundance at site Ah-10.4.

4.3 Measuring performance criteria

The TFMP provides indicative thresholds for measuring the performance of mitigation measures applied during the project construction. It is noted that some of the performance goals do not relate to the in-situ threatened flora species and monitoring program, such as plant translocation (examined in the translocation monitoring program) and dust monitoring. The relevant construction performance criteria and thresholds (refer to Section 2.4) that trigger corrective actions for this program is presented in Table 4-1 and only relate to those sites situated outside of the updated clearing boundary.

Goals supporting the management of dust, translocation and habitat revegetation is not covered in the construction monitoring program. No dust was observed affecting in-situ sites.

The relevant goals for mitigating impacts from Year 3 construction (relevant to Sections 3-10) are addressed by the monitoring program as outlined in section 2.4, include:

- Zero mortality of threatened plants from in situ populations (from physical damage during construction) and no loss of threatened plants directly adjacent to the project
- No notable increase in the abundance of weeds within threatened plant habitat during monitoring of in situ populations
- Water and soil quality managed in accordance with the CEMP
- Reduce impacts to threatened orchid species through illegal collection.

This chapter focuses on addressing these goals relevant to the monitoring program and are summarised below.

Goals for mitigating impacts from Year 2 operation (relevant to Section 1 and 2) are addressed by the monitoring program as outlined in section 2.4, include:

- Zero mortality of retained in situ threatened plant populations during construction and for three consecutive monitoring periods post-construction.
- Post the above period 80 per cent survival of tree, shrub and herbaceous perennials after three years
- Less than five per cent weed cover at retained in situ threatened flora sites (end of monitoring program).

4.4 Effectiveness of mitigation measures implemented for in-situ sites

4.4.1 Method of mitigation and discussion of impacts

Where mitigation measures have been applied during construction and operation, the effectiveness of these were assessed in relation to impacts on in-situ threatened plants at the monitoring sites. The mitigation measures applied to protect threatened plants include:

- Identification of exclusion zones and clearing limits prior to clearing.
- Identification of exclusion zones informed by targeted surveys.
- Exclusion zones fenced off to protect in situ threatened plants.
- Monitor in-situ plants at established monitoring sites during construction.
- Salvage and planting of identified plants for translocation undertaken prior to clearing, into suitable habitat, and using appropriate methods that maximise the chance of plant survival.
- Adequate soil and water quality controls installed surrounding retained threatened plants.
- Procedures for maintenance and monitoring of erosion and sediment controls included in the CEMP.
- Restrict the availability of information identifying where orchids occur within the project area, and in close proximity to the project area.
- Limit site access to areas where orchids naturally occur and may be being managed in situ.

Examples of impacts observed during the second and third year of construction within and outside the project boundary are described below, with reference to whether these are project-related and therefore an assessment of the effectiveness of the mitigation applied.

1. As mentioned above, the single mature Endiandra muelleri subsp. bracteata shrub at site Emb-4.2 was inadvertently removed by a construction contractor in January 2019. This site was located within the approved clearing boundary; therefore, it is not an additional impact, however the plant was proposed to be retained for translocation. Pacific Complete have advised that the construction contractor (BGC Contracting) has developed and is implementing the Green-leaved Rose Walnut Rehabilitation Plan – W2B Section 4 Major Civil Works (Geolink 2019) to address corrective actions. The Rehabilitation Plan includes collaboration with local expert Dr Andrew Benwell (ECOS Environmental Pty Ltd) and contains four specific actions:

    i. Targeted Green-leaved Rose Walnut Surveys - Identify additional occurrences of Green-leaved Rose Walnut in the Maclean area.

    ii. Collect and Propagate Seeds/ Cuttings - Collect and propagate at least 20 Green-leaved Rose Walnut seeds/ cuttings sourced from trees in the Maclean area or W2B Section 10.

iii. Vegetation Regeneration and Green-leaved Rose Walnut Plantings (Management Zone 1) - Plant at least 10 propagated Green-leaved Rose Walnut trees as part of a vegetation regeneration area (Management Zone 1).

iv. Vegetation Regeneration (Management Zone 2) - Manage weeds within Management Zone 2 around the retained in-situ Green-leaved Rose Walnut at approximate chainage 81700.

It is understood that the first action has been completed, with the second to commence in April 2020.

2. Continued increases in the cover of weed species was noted at sites with Arthraxon hispidus (Ah-10.1, Ah-10.3, Ah-10.4, Ah-10.5, Ah-10.6) since the beginning of monitoring (refer Table 3-1). The wetland where this site is located is around the upper reaches of Saltwater Creek and appears to have been slowly drying out since 2017. This is likely primarily being caused by lower than average rainfall in the region over the last two years (75 percent in 2018 and 25 percent in 2019). As the wetland has dried, it has become unsuitable for many of the natively occurring plant species, which are being increasingly replaced by exotic species such as Ageratum houstonianum and Commelina benghalensis, forming a dense cover and out-competing small forbs. Similar changes have been noted at control sites Ah-C10.2 and Ah-C10.2. This is not project related, however it is possibly being exacerbated by changes in land use since the commencement of construction (e.g. reduced cattle grazing).

3. Major increases in the abundance and number of weed species was noted in 2018 at Endiandra muelleri subsp. bracteata sites Emb-4.1 and Emb-4.2 within the project boundary. Although sites had existing weeds, long-term monitoring results and site observation of construction works indicated notable weed problems exacerbated by the project. Weed management actions were undertaken at site Emb-4.1 on 11 April 2019, with all actions completed. Ongoing weed maintenance is to continue as per BGC contract requirement. Surveys in spring 2019 confirmed that weed management actions had been effective in removing the weeds impacting this site.

4. Damage to Melaleuca irbyana shrubs at sites Mi-7.1 and Mi-7.2 occurred during vegetation clearing in 2018. Damage occurred to plants inside the project boundary at Mi-7.1, though the impact at Mi-7.2 was to plants just outside the project boundary. Measures to avoid plants was evidenced by establishing flagging to identify the clearing boundary and each individual plant was also flagged. However, damage to stems and dieback of in-situ trees was evident. It seems warranted that plants were damaged during tree felling where removed tree trunks and branches fell outside flagged exclusion areas. New shoots were evident in November 2018 and these plants showed continued recovery in October 2019, indicating no mortality of plants and that these individuals are recovering since the original low-level impact. Plants damaged in site Mi-7.2 occurred outside the project boundary and continued monitoring has demonstrated normal recovery of these plants.

5. Suspected root-rot fungus at the Angophora robur site Ar-3.7. Surveys in 2019 saw continued mortality of native plants Xanthorrhoea sp. and B. oblongifolia. Pacific Complete engaged a consultant in 2018 to undertake sampling for Phytophthora cinnamomi along the entire project alignment, which found the fungus to be widespread. Management specification since the commencement of the project has included requirements for construction equipment wash downs before entering the project area. It is difficult to confirm if construction activities have contributed to the spread and prevalence of Phytophthora cinnamomi.

6. Population of Maundia triglochinoides monitored at three in-situ sites (Mt-1.1, Mt-7.2 and Mt-7.3) was inadvertently impacted by the sediment run-off from the March 2017 storm event. Continued monitoring in 2018 and 2019 has showed that the population is slowly recovering from this flood event. Site Mt-1.1 still has no evidence of re-appearing plants.

4.5 Thresholds triggering corrective actions

As discussed above, the Melaleuca irbyana site Mi-7-2 was inadvertently impacted outside the project boundary in 2018, but it is unknown whether impacts were caused by project construction activities or other contractors. Annual monitoring has shown no loss of threatened plants at sites Mi-7.1 and Mi-7-2 and damaged plants were observed to be recovering with healthy regrowth in spring 2019. All sites will continue to be monitored for the remaining of the program.

The TFMP identifies the parameters for monitoring performance of in-situ populations during construction and operation. These are described as performance measures and set a threshold whereby if impacts occur and exceed this threshold, specific corrective actions are required. The set of threshold triggers and corresponding corrective actions from the TFMP are outlined in Table 4-1.

Table 4-1 Corrective actions relating to triggered performance thresholds

Threshold triggers	Corrective actions
Any loss of retained in situ threatened plants.	Commence assessment of potential reasons for mortality, including seasonal fluctuations, natural events such as drought and fire within one month of trigger being identified. Compare with paired control site. Identify potential threats, implement corrective actions and modify monitoring as necessary.
Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Review adequacy of the erosion, sediment and water quality controls and implement appropriate corrective actions. Commence review of monitoring procedures for controls and implement appropriate corrective actions.
Exclusion zone fencing is damaged or ineffective.	Stop construction in the area of the fencing breach until exclusion fencing has been repaired. Investigate why breach in fencing occurred and implement corrective actions as required to prevent reoccurrence.

Table 4-2 summarises the assessment of these species at in-situ sites that have been impacted within and outside the project boundary and triggered corrective actions. There was no evidence to suggest a breach of the performance goal ‘reduce impacts to threatened orchid species through illegal collection’ relevant to O. titania. Monitoring and location data is kept secure and only reported to Transport for NSW.

Table 4-2 Assessment of thresholds triggering corrective actions for threatened flora during construction (relevant to Sections 3-10)

Species	Thresholds (triggers for corrective actions)				Impacts within approved project boundary.	Requires corrective actions (inadvertent construction impact
	Any loss of retained in situ threatened plants.	Noxious and environmental weeds reported in areas adjacent to threatened plants Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Exclusion zone fencing is damaged or found to be ineffective.		
Year 3 construction (Section 3-10)						
Angophora robur	Yes – 1 dead tree identified at Ar-3.5 in 2018 but not project related	Possible – root rot fungus at Ar-3.7. No mortality noted for A. robur sites	No	No	No	No, past sampling of Cinnamon Fungus has indicated positive detection across entire site, with no known source. Appropriate mitigation measures were undertaken to reduce risk such as construction equipment wash downs before entering the project area.
Arthraxon hispidus	Yes – Loss of all plants at Ah-10.4 and Ah-10.5	Yes – cover of weeds at Ah-10.1, Ah-10.2, Ah-10.3, Ah-10.4, Ah-10.5 and Ah-10.6 has increased since baseline surveys, though not expected to be project related	No	No	Yes	No. These individuals were found to be within the approved clearing limits of the detailed design and the impact is unlikely to be construction related.

Species	Thresholds (triggers for corrective actions)				Impacts within approved project boundary.	Requires corrective actions (inadvertent construction impact
	Any loss of retained in situ threatened plants.	Noxious and environmental weeds reported in areas adjacent to threatened plants Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Exclusion zone fencing is damaged or found to be ineffective.		
Cyperus aquatilis	N/A – no individuals identified	No	No	No	N/A	No
Endiandra muelleri subsp. bracteata	Yes – inadvertent clearing of the single shrub at in-situ site EMB-4.2, which is inside the clearing boundary	No – Weed management action have been conducted at Emb-4.1, which is now mostly free of exotic species	No	No	Yes	Yes, not consistent with goal 'Zero mortality of threatened plants from in situ populations (from physical damage during construction) and no loss of threatened plants directly adjacent to the project' – Pacific Complete have advised that the contractor has developed and is implementing a Remediation Plan to address corrective actions.

Species	Thresholds (triggers for corrective actions)				Impacts within approved project boundary.	Requires corrective actions (inadvertent construction impact
	Any loss of retained in situ threatened plants.	Noxious and environmental weeds reported in areas adjacent to threatened plants Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Exclusion zone fencing is damaged or found to be ineffective.		
Grevillea quadricauda	Yes – dieback of four mature shrubs from Gq-3.1	No	No	No	Yes	No. Dieback is considered natural variation due to drought conditions. This is evidenced by similar dieback of three mature shrubs observed at Gq-C3.1.
Lindsaea incisa	Yes – dieback of plants from all sites. Plants absent in 2019 from Li-3.1, Li-6.1 and Li-6.2	No	No	No	No – Li-3.2, Li-6.1 and Li-6.2 outside	No. Dieback is considered to be a response to drought conditions and not a construction impact.
Macadamia tetraphylla	No	No	No	No	N/A	No
Maundia triglochinoides	Yes – dieback of plants at Mt-3.1, Mt-3.2 and Mt-7.3	No	No	No	No – Mt-31. And Mt-3.2 outside of project boundary	No – dieback of plants at Mt-31 and Mt-3.2 is due to drying of surface water which is a result of drought
Melaleuca irbyana	No	No	No	No	N/A	No
Oberonia titania	No	No	No	No	N/A	No
Persicaria elatior	Yes – dieback of all plants at all sites	No	No	No	No – Pe-4.1 is mostly located outside the boundary.	No. Dieback is considered natural variation and due to drought.

Species	Thresholds (triggers for corrective actions)				Impacts within approved project boundary.	Requires corrective actions (inadvertent construction impact
	Any loss of retained in situ threatened plants.	Noxious and environmental weeds reported in areas adjacent to threatened plants Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.	Exclusion zone fencing is damaged or found to be ineffective.		
Prostanthera cineolifera	Yes – dieback of all plants at Pc-6.1	No	No	No	No	No. Dieback is considered natural variation. This is evidenced by similar dieback of shrubs and seedlings observed at Pc-C6.1.
Rotala tripartita	Yes – dieback of all plants at both sites	No	No	No	No	No. Plants are within the construction boundary. Dieback of plants is due to drying of water which is a result of drought.

Table 4-3 Assessment of thresholds triggering corrective actions for threatened flora during operation (relevant to Sections 1-2)

Species	Thresholds (triggers for corrective actions)		Impacts within approved project boundary.	Requires corrective actions (inadvertent construction impact
	Any loss of retained in situ threatened plant populations for three consecutive monitoring periods post-construction.	Less than five per cent weed cover at retained in situ threatened flora sites (end of monitoring program).		
Year 2 operation (Section 1 and 2)				
Eleocharis tetraquetra	N/A – only two monitoring periods have occurred post construction	N/A – monitoring program still underway. Up to 10% exotic groundcover recorded at Elt-2.1 in 2019.	N/A	No
Eucalyptus tetrapleura	Yes – loss of 1 tree at one site Et-2.1 and Et-2.3 but not project related	N/A – monitoring program still underway. No exotic cover recorded in 2019.	No	No
Lindernia alsinoides	N/A – only two monitoring periods have occurred post construction	N/A – monitoring program still underway. Range of common exotic species recorded over the monitoring surveys.	N/A	No
Lindsaea incisa	N/A – only two monitoring periods have occurred post construction	N/A – monitoring program still underway. Range of common exotic species recorded over the monitoring surveys.	N/A	No
Maundia triglochinoides	N/A – only two monitoring periods have occurred post construction	N/A – monitoring program still underway. Range of common exotic species recorded over the monitoring surveys.	N/A	No
Quassia sp. Moonee Creek	N/A – only two monitoring periods have occurred post construction	N/A – monitoring program still underway.	N/A	No

5. Correction actions and recommendations

5.1 Adaptive management

The TFMP outlines an adaptive and responsive management approach, whereby the results of the monitoring program provide input into the design and refinement of mitigation measures and ongoing monitoring.

Where monitoring results have indicated a substantial decline in the health and number of threatened plants at in-situ sites, adaptive management measures can be implemented. Additional recommendations outlined below may be used to update the TFMP.

5.2 Recommendations

Construction activities exceeding the performance thresholds were noted at one location that is inconsistent with the goals of the TFMP and therefore has triggered the need for corrective actions. The current TFMP sets out prescribed corrective actions for all threatened flora species that have in part been addressed in this report by the assessment of site observations and reasons for impact. Some corrective actions are time bound and require immediate implementation that are not achievable prior to reporting and permanent loss of threatened flora may result. Part of the monitoring program has been already slightly modified to improve the measure of change at threatened flora sites, as well as increasing and replacing the number of plot locations as required.

Operational corrective actions follow the same actions if thresholds are triggered for any loss of plants or increases in weeds. No notable impacts to threatened flora and/or sites observed in Section 1 and 2, therefore no corrective actions are required for sites following the Year 2 operation monitoring period. However, it is noted that the thresholds for operation cannot be assessed until after at least three consecutive operational monitoring events.

Table B-1 in Appendix B provides a detailed overview of all net changes following detailed design which shows an overall reduction in direct impacts to threatened flora populations. Any impact increases have been contained within the approved project boundary as well as mitigation measures to translocate individuals where feasible. Investigation and future monitoring into impacted flora populations outside the approved project boundary is continuing of which none are project-related.

Based on the results of the monitoring in 2019, there are no recommended corrective actions required.

6. References

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Appendix A. Threatened Flora Monitoring Sites (Figures)

Appendix B. Differences in EIS vs Current Clearing Boundary for Threatened Flora (Year 2 reset)