Transport Roads & Maritime Services

2015 Annual Ecological Monitoring Report

Frederickton to Eungai Pacific Highway Upgrade

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1. Introduction

1.1. Purpose

This report provides an update on the ecological issues associated with the Frederickton to Eungai Pacific Highway upgrade. This report covers the period of 1 December 2014 to 30 November 2015. This report has been prepared in accordance with the Ecological Monitoring Program: Frederickton to Eungai (Lewis Ecological 2013), for submission to the Department of Planning and Environment and Environmental Protection Authority (EPA). This report includes *Maundia triglochinoides*, Hairy Joint Grass and nest box monitoring undertaken in 2015. There was insufficient rain to conduct the 2015 Green-thighed Frog monitoring.

1.2. Statutory and planning framework

Approval for the Kempsey to Eungai Pacific Highway upgrade was granted by the State Government on 10 July 2008. Kempsey to Eungai Pacific Highway upgrade is being delivered in two stages with Stage One extending from Kempsey to Frederickton and Stage Two extending from Frederickton to Eungai. This report focuses on ecological monitoring associated with Stage Two, known as the Frederickton to Eungai project.

The Kempsey to Eungai Pacific Highway upgrade approval included the requirement to develop an ecological monitoring program:

ENVIRONMENTAL MONITORING AND AUDITING

Ecological Monitoring

Prior to the commencement of construction, the Proponent shall develop and implement a Monitoring Program to target the effectiveness of the mitigation measures identified in Condition 2.10(d) for the listed threatened species directly impacted by the project. The program shall include (but not necessarily be limited to) the monitoring of Maundia triglochinoides, Green-thighed Frog, Glossy Black Cockatoo and the Brush-tailed Phascogale. The Program shall be developed in consultation with the DECCW and suitably qualified ecologist(s) and shall include but not necessarily be limited to:

> *a) the monitoring of threatened species in and adjacent to the project footprint. The methodology shall be decided in consultation with DECCW;*
> *b) an adaptive monitoring program to assess the effectiveness of the mitigation measures identified in Condition 2.10 (d) and allow their modification if necessary. The monitoring program shall include targets against which effectiveness will be measured;*
> *c) monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the project to traffic (for operation/ongoing impacts) until such time as the effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, or as otherwise agreed by the Director General in consultation with DECCW;*
> *d) provision for the assessment of the data to identify changes to habitat usage and if this can be attributed to the project;*
> *e) details of the contingency measures that would be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the project; and*
> *f) provision for annual reporting of monitoring results to the Director General and the DECCW, or as otherwise agreed by those agencies.*

The Program shall be submitted to the Director General prior to the commencement of construction and shall be updated to incorporate the monitoring methodology for threatened species, once agreed to, in accordance with condition of this approval.

The current Ecological Monitoring Program: Frederickton to Eungai was approved by the Department of Planning and Environment on 25 July 2013. This ecological monitoring program includes the provision for annual reporting to the Director General and EPA.

The Ecological Monitoring Program is currently being updated, due to be submitted to the Department of Planning & Environment soon. Until this plan is reviewed / re-approved the monitoring requirements of the approved Ecological Monitoring Program are being complied with.

1.3 Report Structure

This report details ecological monitoring undertaken between the December 2014 and November 2015 reporting period. The ecological monitoring undertaken during this reporting period is presented as separate reports contained within Attachment A, B and C of this report. Attachment A describes *Maundia triglochinoides* monitoring undertaken three times in 2015, Attachment B includes the Hairy Joint Grass monitoring report undertaken three times in 2015 and Attachment C details the nest box monitoring undertaken in summer and winter 2015.

These reports outline the monitoring that has been undertaken, the results and how the results compare against the key performance criteria. The reports also identify the need for any corrective actions/ contingency measures along with general recommendations. A summary of the results and recommendations from these reports is included within Sections 2 and 3 of this report.

A separate report has been prepared for the pre-clearing and clearing works.

2. Summary of Results

2.1 Maundia triglochinoides

The first *Maundia triglochinoides* monitoring for the project was undertaken in February, April and May 2015. During this monitoring *Maundia triglochinoides* was determined to be present at 11 monitoring locations within and outside the Project boundary. Where observed, plant relative abundance was variable ranging from discrete individuals to extensive swards. Flowering and seed set was evident at several sites. Evidence of recruitment was also observed at several sites although not all impact/ control pairs exhibited regeneration. The monitoring data currently indicates that lifecycle processes for *Maundia triglochinoides* are persisting within the Project boundary and external control/ reference monitoring sites.

General compliance with performance indicators 1 and 2 as specified in the *Maundia triglochinoides* monitoring program has been achieved (i.e. fencing and signage to protect the locations of *Maundia triglochinoides* within the Project boundary are generally in place). Limitations in the monitoring design and method have prevented the use of statistical analyses to assess impact. When using the 'substantial difference' test, it appears that *Maundia triglochinoides* has not declined.

2.2 Hairy Joint Grass

The first Hairy Joint Grass monitoring for the project was undertaken in February, April and May 2015. *Arthraxon hispidus* was determined to be present at two of the three impact monitoring locations (plots) within the Project boundary. In the first (February) monitoring campaign, *Arthraxon hispidus* was determined to be present at all three monitoring locations outside the Project boundary (control sites). Presence on control sites within private lands adjacent to the Project was not determined after the first monitoring event, as the land holders denied access to the sites for subsequent monitoring.

Where it was observed, plants occurred in discrete locations (quadrats) with cover abundance in each quadrat generally determined to be low (up to 5% cover) with some exceptions. Flowering and seed set occurred at both impact plots in which the species occurred. However, each plot supported a dense cover of grass and a mix of exotic and native species so that recruitment of *Arthraxon hispidus* is likely to be restricted in these plots.

General compliance with performance indicators 1 and 2 as specified in the *Arthraxon hispidus* monitoring program has been achieved (i.e. fencing and signage to protect the locations of *Arthraxon hispidus* in the Project boundary are generally in place). However, lack of access to private land adjacent to the Project has prevented monitoring of control sites as required (after the first February monitoring campaign). Therefore performance indicator 3 cannot be assessed as planned. Only a coarse measure of presence-absence can be provided in that plants remain present at two of the three impact sites. General recommendations are discussed in Section 5 of the report.

2.3 Nest boxes

The rate of occupancy by native species was 11% during both the summer and winter monitoring events. A high number of nest boxes showed signs of usage (including those containing native fauna). This includes 47% and 34% of monitored nest boxes during the summer and winter monitoring events, respectively. 47% of boxes in the summer monitoring event and 66% of boxes in the winter monitoring event showed no signs of usage.

An exotic fauna occupancy rate of 8.5% was recorded during the summer survey, which dropped to 1.1% in the winter survey. No nest boxes required maintenance, and those that were removed prior to the monitoring event or could not be found were relocated.

3 Recommendations

The reports contained within Attachment A through to C contain contingency measures and general recommendations. These recommendations as well as Roads and Maritime Services response is summarised in the below table.

Table 1: Consideration of recommendations raised during ecological monitoring.

Recommendations	Roads and Maritime Response
Maundia triglochinoides	
Consideration of adjustments to the monitoring design following ongoing issues with landowner agreements.	The update to the Ecological Monitoring Program, currently being finalised by Roads and Maritime addresses these landowner agreement issues.
Hairy Joint Grass	
Potential impact plots are recommended to be slashed, preferably in winter to provide recruitment opportunities.	In consultation with the EPA, this was conducted in September 2015 at one of the impact sites. The other two sites were left to prevent any disturbance to the Hairy Joint Grass found during the previous monitoring event.
Nest Boxes	
N/A	

Attachment A: Maundia triglochinodes 2015 monitoring report

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Environment and Heritage

F2E Pacific Highway Upgrade

Maundia triglochinoides Monitoring 2015

Prepared for Roads and Maritime Services

May 2016

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Cover photograph: Maundia triglochinoides; flowers, inflorescence and habit (photo by: Mr Mark Aitkens, Niche Environment and Heritage).

Executive summary

Context

This report documents the 2015 monitoring period for *Maundia triglochinoides* as required by the Frederickton to Eungai (F2E) Ecological Monitoring Program, prepared in accordance with the Minister's Condition of Approval 3.1.

Aims

The aim of the F2E Ecological Monitoring Program is to "determine the effectiveness of flora and fauna mitigation measures" as per the Statement of Commitment (SoC) - F22. The term effectiveness for the purposes of the Ecological Monitoring Program will be defined via the performance indicators outlined.

Methods

Maundia triglochinoides is widely distributed within and outside the Project boundary with 14 monitoring sites identified (four reference and 10 paired 'impact' and 'control' monitoring sites). Each monitoring location was surveyed in accordance with the monitoring method and design specified in Lewis (2013).

Key results

Maundia triglochinoides was determined to be present at 11 monitoring locations within and outside the Project boundary. Where observed, plant relative abundance was variable ranging from discrete individuals to extensive swards. Flowering and seed set was evident at several sites. Evidence of recruitment was also observed at several sites although not all impact/ control pairs exhibited regeneration. The monitoring data currently indicates that lifecycle processes for *Maundia triglochinoides* are persisting within the Project boundary and external control/ reference monitoring sites.

Conclusions

General compliance with performance indicators 1 and 2 as specified in the *Maundia triglochinoides* monitoring program has been achieved (i.e. fencing and signage to protect the locations of *Maundia triglochinoides* within the Project boundary are generally in place). Limitations in the monitoring design and method have prevented the use of statistical analyses to assess impact. When using the 'substantial difference' test, it appears that *Maundia triglochinoides* has not declined, although such conclusions must be carefully considered because of methodological limitations in the monitoring design.

Management implications

Access to private lands for the purposes of monitoring was not available for five control sites during differing monitoring campaigns. Adjustments to the monitoring design could be considered to improve monitoring outcomes if access to private lands is expected to be an ongoing issue.

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1. Introduction

1.1 Context

The Minister for Planning approved the Kempsey to Eungai upgrade under part 75J of the EP&A Act on 10 July 2008 subject to a number of conditions. One of these conditions (MCoA 3.1) states that:

Prior to the commencement of construction, the Proponent shall develop and implement a Monitoring Program to target the effectiveness of the mitigation measures identified in Condition 2.10(d) for the listed threatened species directly impacted by the Project. The program shall include (but not necessarily be limited to) the monitoring of *Maundia triglochinoides*, Green-thighed Frog, Glossy Black Cockatoo and the Brush-tailed Phascogale. The Program shall be developed in consultation with the Department of Environment Climate Change and Water (DECCW) and suitably qualified ecologist(s) and shall include but not necessarily be limited to:

a) The monitoring of threatened species in and adjacent to the Project footprint. The methodology shall be decided in consultation with DECCW;
b) An adaptive monitoring program to assess the effectiveness of the mitigation measures identified in Condition 2.10 (e) and allow their modification if necessary. The monitoring program shall include targets against which effectiveness will be measured;
c) Monitoring shall be undertaken during construction (for construction-related impacts) and from opening of the Project to traffic (for operation/ongoing impacts) until such time as the effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, or as otherwise agreed by the Director-General in consultation with DECCW;
d) Provision for the assessment of the data to identify changes to habitat usage and if this can be attributed to the Project;
e) Details of the contingency measures that would be implemented in the event of changes to habitat usage patterns directly attributable to the construction or operation of the Project; and
f) Provision for annual reporting of monitoring results to the Director-General and the DECCW, or as otherwise agreed by those agencies.

The mitigation measures identified in MCoA No. 2.10 (e) shall be developed in consultation with Department of Environment Climate Change and Water (DECCW) and include:

I. Fauna crossing structures and associated fauna fencing to be installed as part of the Project;
II. Revegetation measures;
III. Translocation plans; and
IV. Any other fauna mitigation measures such as nest boxes and frog breeding ponds.

Lewis Ecological Surveys (LES) prepared the Ecological Monitoring Program (Lewis 2013) for the Project which outlines the monitoring methodology for threatened species agreed to, in accordance with condition of this approval. Monitoring has been undertaken in accordance with the approved F2E Ecological Monitoring Program

The aim of this Ecological Monitoring Program is to "determine the effectiveness of flora and fauna mitigation measures" as per the Statement of Commitment (SoC) - F22.

The term effectiveness for the purposes of this Ecological Monitoring Program will be defined via the performance indicators outlined.

Legal Status

Maundia triglochinoides is listed as vulnerable on the New South Wales *Threatened Species Conservation Act* (TSC Act 1995). Monitoring of the species is required under the Project approval. The design, methods and performance indicators that define this monitoring requirement is specified in the approved Ecological Monitoring Plan for the Project (Lewis 2013).

Baseline Data

Lewis (2013) provides the following background information for the *Maundia triglochinoides* populations within and adjacent to the Project in relation to the known locations:

"Maundia triglochinodes populations are known from at least 36 locations within the vicinity (i.e. <2 km) of the Project extending from CH14200 to CH31100. Combined, this mapped extent was estimated at 29.86 ha in March-August 2012. Individual location data is provided in Appendix A (Table A1 and A2) of Lewis (2013)".

No data detailing relative cover abundance (i.e. Braun Blanquet scores), incidence of flowering/ seeding or recruitment was provided as part of this baseline dataset.

1.2 Project commitments

The Project commitments for *Maundia triglochinoides* and the associated monitoring program are specified in the SoC and MCoA for the Project, specifically MCoA 3.1 (above), SoCs F4 and F22, as listed in Table 1-1.

Table 1-1. Project Statement of Commitments relevant to the monitoring program

Objective	Reference Number	Commitment	Timing
Avoid or protect individual threatened plant species where possible.	F4	Threatened plants in proximity to the Proposal to be retained will be protected during construction through exclusion fencing, warning sign posting and education of construction workers through the site induction process.	Pre-construction and construction.
Determine effectiveness of flora and fauna mitigation measures.	F22	An adaptive monitoring program will be developed and implemented to allow the effectiveness of mitigation and offset measures to be assessed and allow for their modification if necessary. The program will be for a minimum of three years after construction completion.	Pre-construction, construction and operation.

1.3 Performance measures

The approved Ecological Monitoring Program for the Project specifies the following performance indicators for *Maundia triglochinoides* (Lewis 2013).

Success (protection of retained populations) is indicated by:

- Exclusion fencing in place with signage identifying 'no go' zones around plants.
- Sediment control fencing in place and working effectively.
- Flowering and/or seeding is consistent with paired control and/or nearest reference site.

Failure (a potential breach or trigger for further investigations) is therefore indicated by:

- Breached exclusion fencing.
- No signage in place identifying the sensitive nature of the location as threatened species habitat.
- A significant (if statistics are used) or substantial difference (i.e. 15% allowance) between paired monitoring sites (those within and those outside of the Project Area boundary) with regard to flowering/seeding and overall extent or recruitment.

2. Methods

2.1 Project Area

The Project is located north of Kempsey on the mid-north coast of New South Wales. An overview of the Project boundary and monitoring sites is provided in Figure 1.

2.2 Monitoring design

Ten paired 'impact-control' monitoring sites have been established for the monitoring of *Maundia triglochinodes* within the Project boundary. The location of these is shown in Figure 2 and Figure 3, with details provided in Table 2-1.

Table 2-1. Paired 'Impact –Control' monitoring sites

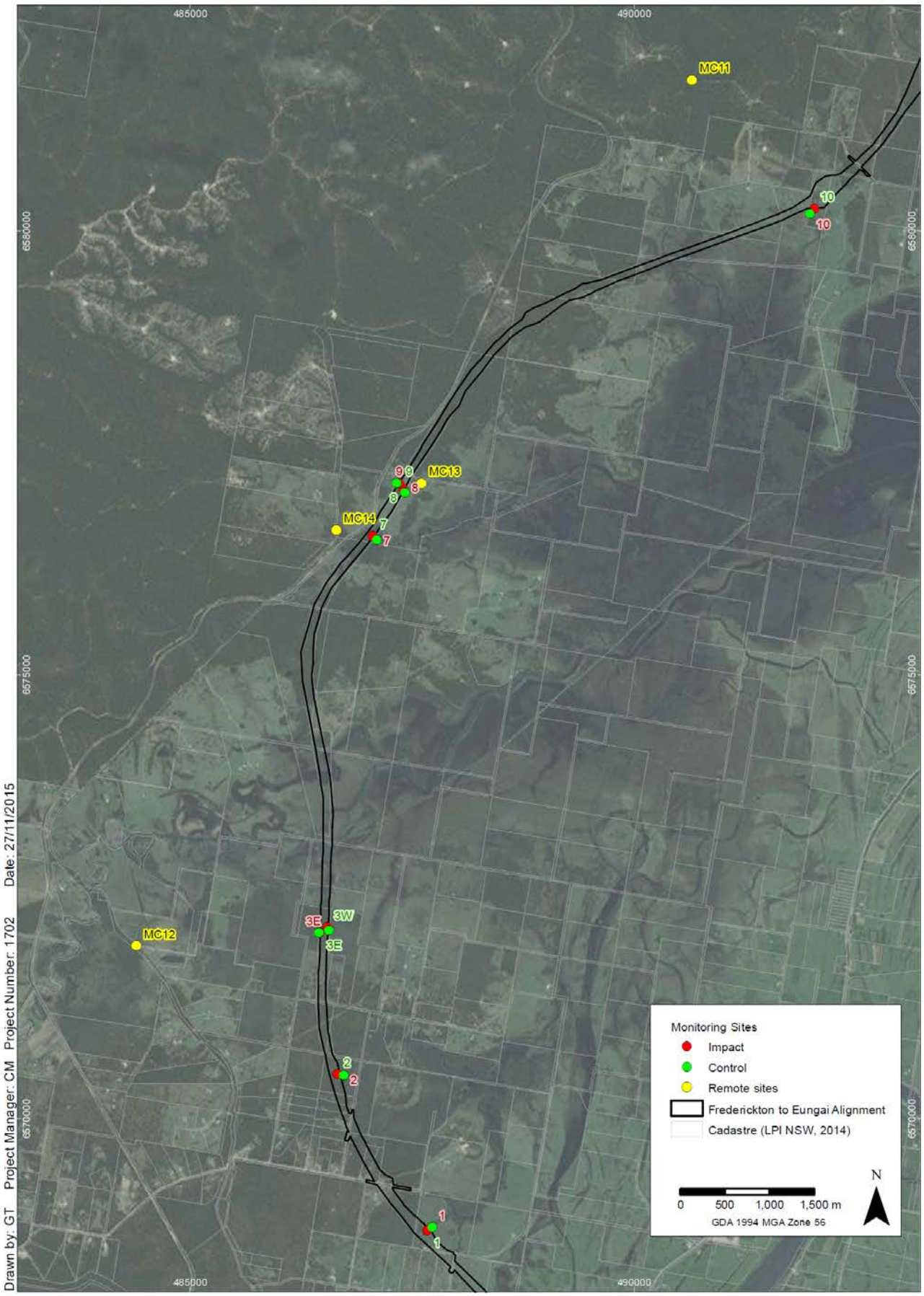
Site	Chainage (Location)	Easting of	Northing	Paired Control plot for potential impact plot	Easting of Control Plot	Northing of Control Plot
1	15360 (East)	487671	6568746	100 m downstream	487723	6568775
2	17360 (East)	486650	6570499	50 m downstream	486727	6570489
3E	19200 (East)	486461	6572090	0-20 m outside road corridor	486453	6572097
3W	19200 (West)	486546	6572155	0-20 m outside road corridor	486558	6572126
4[1]	19950 (West)	-	-	Upstream of road corridor	-	-
5	20100 (East)	496604	6573123	100 m downstream	496604	6573123
6	20850 (East)	486531	6573953	100 m downstream	486564	6573899
7	23800 (East)	487058	6576563	Adjacent to wetland habitat	487098	6576520
8	24425 (East)	487403	6577089	50-100 m downstream	487416	6577051
9	24450 (West)	487352	6577162	50-100 m downstream	487323	6577162
10	30275 (South)	492027	6580246	50 – 100 m downstream	491981	6580190

Four external reference sites have also been established (Table 2-2). These are independent of the Project and are to be used to monitor *Maundia triglochinoides* populations in the broader area for comparative purposes. It is assumed that any change detected at these sites would be indicative of variance unrelated to the impacts of road construction or operation.

Table 2-2. Reference monitoring sites

Site	Easting	Northing	Reference site name
11	490652	6581695	Cols Causeway
12	484393	6571941	Collombatti-Tamban Road
13	487600	6577150	Old Stock dam
14	486641	6576627	Tamban Road

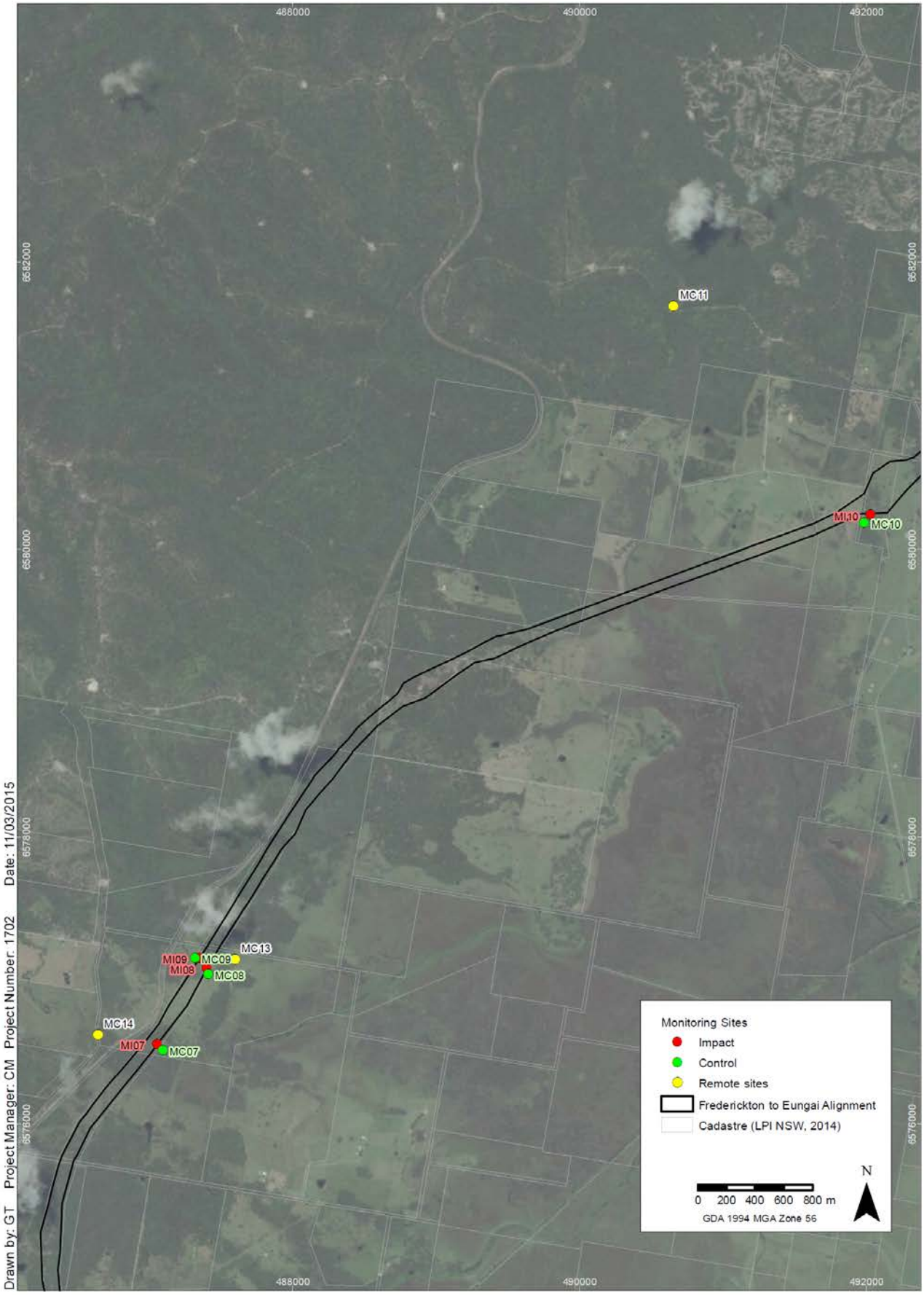
[1] No property access available for this site



F2E Maundia Monitoring Locations Site Plan (Overview)

Pacific Highway Upgrade - Oxley Highway to Kempsey & Frederickton to Eungai

FIGURE 1

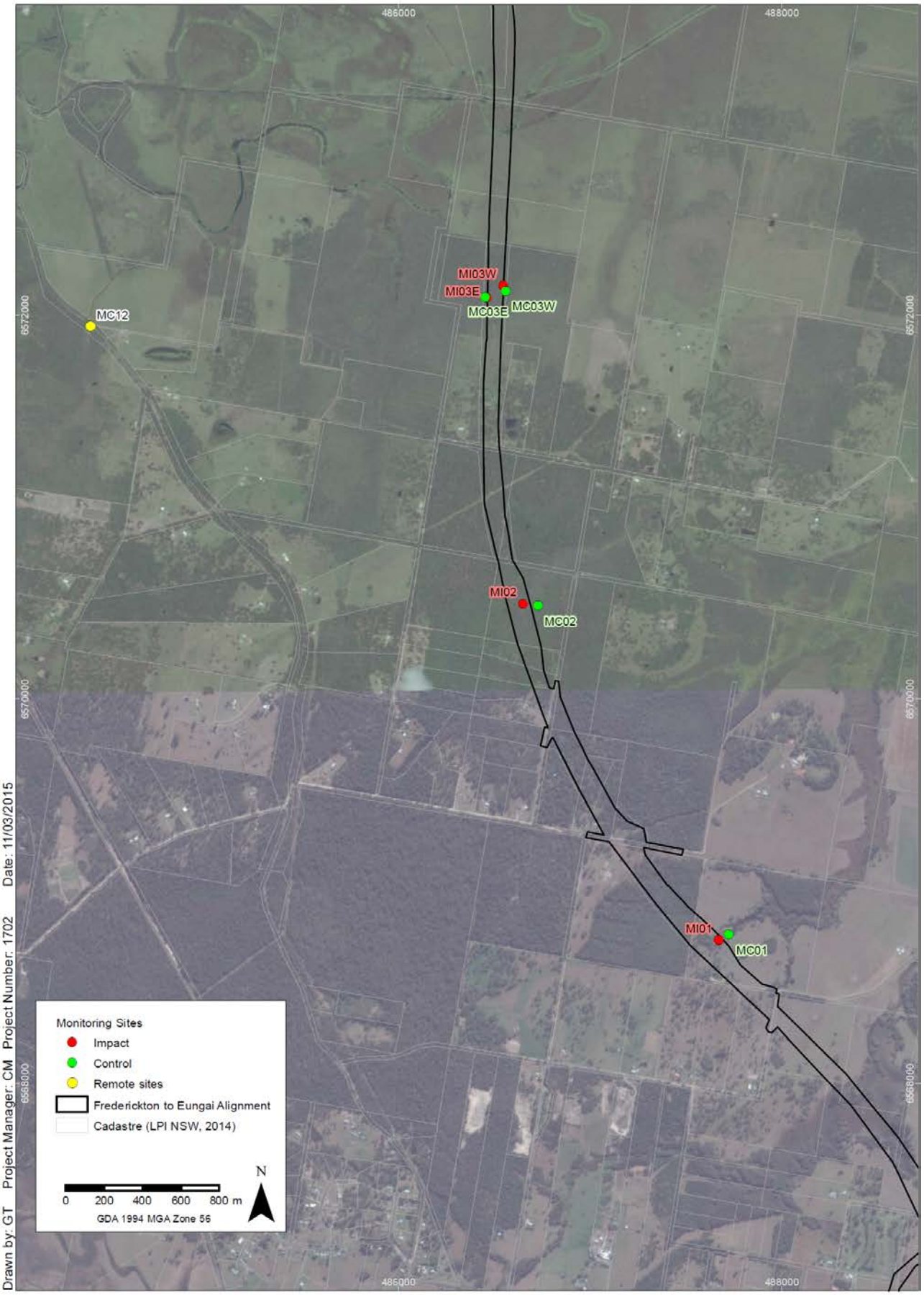


F2E Maundia Monitoring Locations Site Plan (northern sites)

Pacific Highway Upgrade - Oxley Highway to Kempsey & Frederickton to Eungai

FIGURE 2

Path: T:\spatial\projects\a1700\a1702_OH2K_Ecology\Maps\PI_6_Ecological Monitoring_F2E\PI_62_Maundia\1702_PI_62_Figure_1b_nth.mxd



F2E Maundia Monitoring Locations Site Plan (southern sites)

Pacific Highway Upgrade - Oxley Highway to Kempsey & Frederickton to Eungai

FIGURE 3

Path: T:\spatial\projects\a1700\a1702_OH2K_Ecology\Maps\PI_6_Ecological Monitoring_F2E\PI_62_Maundia\1702_PI_62_Figure_1a_Sth.mxd

2.3 Method

Measurements collected at each of the 14 monitoring sites included the following parameters:

- Current extent of cover using the Braun-Blanquet scale (20m X 20m quadrat or 400 m^2). The monitoring area extends from the installed monitoring marker point into the water body, with the marker point located midway along the quadrat boundary.
- Mean water depth was estimated for the quadrat.
- The extent of flowering or seeding (per cent of total number of observed plants within quadrat).
- Signs of recruitment (per cent of total number of observed plants within quadrat).
- Signs of disturbance (i.e. cattle) and to what extent/area.
- Specific photo point installed.

The Braun-Blanquet scale used in this monitoring program is provided in Table 2-3.

Table 2-3: Braun-Blanquet cover abundance scale used in each 400m^2 quadrat

Score	Cover Abundance Category
1	1-5% cover - rare
2	1-5% cover - common
3	6-25% cover
4	26-50% cover
5	51-75% cover
6	76-100% cover

It is noteworthy to mention that the approved Ecological Monitoring Plan (Lewis 2013) does not specify the Braun-Blanquet scale required to be used in the monitoring program. The scale specified in Table 2-3 is a standard scale used frequently in flora assessments and will be adopted for all future monitoring events.

2.4 Analyses

Lewis (2013) specifies the following approach to the data analysis.

“A paired t-test or a non parametric equivalent (i.e. Mann Whitney) will be used to explore the usefulness of statistics in data comparisons (Lewis 2013).

3. Results

Data collected from each of the paired impact-control sites and reference sites for the three monitoring events are provided in Annex 1 with explanatory notes for sites that could not be accessed due to flooding or private property access restrictions. Results are reported below for each of the performance indicators pertaining to *Maundia triglochinoides* that require assessment in the Ecological Monitoring Program.

3.1 Performance indicator 1 - Exclusion fencing with signage identifying 'no go' zones around *Maundia triglochinoides* plants

Fencing and signage had been installed at all paired impact – control sites. Fencing and signage was effective and overall intact for accessible sites.

3.2 Performance indicator 2 - Sedimentation fencing / protection in place (if required) and working (no sedimentation occurring which could affect plants)

Sedimentation was found at one site (Site 10), although there was no evidence of any damage to plants as a result of this sedimentation. Sedimentation appears to be present as a consequence of extreme weather conditions where localised flooding has occurred and licensed sedimentation basins had discharged in accordance with their approved Environmental Protection Licence design limits.

3.3 Performance indicator 3 - Flowering, seeding and recruitment

Under the Approved Ecological Monitoring Program, compliance with performance indicator 3 is indicated by the impact site having no significant or substantial difference in flowering/ seeding or recruitment between the paired control and/or nearest reference site (Lewis 2013). This is based on: a significant (if statistics are used) or substantial difference (15% allowance) between the paired monitoring sites with regard to flowering/seeding and overall extent or recruitment.

A statistical analysis determining if there is a significant difference between impact – control paired sites for extent of cover could not be performed as the paired sites are not independent of each other (i.e. difference, if detected, cannot be attributed only to the road; see Section 4.2).

The 'substantial difference' test is subject to the same concerns. However, an analysis for change in 'flowering/ seeding' and 'recruitment' using the 'substantial difference' test was performed and found that all sites complied with the performance indicator except for site 2, where the impact site was observed to have significantly higher recruitment than the control site.

4. Discussion

4.1 General discussion

The increased recruitment observed at site 2 'impact' is restricted to disturbed soils adjacent to the sediment and erosion control fencing and permanent fauna fencing. Reasons for this observed recruitment are not clear. However, it is speculated that the observed localised increase in *Maundia triglochinoides* recruitment is likely a consequence of recent flood events. It is possible that the seed of *Maundia triglochinoides* has been transported to and settled on these disturbed soils during the recent flood events (i.e. while water levels rose above the height of sediment and erosion control fencing). Germination has followed in what appears to be new areas of suitable habitat, with the retention of recruited individuals enhanced by the absence of herbivory (e.g. livestock grazing). Whatever the reason for this change, it is considered that this is 'a positive' change and does not require the application of any contingency measures.

4.2 Plan review

Project SoC F22 states:

"An adaptive monitoring program will be developed and implemented to allow the effectiveness of mitigation and offset measures to be assessed and allow for their modification if necessary. The program will be for a minimum of three years after construction completion."

4.2.1 Site Locations

Many of the paired impact-control sites established in the Ecological Monitoring Program are spatially close to each other and are unlikely to be independent. For example, most control sites located downstream of their paired impact site continue to be influenced by livestock grazing, while the impact site is no longer subject to this land use activity (due to Project boundary fencing) and this could be the reason for any observed changes.

4.2.2 Site Access

Access to private properties designated as paired control sites was unable to be secured for several sites in the 2015 monitoring period. Notwithstanding, observations from the Project boundary were possible in the majority of paired control sites, thus allowing for some data collection at these sites. Sites that could not be properly surveyed included Control sites 4,7,8,9 as noted in Annex 1

4.2.3 Methods

Methodological uncertainties can be addressed in the following manner:

- Measure 'flowering/ seeding' and 'recruitment' as a percentage with 5% increments (i.e. limit of visual perception). Sites with very low but detectable features would be given a score in 1% increments.
- Dispense with the 'Braun-Blanquet Scale' for measuring relative abundance and replace with actual per cent cover using 5% increments. This would allow application of the 'substantial difference' test, as the measurement is based on a linear scale (i.e. even incremental differences). At present, it is impossible to determine if a change has occurred through the 'substantial difference' test for sites with a Braun-Blanquet Scale score of '3' (i.e. 5-25% cover) or above, as the per cent range exceeds the 15% threshold for detecting change. Such data anomalies in measurement and analysis may potentially lead to circumstances akin to a Type II error (i.e. a false negative). Percent cover will be used for future data

collection. It can also be expressed as a Braun-Blanquet Scale as required by the Ecological Monitoring Program methodology.

4.3 Contingencies

The Ecological Monitoring Program (Lewis 2013) describes contingencies for potential problems identified in the construction and post construction period. Table 4-1 summarises the contingency actions to be undertaken (Lewis 2013) against actions this report deems to be required.

Table 4-1: Contingencies for ineffective mitigation measures (Lewis 2013)

Potential Problem	Contingency Measures	Proposed actions
a) Residual area of Maundia impacted by construction works (i.e. clearing, habitat damage, sedimentation, scouring)	Review the exclusion fencing Review extent of signage used to demarcate the habitat protection zone. Review clearing procedures.	No impact by construction works detected. No actions proposed.
b) Significant difference ($p<0.05$ level) in flowering/seeding and/or extent of relative cover between control sites (adjacent road corridor) and treatment sites (habitat protection zones within road corridor)	Review drainage (local hydrological patterns)	Statistical analysis not possible, thus unable to determine if there is a significant difference ($p<0.05$) due to monitoring design and methodological limitations. 'Substantial difference' test applied instead, resulting in the detection of one difference (site 2) where the impact site was observed to have significantly higher recruitment than the control site. No actions proposed.
c) Increased extent of weed or competitor species	Review drainage	No increased extent of weed or competitor species detected. No actions proposed.

References

Lewis, B.D (2013). Ecological Monitoring Report: Frederickton to Eungai Upgrade. Report prepared for Roads and Maritime Services by Lewis Ecological Surveys.

Morrison, D.A. (2002). How to improve statistical analysis in parasitology research publications. *International Journal for Parasitology* 32: 1065-1070.

Annex 1 Monitoring data - 2015

Site	Design	Easting	Northing	Inspection Date			Campoint installed			Maundia present			Braun-Blanquet Score			Water Depth (cm)			Flowering / Seeding			Recruitment			Notes
				Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	
MI01	impact	487671	6568746	26/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	3	3	400	400	400	<5%	nil	nil	nil	1%	nil	
MC01	control	487723	6568775	26/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	3	3	400	500	400	<5%	nil	nil	nil	<1%	nil	
MI02	impact	486650	6570499	26/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	3	3	100	200	100	10%	<5%	<5%	30%	40%	nil	
MC02	control	486727	6570489	26/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	3	3	100	300	100	nil	nil	<5%	nil	<5%	<5%	
MI03E	impact	486461	6572090	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	1	2	2	300	100	300	nil	nil	nil	nil	5%	nil	
MC03E	control	486453	6572097	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	1	1	800	800	800	nil	nil	nil	nil	nil	nil	
MI03W	impact	486546	6572155	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	1	2	2	40	300	40	10%	nil	nil	<5%	<5%	nil	
MC03W	control	486558	6572126	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	3	2	2	400	400	400	10%	nil	nil	<5%	nil	nil	
MI04	impact	486484	6572948	Unk	29/04/2015	21/05/2015	N	N	N	N	N	N	0	0	0	0	0	0	nil	nil	nil	nil	nil	nil	Site was occupied by a haul track and rock crane platform for the duration of 2015 surveys –since being reinstated, this shows evidence of recruiting Maundia in 2016 surveys
MC04	control	486484	6572948	Unk	Unk	Unk	N	N	N	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Unk	Property access denied. Site is east side of the property

Site	Design	Easting	Northing	Inspection Date			Campoint installed			Maundia present			Braun-Blanquet Score			Water Depth (cm)			Flowering / Seeding			Recruitment			Notes
				Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	
																									boundary fence.
MI05	impact	486605	6573119	Unk	29/04/2015	21/05/2015	N	Y	Y	Unk	N	Y	Unk	0	2	Unk	400	0	Unk	nil	nil	Unk	nil	nil	Inaccessible in Feb due to Flooding
MC05	control	486605	6573119	Unk	29/04/2015	21/05/2015	N	Y	Y	Unk	N	Y	Unk	0	2	Unk	400	0	Unk	nil	nil	Unk	nil	nil	Inaccessible in Feb due to Flooding
MI06	impact	486531	6573953	Unk	29/04/2015	22/05/2015	N	Y	Y	Unk	Y	Y	Unk	2	2	Unk	5	0	Unk	<5%	<5%	Unk	1%	nil	Inaccessible in Feb due to Flooding
MC06	control	486564	6573899	Unk	29/04/2015	22/05/2015	N	Y	Y	Unk	Y	Y	Unk	1	1	Unk	200	0	Unk	nil	<5%	Unk	nil	nil	Inaccessible in Feb due to Flooding
MI07	impact	487058	6576563	19/02/2015	28/04/2015	21/05/2015	Y	Y	Y	N	N	N	0	0	0	300	300	300	nil	nil	nil	nil	nil	nil	
MC07	control	487098	6576520	19/02/2015	Unk	Unk	N	N	N	N	Unk	Unk	0	Unk	Unk	300	Unk	Unk	nil	Unk	Unk	nil	Unk	Unk	Property access denied April & May
MI08	impact	487403	6577089	19/02/2015	28/04/2015	21/05/2015	Y	Y	Y	N	N	N	0	0	0	400	400	400	nil	nil	nil	nil	nil	nil	Coffer dam and pump around system may have impeded flow to site during 2015 campaigns
MC08	control	487416	6577051	19/02/2015	28/04/2015	Unk	Y	Y	Y	Y	Y	Unk	3	3	Unk	400	500	400	nil	Unk	Unk	nil	Unk	Unk	Property access denied May
MI09	impact	487352	6577162	18/02/2015	28/04/2015	20/05/2015	Y	Y	Y	N	N	N	0	0	0	300	500	300	nil	nil	nil	nil	nil	nil	Coffer dam and pump around system may have impeded flow to site during April & May 2015 campaigns
MC09	control	487323	6577162	18/02/2015	Unk	Unk	Y	Y	Y	Y	Unk	Unk	3	Unk	Unk	300	Unk	300	nil	Unk	Unk	nil	Unk	Unk	Property access denied April & May
MI10	impact	492027	6580246	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	N	N	1	0	0	200	<5	200	nil	nil	nil	nil	nil	nil	

Site	Design	Easting	Northing	Inspection Date			Cam point installed			Maundia present			Braun-Blanquet Score			Water Depth (cm)			Flowering / Seeding			Recruitment			Notes
				Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	Feb	Apr	May	
MC10	control	491981	6580190	18/02/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	1	2	2	200	<5	200	nil	nil	nil	nil	10%	nil	
MC11	Ref	490652	6581695	24/2/2015	29/04/2015	21/05/2015	Y	Y	Y	Y	Y	Y	2	2	2	600	500	600	nil	nil	nil	nil	nil	nil	
MC12	Ref	484393	6571941	24/2/2015/a	29/04/2015	22/05/2015	Y	Y	Y	Y	Y	Y	4	4	4	400	400	400	nil	nil	nil	nil	<1%	nil	
MC13	Ref	487600	6577150	26/2/2015	Unk	Unk	Y	Y	Y	Y	Unk	Unk	2	Unk	Unk	Unk	Unk	Unk	nil	Unk	Unk	nil	Unk	Unk	Property access denied April & May
MC14	Ref	486641	6576627	24/2/2015	29/04/2015	22/05/2015	Y	Y	Y	Y	Y	Y	1	1	1	500	500	500	nil	nil	nil	nil	nil	nil	

Unk = no property access Feb due to flooding - sites 4,5 and 6. April and May due to property access -Control sites 4,7,8,9 and reference site 3 (MC13).

Y = Yes

N = No

Site	Design	Easting	Northing	Inspection Date			Compliance with Mitigation Measures		
				Feb	Apr	May	Feb	Apr	May
MI01	impact	487671	6568746	26/02/2015	29/04/2015	21/05/2015	Yes	Yes	Yes
MC01	control	487723	6568775	26/02/2015	29/04/2015	21/05/2015	No	Yes	Yes
MI02	impact	486650	6570499	26/02/2015	29/04/2015	21/05/2015	Yes	Yes	Yes
MC02	control	486727	6570489	26/02/2015	29/04/2015	21/05/2015	No	Yes	Yes
MI03E	impact	486461	6572090	18/02/2015	29/04/2015	21/05/2015	Yes	Yes	Yes
MC03E	control	486453	6572097	18/02/2015	29/04/2015	21/05/2015	No	Yes	Yes
MI03W	impact	486546	6572155	18/02/2015	29/04/2015	21/05/2015	Yes	Yes	Yes
MC03W	control	486558	6572126	18/02/2015	29/04/2015	21/05/2015	No	Yes	Yes
MI04	impact	486484	6572948	Unk	29/04/2015	21/05/2015	Unk	Yes.	Yes.
MC04	control	486484	6572948	Unk	Unk	Unk	Unk	Unk	Unk
MI05	impact	486605	6573119	Unk	29/04/2015	21/05/2015	Unk	Yes	Yes
MC05	control	486605	6573119	Unk	29/04/2015	21/05/2015	Unk	Yes	Yes
MI06	impact	486531	6573953	Unk	29/04/2015	22/05/2015	Unk	Yes	Yes
MC06	control	486564	6573899	Unk	29/04/2015	22/05/2015	Unk	Yes	Yes
MI07	impact	487058	6576563	19/02/2015	28/04/2015	21/05/2015	Yes	Yes	Yes
MC07	control	487098	6576520	19/02/2015	Unk	Unk	No	Yes	Yes
MI08	impact	487403	6577089	19/02/2015	28/04/2015	21/05/2015	Yes	Yes	Yes
MC08	control	487416	6577051	19/02/2015	28/04/2015	Unk	No	Yes	Yes
MI09	impact	487352	6577162	18/02/2015	28/04/2015	21/05/2015	Yes	Yes	Yes
MC09	control	487323	6577162	18/02/2015	Unk	Unk	No	Yes	Yes
MI10	impact	492027	6580246	18/02/2015	29/04/2015	21/05/2015	Yes	Yes	Yes
MC10	control	491981	6580190	18/02/2015	29/04/2015	21/05/2015	No	Yes	Yes
MC11	Ref	490652	6581695	24/2/2015	29/04/2015	21/05/2015	None required	None required	None required
MC12	Ref	484393	6571941	24/2/2015/a	29/04/2015	22/05/2015	None required	None required	None required
MC13	Ref	487600	6577150	26/2/2015	Unk	Unk	None required	None required	None required

Site	Design	Easting	Northing	Inspection Date			Compliance with Mitigation Measures		
				Feb	Apr	May	Feb	Apr	May
MC14	Ref	486641	6576627	24/2/2015	29/04/2015	22/05/2015	None required	None required	None required

Unk = no property access Feb due to flooding - sites 4, 5 and 6. April and May due to property access -Control sites 4,7,8,9 and reference site 3 (MC13).

Annex 2 Photographs of each monitoring site 2015

Site ID	February	April	May
MI01			
MC01			

Site ID	February	April	May
MI02			
MC02			
MI03E			

Site ID	February	April	May
MC03E			
MI03W			
MC03W			

Site ID	February	April	May
MI04	Inaccessible due to construction works.	Inaccessible due to construction works.	Inaccessible due to construction works.
MC04	Property access denied	Property access denied	Property access denied
MI05	Not accessed due to flood		
MC05	Not accessed due to flood		

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Attachment B: Hairy Joint Grass 2015 monitoring report

niche
Environment and Heritage

F2E Pacific Highway Upgrade
Hairy Joint Grass Monitoring 2015

Prepared for RMS

29 April 2016

Document control

Project no.:	1702
Project client:	Roads and Maritime Services (RMS)
Project office:	Central Coast
Document description:	Hairy Joint Grass Monitoring 2015
Project Director:	Rhidian Harrington
Project Manager:	Chris McEvoy
Authors:	David Tierney
Internal review:	Mark Aitkens, Frank Lemckert, Rhidian Harrington
Document status:	Rev 3
Local Government Area:	Kempsey

Document revision status

Author	Revision number	Internal review	Date issued
David Tierney	Rev D1	Mark Aitkens	
David Tierney	Rev 0	Frank Lemckert	2/10/2015
David Tierney	Rev 1	Chris McEvoy	15/2/2016
David Tierney	Rev 2	Chris McEvoy & Rhidian Harrington	22/3/2016
David Tierney	Rev 3	Chris McEvoy & Rhidian Harrington	29/4/2016

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Cover photograph: Hairy Joint Grass quadrat. Niche Environment and Heritage.

Executive summary

Context

This monitoring report documents the first monitoring period for *Arthraxon hispidus* (Hairy Joint Grass) as required by the Frederickton to Eungai (F2E) Ecological Monitoring Program, prepared in accordance with the Minister's Condition of Approval 3.1.

Aims

The monitoring for *Arthraxon hispidus* is designed to determine the effectiveness of the F2E Project's flora and fauna mitigation measures.

Methods

Arthraxon hispidus populations are known at two locations within the project corridor. These populations were monitored at six sites based on the monitoring design for this species specified in *Lewis, B.D (2013) Ecological Monitoring Report: Frederickton to Eungai Upgrade. Report prepared for Roads and Maritime Services by Lewis Ecological Surveys.*

Key results

Arthraxon hispidus was determined to be present at two of the three impact monitoring locations (plots) within the Project boundary. In the first (February) monitoring campaign, *Arthraxon hispidus* was determined to be present at all three monitoring locations outside the Project boundary (control sites). Presence on control sites within private lands adjacent to the Project was not determined after the first monitoring event, as the land holders denied access to the sites for subsequent monitoring.

Where it was observed, plants occurred in discrete locations (quadrats) with cover abundance in each quadrat generally determined to be low (up to 5% cover) with some exceptions. Flowering and seed set occurred at both impact plots in which the species occurred. However, each plot supported a dense cover of grass and a mix of exotic and native species so that recruitment of *Arthraxon hispidus* is likely to be restricted in these plots.

Conclusions

General compliance with performance indicators 1 and 2 as specified in the *Arthraxon hispidus* monitoring program has been achieved (i.e. fencing and signage to protect the locations of *Arthraxon hispidus* in the Project boundary are generally in place). However, lack of access to private land adjacent to the Project has prevented monitoring of control sites as required (after the first February monitoring campaign). Therefore performance indicator 3 cannot be assessed as planned. Only a coarse measure of presence-absence can be provided in that plants remain present at two of the three impact sites.

Management implications

The monitoring locations within the Project boundary are now densely covered in a mix of exotic and native plant species and recruitment of *Arthraxon hispidus* is unlikely whilst this cover persists. Flowering and seed set appears to have occurred in plots and slashing of these plots may promote recruitment.

Consultation was undertaken by Roads and Maritime Services with the NSW Environment Protection Authority (EPA) regarding management of the sites. At the recommendation of the NSW Environment Protection Authority Threatened Species Officer the following was done:

- Slashing of Hairy Joint Grass at CH 29500 was undertaken on 5 Sept 2015 to encourage Hairy joint grass regeneration (it is not currently evident as this site).
- No slashing was undertaken at the ch24000 sites in order to prevent any disturbance to the HJG found there during the last monitoring event.

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1. Introduction

1.1 Context

This monitoring report documents the first monitoring period for *Arthraxon hispidus* (Hairy Joint Grass) as required by the Frederickton to Eungai (F2E) Ecological Monitoring Program, prepared in accordance with the Minister's Condition of Approval 3.1.

Arthraxon hispidus is in the family Poaceae (a grass) and has a cosmopolitan (global) distribution. The genus *Arthraxon* contains about 25 species and is distributed across parts of Asia, India and Africa. *Arthraxon hispidus* is considered an invasive weed in North America. In Australia the species is distributed from around Kempsey northwards and it is listed as vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act 1999) and the New South Wales *Threatened Species Conservation Act* (TSC Act 1995). Monitoring of the species is required under *Lewis, B.D (2013) Ecological Monitoring Report: Frederickton to Eungai Upgrade. Report prepared for Roads and Maritime Services by Lewis Ecological Surveys* which sets performance indicators to be assessed via this design (see below).

Baseline Data

Lewis (2013) provides the following background data for the Hairy Joint Grass *Arthraxon hispidus* populations in relation to the known locations:

1. Southern population. The southern population occurs at chainage 24000 and occurred over a mapped extent of 3.71 ha in March 2012 (Richards 2012). The Project will remove 0.32 ha with a further 0.84 ha retained within the Project corridor which may be subject to indirect impacts including weed invasion, sedimentation, changes to hydrology and soil eutrophication. The existing landuse is pasture production for beef cattle grazing with this area supporting Kikuyu, Paspalum, Carpet Grass and Bladey Grass. Fertilizer applications in the form of super phosphate were historically applied to this area up until about 2007. The western boundary of the mapped extent extends into the North Coast Railway Corridor which contains rank grassland and early successional plants such as Acacia.

2. Northern population. The northern population occurs at chainage 29500 and occurred over a mapped extent of 2.43 ha in March 2012 (Richards 2012). The Project was re aligned to avoid this population. The existing landuse is pasture production for beef cattle grazing with this area supporting Paspalum, Carpet Grass and occasionally Kikuyu and White Clover. Fertilizer applications in the form of super phosphate are not known at this location.

At both locations, the plants occur sporadically throughout the mapped extent with Braun-Blanquet scale numbers ranging from 1 (solitary, insignificant cover) to 2 (10-25%) in 2 x 2 m quadrats.

1.2 Project objectives

The monitoring for *Arthraxon hispidus* is designed to determine the effectiveness of the F2E Project's flora and fauna mitigation measures.

The relevant Statement of Commitment (SoC) for the Project is Soc F4:

SoC F4: Threatened plants in proximity to the Proposal to be retained will be protected during construction through exclusion fencing, warning sign posting and education of construction workers through the site induction process.

1.3 Performance measures

The Ecological Monitoring Program Frederickton to Eungai (Lewis 2013) specifies the following performance indicators (PI) in relation to the monitoring of *Arthraxon hispidus*.

Success (protection of retained populations) is indicated by:

1. Exclusion fencing with signage identifying 'no go' zones around *Arthraxon hispidus* plants.
2. Sediment control fencing in place and working effectively.
3. Flowering and/or seeding is consistent with paired control and/or nearest reference site.

2. Methods

2.1 Study area

The Project is located north of Kempsey on the mid-north coast of New South Wales (Figures 1 and 2). *Arthraxon hispidus* has been recorded from two populations within the Project boundary described by Lewis (2013):

1. *Southern population occurs at chainage 24000 and occurred over a mapped extent of 3.71 ha in March 2012 (Richards 2012). The western boundary of the mapped extent extends into the North Coast Railway Corridor which contains rank grassland and early successional plants such as Acacia*.

2. *Northern population occurs at chainage 29500 and occurred over a mapped extent of 2.43 ha in March 2012 (Richards 2012). The Project was re aligned to avoid this population*.

2.2 Monitoring sites

Six monitoring sites have been determined for *Arthraxon hispidus* (Lewis 2013). This includes three 'Potential Impact Plots' (located within the Project boundary) and for each of these a paired 'Control Plot' (located outside of the Project Area – Table 2-1). However, since the completion of the first February 2015 monitoring event (where all six sites were monitored), the paired Control Plots which are located on private land were not surveyed as landholder agreements for access had not been secured (see Figure 2 for plot locations).

Table 2-1: Potential Impact and Control Plots (plot numbering follows Lewis 2013 and the numbers 1, 2 and 3 for paired plots are the same as in Figure 2)

Monitoring plot	Chainage/ Location	Easting	Northing	Plot type	Side of Carriageway	No. 2 x 2m Quadrats	Landholder Access Agreement Status
1HE	**24000**	**487175**	**6576696**	**Potential Impact**	**East**	**10**	Not required
1CE	24000	487306	6576647	Control	East	10	Access not granted
2HW	**24000**	**487173**	**6576695**	**Potential Impact**	**West**	**10**	Not required
2CW	24000	487084	6576742	Control	West	10	Access not granted
3HN	**29500**	**491349**	**6580096**	**Potential Impact**	**North**	**10**	Not required
3CN	29500	491261	6580161	Control	North	10	Access granted in late 2015. (No access for 2015 surveys after the February campaign).

2.3 Survey method

Monitoring surveys of the three Potential Impact Plots (1HE, 2HW and 3HN - see Table 2-1 above) were undertaken in February, April and May of 2015. Each plot was sampled with ten 2 m^2 quadrats in each sampling event. In each quadrat the following were recorded:

- Plant species present and relative cover using a standard 6 point Braun-Blanquet scale (Table 2-2).
- The extent of flowering and / or seeding of *Arthraxon hispidus*.
- Signs of disturbance (i.e. cattle), sedimentation and the extent of any disturbance.
- A photo of the quadrat.

Additionally, each of the three Potential Impact Plots were inspected to determine if exclusion fencing was in place or breached, and if signage was present indicating that the area was being recognised as a "no go" zone.

Table 2-2: Braun-Blanquet cover abundance scale used in each 4m^2 quadrat

Score	Cover Abundance Category
1	1-5% cover - rare
2	1-5% cover - common
3	6-25% cover
4	26-50% cover
5	51-75% cover.
6	76-100% cover

2.4 Data reporting and analyses

Compliance across the monitoring period is reported for fencing and signage. Species composition and cover abundance of plant species for quadrats is also reported, as well as the cover abundance, flowering and seed set of *Arthraxon hispidus*.

3. Results

Results are reported below for each of the performance indicators determined for the *Arthraxon hispidus* monitoring program.

3.1 Performance indicator 1. Exclusion fencing with signage identifying 'no go' zones around *Arthraxon hispidus* plants in the construction area.

Fencing and signage was in place across the three monitoring events (February, April and May) at all three monitored Potential Impact Plots (1HE, 2HW and 3HN) (see Figure 2). Improvements to the signage and repair of damaged fencing occurred following the first monitoring event.

Fencing and signage was deemed effective and intact by April 2015 at all three monitored Potential Impact Plots. The only location where a fault was determined was at 3HN where the fencing has been partly damaged and it required some repair. Repairs were completed as required.

3.2 Performance indicator 2. Sedimentation fencing / protection in place (if required) and working (no sedimentation occurring which could affect plants) at Potential Impact Sites.

All Potential Impact plots were raised above the level of any immediate earthworks so that sedimentation onto the plots was unlikely. Therefore, sedimentation barriers were generally not required for these plots. No sedimentation was found within plots and no damage to plants within plots was observed as a result of sedimentation.

3.3 Performance indicator 3. Flowering, seeding and recruitment.

Property access to adjacent private properties that were designated as paired Control sites had not been secured, although one monitoring event did occur at the Control sites in February before access was formally denied or approved. Therefore, no effective comparison was possible between the designated Potential Impact and Control Plots.

The density of *Arthraxon hispidus* plants in all three Potential Impact Plots was low. Ten 4 m^2 quadrats were established in each of these plots. No plants were found in 3HN and only a few plants on an old track were found within 1HE (within one of the ten quadrats only). Site 2HW had a higher density of *Arthraxon hispidus* plants with eight to nine out of the ten quadrats having plants across the February, April and May campaigns (refer Table 3-1). Mean cover abundance values for *Arthraxon hispidus* were also low within each of the quadrats that contained *Arthraxon hispidus* (Table 3-1).

The density of *Arthraxon hispidus* plants in the three Control Plots was variable. Only one quadrat (1CE) had *Arthraxon hispidus* plants, which reflected the results of the paired impact site 1HE. Control site 2CW had *Arthraxon hispidus* plants in seven quadrats, while the paired control 2HW had nine quadrats with *Arthraxon hispidus* plants. Control site 3CN had *Arthraxon hispidus* plants in all ten quadrats in contrast to the paired impact site 3HN, which had zero quadrats with *Arthraxon hispidus* plants. Mean cover abundance values for *Arthraxon hispidus* were also low within each of the Control quadrats (Table 3-1).

Table 3-1: Number of plots with *Arthraxon hispidus* and mean cover of quadrats of *Arthraxon hispidus* in each plot

Potential Impact Plot	Number of quadrats containing *Arthraxon hispidus*			Cover abundance scores for quadrats with *Arthraxon hispidus* (mean±se)		
	February	April	May	February	April	May
1HE	1	1	1	2	2	1
1CE	1	-	-	2	-	-
2HW	9	8	8	2.5±0.2	1.9±0.2	1.1±0.2
2CW	7	-	-	2±0.2	-	-
3HN	0	0	0	-	-	-
3CN	10	-	-	1.5±0.2	-	-

No data for control sites in April and May due to private property access restrictions.

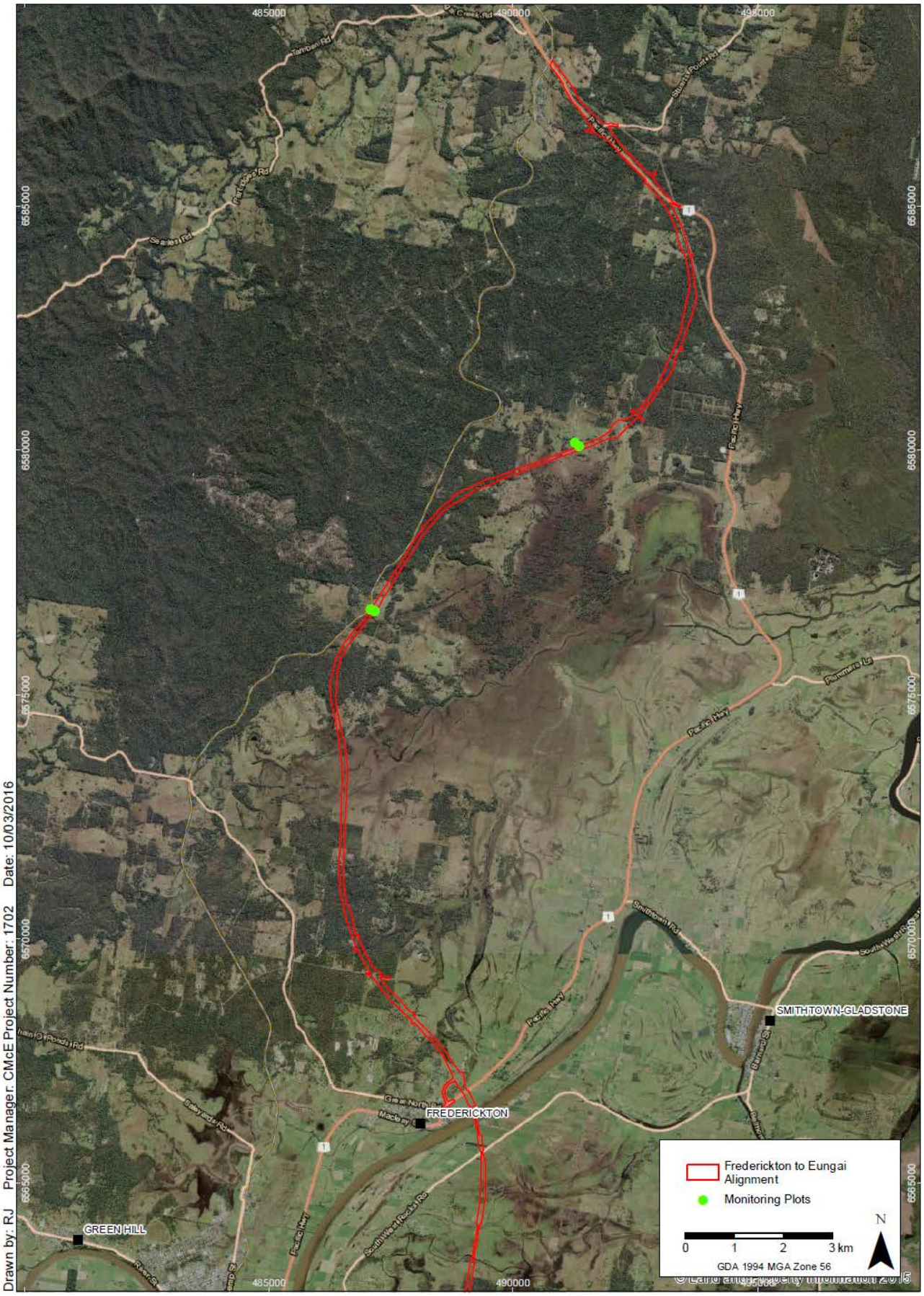
In quadrats that contained *Arthraxon hispidus* flowering and seed set appeared to be occurring across April 2015 but had finished by May 2015 (Table 3-2). In May 2015 some flowers appeared to have progressed to setting seed. Overall, based on this single observation period, flowering and seed set appeared to occur over a relatively short timeframe from summer to autumn.

Table 4-2: Number of quadrats with flowering and seed set observed

Potential Impact Plot (number of quadrats with *Arthraxon hispidus* present)	Flowers (no of quadrats)			Seed set (no of quadrats)		
	February	April	May	February	April	May
1HE (1)	0	1	0	0	0	0
1CE (1)	0	-	-	0	-	-
2HW (9)	0	8	0	0	0	3
2CW (7)	0	-	-	0	-	-
3HN (0)	0	0	0	0	0	0
3CN (10)	0	-	-	0	-	-

No data for control sites in April and May due to private property access restrictions.

No recruitment of *Arthraxon hispidus* was observed in any quadrats and all quadrats supported a dense cover of exotic and native plants (Plate 2). A total of 38 flora species were observed in all quadrats and generally quadrats were dominated by exotic grasses (Annex 1).

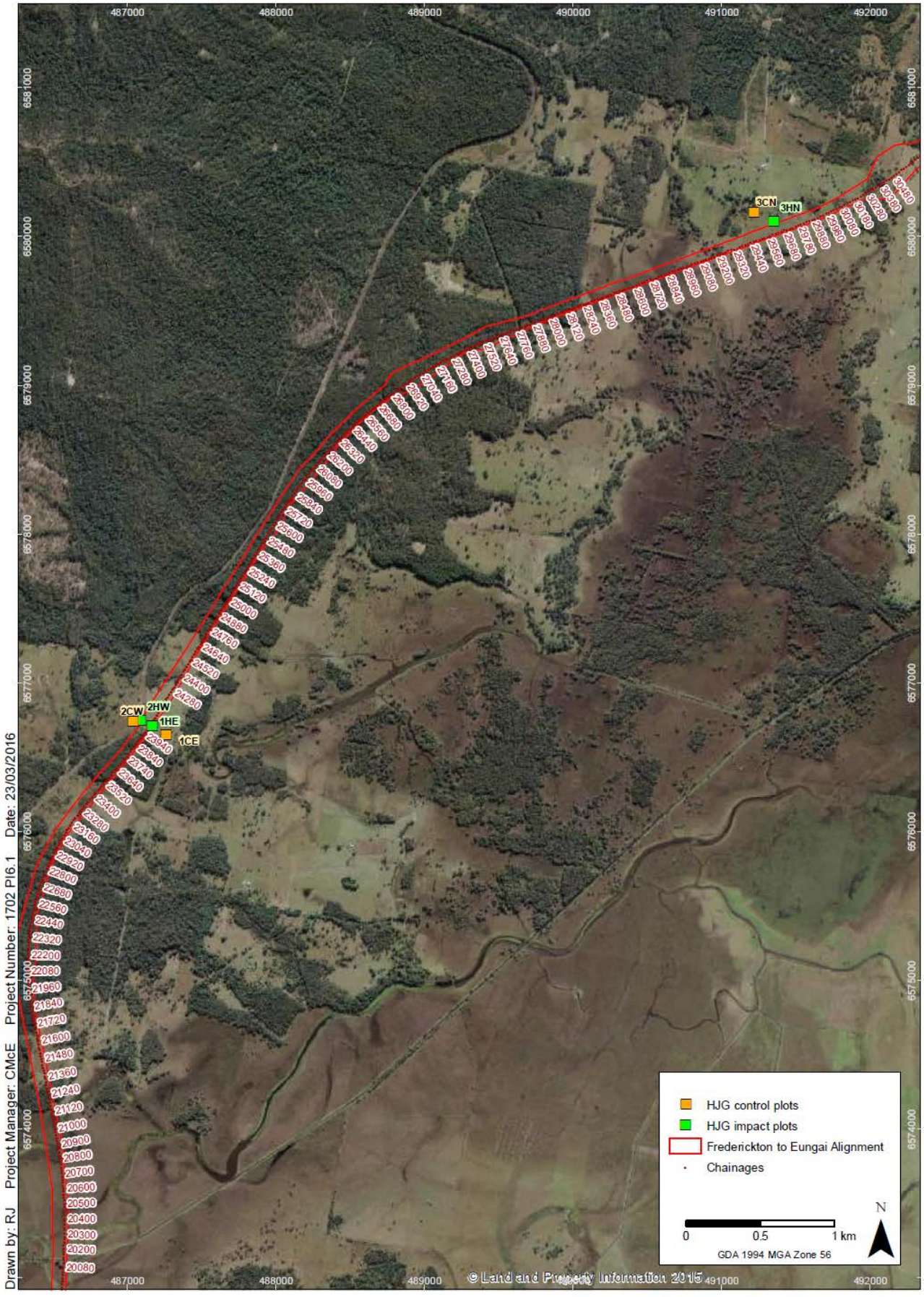


F2E Hairy Joint Grass Monitoring Locations Site Plan (Overview)

Pacific Highway Upgrade - Fredericton to Eungai

FIGURE 1

Path: T:\spatial\projects\a1700\a1702_OH2K_Ecology\Maps\PI_6_Ecological Monitoring_F2E\PI_61_HairyJointGrass\report\1702_PI_61_HJG_Figure_1_Overview.mxd



F2E Hairy Joint Grass Monitoring Locations

Pacific Highway Upgrade - Frederickton to Eungai

FIGURE 2

T:\spatial\projects\a1700\a1702_OH2K_Ecology\Maps\PI_6_EcologicalMonitoring_F2E\PI_61_HairyJointGrass\report\1702_PI_61_HJG_Figure_2_SiteMap.mxd Imagery: (c) LPI 2009-04-26

Plate 1: Installed fencing and signage at 1HE in May 2015.

Plate 2: Installed photo point at 3NW showing the dense vegetation present which is likely to exclude recruitment of *Arthraxon hispidus* seedlings.

4. Discussion

Monitoring of impacts upon *Arthraxon hispidus* is based on three performance indicators. The first indicator is the presence and effectiveness of exclusion fencing and 'no go' signage around the three monitored Potential Impact Plots. Monitoring to date has found no direct mechanical damage to *Arthraxon hispidus* plants or habitat in these plots. Signage and fencing was installed at all three plots by the second monitoring event (April 2015). Fencing required some correction due to damage at one location, but in this instance the plot was effectively isolated from any earthworks by a culvert. Overall, signage and fencing was considered to be in place and effective by April 2015.

Sedimentation impacts upon *Arthraxon hispidus* plants in the Potential Impact Plots are considered unlikely as they are either isolated from earthworks by drainage or upslope of any earthworks. In the general locations of the plots, sedimentation fences were in place and appeared to be effective in catching most sediment. In sum, overall compliance with performance indicators 1 and 2 was high and mechanical damage and sedimentation effects on Potential Impact plots had not occurred.

Performance indicator 3 could not be assessed in the manner indicated in the Ecological Monitoring Program (Lewis 2013) in this monitoring period as access to control plots on adjacent private property had been denied after the first monitoring event in February 2015, hence only one full monitoring event was conducted as per the Ecological Monitoring Program. Since the 2015 monitoring campaigns, the NSW Roads and Maritime Services has arranged agreed access for Site 3CN for future monitoring. Roads and Maritime Services has also undertaken consultation with EPA for sites where access is not permitted. The control sites 2CW and 1CE will be removed from the monitoring program and the F2E Ecological Monitoring Program will be amended to reflect this. At sites 1HE and 2HE, monitoring will concentrate on identifying any changes in cover abundances at the remaining *Arthraxon hispidus* monitoring sites.

Grasslands are generally dynamic and once factors controlling growth rates or grazing levels change (i.e. stock are excluded from an area) it is likely that the composition of species in a grassland will also change. The adjacent fenced paddocks to the Project are still grazed and the grass is shorter and with some bare patches when compared to the fenced and signed Potential Impact plots. Limited observations at the property boundaries, and from the control sites from the February 2015 monitoring event, suggest that *Arthraxon hispidus* occurs more widely in these paddocks. It appears likely that the dense grass swards of exotic grasses growing in the Potential Impact plots are likely to out-compete *Arthraxon hispidus* over time. The Control site data from the February 2015 monitoring event suggests that *Arthraxon hispidus* is more prolific in grazed areas compared to areas now excluded from grazing. It is likely that any decline in population observed at the impact sites is related to the exclusion of cattle grazing rather than the road construction activity, noting that the Impact sites appear relatively free of road construction impacts.

Generally the density of *Arthraxon hispidus* in the Potential Impact Plots is low, which is consistent with baseline surveys of cover abundance as reported by Lewis (2013). No plants of *Arthraxon hispidus* could be found in Impact site 3HN and only one quadrat in Impact site 1HE contained *Arthraxon hispidus*, although nine quadrats in Impact site 2HW contained *Arthraxon hispidus*. This suggests density among these plots is generally low and skewed, and this pattern provides challenges for effective monitoring in relation to statistical analyses.

5. Recommendations

The following suggestions are provided to improve the effectiveness of the monitoring and management of this species.

Management of Potential Impact Plots

Potential Impact Plots are recommended to be slashed, preferably in winter (June – August). This may provide recruitment opportunities for *Arthraxon hispidus* seedlings. Slashing is recommended to be undertaken so that the cover is reduced to the order of only a few centimetres in height. Slashing should avoid any standing *Arthraxon hispidus* plants, although the plant is considered to be an annual or to die-back significantly during winter. An ecologist familiar with the species should be present during slashing to ensure that individuals of *Arthraxon hispidus* are avoided.

Consultation was undertaken by Roads and Maritime Services with the NSW Environment Protection Authority Senior Threatened Species Officer regarding management of the sites.

At the recommendation of the NSW Environment Protection Authority the following was conducted:

- Slashing of *Arthraxon hispidus* at CH 29500 (Site 3HN) was undertaken on the 5 Sept 2015 to encourage Hairy joint grass regeneration (it is not currently evident as this site).
- No slashing was undertaken at the ch24000 sites (Sites 1HE and 2HW) to prevent any disturbance to the *Arthraxon hispidus* found there during the last monitoring event.

Refer Annex 2 for details of the slashing management.

References

Lewis, B.D. (2013) Ecological Monitoring Report: Frederickton to Eungai Upgrade. Unpublished report prepared for the NSW Roads and Maritime Services by Lewis Ecological Surveys.

Annex 1 *Arthraxon hispidus* Plot Data

a. February 2015 Data – All three Impact and three Control Sites (Flower = f; Seed = s; Recruitment = r)

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Flower; seed; recruitment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthraxon hispidus	**2**	0	0	0	0	0	0	0	0	0	**2**	**2**	**3**	**2**	**2**	**2**	**4**	**3**	**3**	0	0	0	0	0	0	0	0	0	0	0
Axonopus fissifolius	2	5	4	0	4	3	0	3	3	2	0	0	0	0	0	0	2	2	0	3	0	0	0	0	0	0	0	0	0	0
Paspalum dilatatum	2	2	3	0	3	0	4	4	4	5	3	4	0	0	3	2	3	2	0	0	5	5	5	5	5	5	5	5	5	5
Sporobolus fertilis	0	1	0	0	0	0	0	0	0	0	0	0	2	2	3	3	4	0	3	2	0	0	0	0	0	0	0	1	0	0
Andropogon virginicus	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Setaria pumila	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	1	0	0	0	0	2	3	3	3	3	1	3	4	0	0
Casuarina glauca	0	0	0	0	0	0	0	1	1	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pratia purpurea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio madagascariensis	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	3	2	1	1	0	2	0	2	0	2
Trifolium dubium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Verbena rigida	0	0	0	0	0	1	1	0	0	0	0	0	0	2	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Imperata cylindrica	5	0	0	6	0	0	0	0	0	0	3	2	3	4	2	3	3	0	0	3	0	0	0	0	0	0	0	0	0	0
Microlaena stipoides	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Oxalis exilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago lanceolata	0	0	1	0	0	2	1	0	1	0	1	0	0	0	0	0	0	0	0	0	3	3	0	2	1	0	0	0	0	0
Eragrostis leptostachya	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Taraxacum officinale	1	0	0	0	0	1	3	2	2	2	0	1	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0
Centella asiatica	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	3	2	0	2	0	1	3	3	0	0	0	0	0
Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenus aemulus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum nigrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rannunculus inundatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Commelina cyanea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Glycine microphylla	2	0	0	2	1	2	0	0	0	0	0	2	3	3	0	4	2	0	3	3	0	0	0	0	0	0	0	0	0	0
Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eragrostis tenuifolius	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus brevifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
Wahlenbergia communis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycine tabacina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola hederacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calochlaena dubia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis dichotoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaemochaeata americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocotlye peduncularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichondra repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0

Quadrat	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Site	**1CE**										**2CW**										**3CN**									
Flowers/ seed/ recruitment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arthraxon hispidus	**2**										**2**	**2**	**1**	**2**	**2**	**3**	**2**				**1**	**1**	**1**	**1**	**2**	**3**	**2**	**1**	**1**	**2**
*Paspalum dilatatum**	5	2					2			2				3	4	4				3	3	4	3	4	2		4	4	4	5
*Sporobolus fertilis**			2		2	2				2				3						4										
Cymbopogon refractus	2	1																												
Setaria gracilis																							3				1			
Digitaria didactyla		5	5	5	4	5	4	5	5	3		2			2						5			3	4			4	5	
Cyperus eragrostis			2																				2	1	3	2	1	1		
Allocasurina litoralis				1																										
Pratia purpurea				1						2													2							
Leptospermum					1																									
Senecio mad					1	2		1	1		1	1			1							1	2	2			2			
Trifolium dubium																														
Verbena bon							1				1			1				2												
Pteridium esc																														
Carex inversa									2																					
Imperata cylindrica									3		3	4	5				2	4	4											
Microlaena stipoides									1																					
Eucalyptus microcorys																														
Oxalis exilis																														
Plantago lance																2					2			2			2			
Eragrostis leptostachya																														
Taraxacum off	3	2		2	2	3	2							2	2	2														
Centella	1	1			1		2	2	2	3	1	2			1		2				3	2	3		3					3
Conyza bon																			1	1										
Siezbeckia											2																			
Oplismenus imb													2				2		2											
Solanum nigrum																	1													
Rannunculus inundatus																													1	

Quadrat	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Site	**1CE**										**2CW**										**3CN**									
Commelina																														
Juncus cognatus																														
Geranium homeanum															1															
Babingtonia similis																														
Bracken								1		3	3	3	2	3		3	4	3	2	3										
E. microcou										4																				
Glycine																														
Hydrotyte																											2	2		
viola																							1							

b. April 2015 Data – Three Impact Sites Only

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Flowers; seed; recruitment	f	0	0	0	0	0	0	0	0	0	f	f	0	f	f	f	f	f	f	0	0	0	0	0	0	0	0	0	0	0
Arthraxon hispidus	**2**	0	0	0	0	0	0	0	0	0	**2**	**1**	0	**2**	**2**	**2**	**2**	**2**	**2**	0	0	0	0	0	0	0	0	0	0	0
Axonopus fissifolius	2	3	3	0	4	3	2	2	2	2	0	0	0	0	0	0	2	3	0	3	3	2	3	3	3	2	4	3	4	4
Paspalum dilatatum	2	3	3	0	2	3	0	2	3	3	2	0	1	2	2	2	0	2	0	2	4	3	3	2	2	2	2	3	3	3
Sporobolus fertilis	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0
Andropogon virginicus	3	2	3	0	3	3	3	3	3	0	3	3	1	0	2	3	2	2	3	3	0	0	0	0	0	0	2	0	1	0
Setaria pumila	0	0	0		1	2	0	0	0	1	0	0	0	0	0	0	1	0	0	0	2	2	3	2	2	2	2	2	2	0
Casuarina glauca	2	3	0	0	0	0	3	1	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pratia purpurea	0	0	0	0	1	0	0	0	0	2	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Senecio madagascariensis	0	0	0	0	1	2	0	2	0	0	1	0	1	1	1	1	2	0	2	0	2	2	0	0	0	1	0	0	1	0
Trifolium dubium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	3	2	3	2	3	3	2
Verbena rigida	2	0	0	0	0	2	0	0	0	0	2	0	2	2	2	0	1	2	2	2	0	0	0	0	0	0	0	0	0	0
Pteridium esculatum	1	0	0	3	0	2	0	0	0	0	0	3	3	3	2	0	2	3	3	3	0	0	0	0	0	0	0	0	0	0
Imperata cylindrica	1	2	0	4	0	0	0	0	0	0	0	3	4	3	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Microlaena stipoides	2	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxalis exilis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago lanceolata	0	1	0	0	0	2	1	1	0	2	1	1	0	0	0	1	1	0	2	0	2	0	1	0	1	0	1	0	0	0
Eragrostis leptostachya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraxacum officinale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centella asiatica	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2	2	3	0	3	0	0	0	2	2
Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenus aemulus	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum nigrum	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rannunculus inundatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0
Commelina cyanea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Glycine microphylla	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Hypochaeris radicata	0	0	2	0	0	0	2	1	2	2	0	0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Eragrostis tenuifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus brevifolius	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	2	0	0
Wahlenbergia communis	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycine tabacina	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola hederacea	0	0	0	0	0	2	0	0	0	2	0	0	0	2	2	2	2	2	0	3	0	0	0	0	0	0	0	0	0	0
Calochlaena dubia	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis dichotoma	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Gaemochaeata americana	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocotlye peduncularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	1	0	1
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0
Dichondra repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0

c. May 2015 Data – Three Impact Sites Only

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Flowers; seed; recruitment	0	0	0	0	0	0	0	0	0	0	0	0	s	s	0	0	0	s	0	0	0	0	0	0	0	0	0	0	0	0
Arthraxon hispidus	**1**	0	0	0	0	0	0	0	0	0	**1**	**1**	**1**	**1**	**1**	0	**1**	**2**	**1**	0	0	0	0	0	0	0	0	0	0	0
Axonopus fissifolius	3	2	3	0	2	2	0	2	1	0	1	2	2	0	0	0	0	1	1	0	0	0	3	3	3	3	4	4	3	4
Paspalum dilatatum	3	3	3	0	3	0	3	3	4	4	2	2	0	0	0	3	0	3	0	2	4	3	3	4	3	3	3	2	2	3
Sporobolus fertilis	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	2	0	2	0	0	0	0	0	0	0	0	0	0
Andropogon virginicus	0	2	3	2	3	3	3	3	3	4	4	3	0	2	3	3	3	3	3	2	0	0	0	1	1	0	3	0	1	1
Setaria pumila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3	0	1	3	2	2	2	2
Casuarina glauca	1	2	0	0	0	0	3	2	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pratia purpurea	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio madagascariensis	1	0	0	0	1	2	1	2	0	1	2	2	0	0	2	0	3	0	2	2	2	0	1	2	1	2	1	1	2	2
Trifolium dubium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	3	3	3	3	3	2	2	3	3
Verbena rigida	2	0	0	0	0	2	1	0	0	0	2	0	2	2	2	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0
Pteridium esculatum	1	0	0	2	2	3	0	0	0	0	2	2	3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0
Imperata cylindrica	0	0	0	4	0	0	0	0	0	0	0	0	4	3	3	3	4	0	3	0	0	0	0	0	0	0	0	0	0	0
Microlaena stipoides	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	2	0	0	0	0	0	0	0	0	0	0
Oxalis exilis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago lanceolata	0	0	0	0	0	0	2	2	2	2	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0
Eragrostis leptostachya	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraxacum officinale	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centella asiatica	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	3	2	1	1	2	0	1	1	2
Conyza bonariensis	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oplismenus aemulus	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanum nigrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rannunculus inundatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0
Commelina cyanea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Glycine microphylla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypochaeris radicata	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	3	3	2	1	0	0	0	0	0	0	0	0	0

Quadrat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Site	**1HE**										**2HW**										**3NH**									
Eragrostis tenuifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperus brevifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wahlenbergia communis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycine tabacina	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Viola hederacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calochlaena dubia	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fimbristylis dichotoma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gaemochaeata americana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrocotlye peduncularis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pennisetum clandestinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	2
Juncus usitatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	1	0	0	0
Dichondra repens	0	0	0	0	0	0	0	1	0	0	0	1	0	2	2	0	0	2	1	2	0	0	0	0	0	0	0	0	0	0
Conyza canadensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0

Annex 2 Slashing Management Details

Slashing of Hairy Joint Grass at CH 29500 on the 5 Sept 2015

Slashing supervised by Peter Monsted

Before	After
	
	
	

During Slashing	
First Pass	
End of first pass	
Second pass to cut lower and mulch cut material	

Peter Monsted

From: Brian Tolhurst <Brian.Tolhurst@epa.nsw.gov.au>
Sent: Monday, 20 July 2015 9:20 AM
To: MAYFIELD-SMITH Melissa
Cc: O'BRIEN Bernard; Peter Monsted
Subject: RE: F2E - Slashing of Hairy Joint Grass areas

Hi Melissa, thanks for the summary of our discussion of the HJG issue on 16/7/15. I can confirm that the EPA is satisfied with the approach that you have outlined below. Please keep an accurate record of when the slashing is undertaken at the CH29500 site. The results from the ongoing monitoring of these sites (now with different management regimes including grazing exclusion) will be interesting and useful to inform further actions and approaches that are appropriate for HJG management.
Regards
Brian

Brian Tolhurst | Senior Threatened Species Officer | NSW Environment Protection Authority | ☎: (02) 6659 8277
388 | 🖷: (02) 6651 6187

From: MAYFIELD-SMITH Melissa [mailto:Melissa.MAYFIELD-SMITH@rms.nsw.gov.au]
Sent: Monday, 20 July 2015 9:06 AM
To: Tolhurst Brian
Cc: O'BRIEN Bernard; Peter Monsted (PXMonsted@thiess.com.au)
Subject: F2E - Slashing of Hairy Joint Grass areas

Hi Brian

As discussed at the ERG last week, part of Thiess Scope of Works and Technical Criteria is to:

> "undertake annual slashing in winter or spring of Hairy Joint Grass areas within the construction site, in consultation with EPA and the Project Ecologist, which have not been continually grazed by cattle in the previous year."

There are two different locations in which this is applicable, ch24000 (eastern and western side) and ch29500 (western side only).
Monitoring has been undertaken on three occasions at these sites between summer and autumn 2015. While I don't have any results back from Niche, Bernie attended the survey and has advised that HJG was found at the ch24000 site but not the ch29500 site.

As mentioned on Thursday, it is proposed to undertake slashing this Winter, however when the project is in operation, no slashing is proposed.

I would like to confirm your advice, to proceed with slashing the ch29500 site in a hope that any Hairy joint grass will regenerate. No slashing should be undertaken at the ch24000 site to prevent any disturbance to the HJG found there during the last monitoring event.

Regards,

Melissa Mayfield-Smith
Environment Officer
Environment | Strategy and Engagement

www.rms.nsw.gov.au
Every journey matters

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Niche Environment and Heritage

A specialist environmental and heritage consultancy.

Head Office

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PO Box 2443 North Parramatta NSW 1750
Email: info@niche-eh.com

All mail correspondence should be through our Head Office

Attachment C: Nest Box 2015 monitoring report.

Transport Roads & Maritime Services

Frederickton to Eungai Pacific Highway Upgrade

Nest Box Monitoring Report

Terms and acronyms

Acronym or term	Meaning
CoA	Conditions of Approval
CEMP	Construction environmental management plan
EIA	Environmental impact assessment
EMP	Ecological Monitoring Program
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW). Provides the legislative framework for land use planning and development assessment in NSW
Project EA	Kempsey to Eungai Upgrading the Pacific Highway Environmental Assessment
TSC Act	*Threatened Species Conservation Act 1995* (NSW)

Table of Contents

1. Introduction

1.1. Background

Roads and Maritime Services (Roads and Maritime) completed an environmental assessment for the Kempsey to Eungai Pacific Highway Upgrade (the Project EA) in July 2007. The Project EA identified a range of environmental, social and planning issues associated with the construction and operation of the Kempsey to Eungai Pacific Highway upgrade and proposed measures to mitigate or manage those potential impacts.

The Project EA was publicly exhibited in August 2007 for a period of 30 days. Following public exhibition, submissions from stakeholders were received and addressed by Roads and Maritime in the Submissions Report which was lodged with the Director-General in March 2008.

After consideration of the Project EA and Submissions Report, the Minister for Planning approved the Kempsey to Eungai Pacific Highway upgrade under Part 75J of the Environmental Planning and Assessment Act 1979 (EP&A Act) on 10 July 2008 subject to the Minister's Conditions of Approval (CoA) being met. CoA 3.1 required development and implementation of an Ecological Monitoring Program (EMP) to target the effectiveness of mitigation measures for the listed threatened species directly impacted by the Project.

The Kempsey to Eungai Pacific Highway Upgrade is being delivered in stages, with Stage One involving the upgrade between South Kempsey and the Frederickton Interchange and Stage Two involving the upgrade between the Frederickton Interchange and Eungai. A separate EMP has been developed for each stage of the upgrade. This nest box monitoring report has been prepared in accordance with the Frederickton to Eungai EMP.

1.2. Nest Boxes

A total of 256 nest boxes have been installed as part of the Frederickton to Eungai Pacific Highway upgrade (the Project). 36 of these additional boxes installed as part of the Cooks Lane upgrade. These 36 boxes are not subject to this monitoring program. The nest boxes are positioned on tree trunks between five and 20 metres above ground. Their installation is aimed at compensating for the loss of hollow bearing trees as part of the construction of the Project. A number of different nest box designs have been installed suitable for a wide range of arboreal mammals and hollow nesting birds, including threatened species such as Brush-tailed Phascogale (*Phascogale tapoatafa*) and Squirrel Glider (*Petaurus norfolcensis*), which are both listed as Vulnerable under the *Threatened Species Conservation Act 1995* (TSC Act). The nest box designs installed include:

- Microbat boxes.
- Small glider boxes designed for Feather-tail and sugar gliders.
- Large gliders designed for Yellow-bellied and Squirrel gliders.
- Scancorial fauna designed for Antechinus and Brush-tailed phascogale.
- Possum boxes designed for Common Ringtail and Common Brushtail possums.
- Medium parrot boxes designed for Lorikeets, Rosellas etc.
- Larger parrot boxes designed for Glossy black cockatoo, King parrot and small owls.
- Large owl boxes.

These nest boxes were installed between July and September 2013. This is the first monitoring event of the nest boxes. This report details the summer 2014/2015 and winter 2015 nest box monitoring event, conducted in early and mid 2015.

1.3. Performance Measures

In keeping with the EMP the performance of the nest box program would be assessed against the following parameters:

- Use of nest boxes by a wide range of native fauna.
- Use of nest boxes designed for specific species by those species (i.e. scansorial fauna nest box being used by these species).
- Low rates of exotic fauna using nest boxes.
- Reduced maintenance requirements (<10% requiring attention).

2. Methodology

Inspection of the nest boxes was undertaken by the Project Ecologist. These inspections were undertaken between 31 January and 14 February 2015 for the summer monitoring event and between 17 July and 28 August 2015 for the winter monitoring event.
To minimise disturbance of fauna that may be occupying the boxes, inspections were undertaken using a pole camera with an extension capability of up to eight metres. Where required the pole camera was used in conjunction with a ladder.

A field form was produced to ensure that the information required by the EMP was recorded. The field form documented the following:

- Inspection date.
- Nest box location, number and type.
- Evidence of occupation and if possible identification of species.
- Evidence of pest species.
- Condition of the box.
- Any maintenance requirements.
- Any other relevant comments, including any changes in the landscape.

Unfortunately weather conditions were not recorded during the winter and summer monitoring events. This will be rectified for all future monitoring events.

3. Figure 1: Nest box identification tag

3. Results

3.1. Summary

3.1.1. Summer

Of the 220 nest boxes nominated for installation in the EMP 208 were located. All of these 208 nest boxes were monitored for their condition. Of these the pole cam was unable to reach 21 boxes resulting in 187 boxes being monitored internally for utilisation.

Table 1: Summary of Nest Box Results

Criteria	Number of Boxes[1]
Native Vertebrate Fauna Present	20
Signs of Presence of Native Fauna[2]	68
Non native fauna	1
Signs or presence of Pest Fauna	15
Unable to be located	12
No evidence of use	87
Monitored via binoculars	21

3.1.2. Winter

Of the 220 nest boxes nominated for installation in the EMP 207 were located. All of these 207 nest boxes were monitored for their condition. Of these 24 boxes were monitored via binoculars, resulting in 183 boxes being motioned internally for utilisation.

Table 2: Summary of Nest Box Results

Criteria	Number of Boxes[1]
Native Vertebrate Fauna Present	21
Signs of Presence of Native Fauna[2]	42
Non native fauna	1
Signs or presence of Pest Fauna	2
Unable to be located	13
No evidence of use	120
Monitored via binoculars	24

[1] Some nest boxes fit under more than one category
[2] Excluding boxes that contained native vertebrate fauna present

3.2. Observed Fauna

3.2.1. Summer

Native vertebrates were recorded within 20 or 10.7% of the nest boxes surveyed (n=187). 25 individuals were recorded comprising of seven different species, as listed in Table 3.

Table 3: Vertebrates recorded occupying the nest box

Common name	Scientific Name	Total number of individuals recorded	Total Number of nest boxes where species were present
Antichinus sp	*Antichinus sp*	1	1
Brushtail Possum	*Trichosurus vulpecula*	9	8
Brush-tailed Phascogale	*Phascogale tapoatafa*	1	1
Green Tree Snake	*Dendrelaphis punctulata*	1	1
Lace Monitor	*Varanus varius*	2	2
Northern Mallard*	*Anas platyrhynchos*	1 (with 11 eggs)	1
Ringtail Possum	*Pseudocheirus peregrinus*	1	1
Sugar Glider	*Petaurus breviceps*	10	6

* = introduced species

Sugar gliders were the most abundant species with 10 individuals detected across 6 different boxes. Four of these Sugar gliders were recorded individually and on two occasions three were detected sharing a box. Sugar gliders were found within scansorial boxes on three occasions and within a small glider, medium parrot and a large glider box on one occasion.

Figure 2: Three Sugar gliders

Brush-tailed possums were the next most abundant species recorded with nine individuals found within eight different nest boxes. Brush-tailed possums were mostly found within the possum box design (three occasions). They were also recorded within large glider boxes and medium parrot boxes (both on two occasions) and within a large parrot box on one occasion.

Figure 3: Two Brushtail possums

One Common ringtail possum was recorded within a possum box and an Antichinus sp. within a scansorial box, both nest boxes corresponded to these species.

One Brush-tailed phascogale was found within a scansorial next box, which is designed to be inhabited by this species. This species is listed as Vulnerable under the TSC Act and is a target species for the EMP. This individual was found on the western side of the carriageway, just north of Raymonds Lane.

Figure 4: Brush-tailed phascogale

One Green tree snake was recorded inhabiting a large glider nest box and two Lace monitors were found occupying a medium parrot and a small glider box.

A Northern mallard with 11 eggs was found within a possum box.

3.2.2. Winter

Native vertebrates were recorded within 21 or 11.5% of the nest boxes surveyed (n=183). The number of individuals recorded was 21 including six different native species as listed in Table 4.

Table 4: Vertebrates recorded occupying the nest box

Common name	Scientific Name	Total number of individuals recorded	Total Number of nest boxes where species were present
Antichinus sp	*Antichinus sp*	1	1
Brushtail Possum	*Trichosurus vulpecula*	6	6
Diamond Python	*Morelia spilota spilota*	1	1
Lace Monitor	*Varanus varius*	3	3
Short eared Brushtail Possum	*Trichosurus caninus*	1	1
Northern Mallard*	*Anas platyrhynchos*	1	1
Sugar Glider	*Petaurus breviceps*	10	9

* = introduced species

Sugar gliders were the most abundant species with 10 individuals detected within nine nest boxes. Nine of these Sugar gliders were recorded individually and on one occasion two were detected sharing a box. Sugar gliders were found within scansorial mammal boxes on five occasions and within a small glider boxes on four occasions. Two of the nine boxes contained sugar gliders in both the summer and winter monitoring events.

Brushtail Possums were the next abundant with six individuals recorded all individually. Brushtail possums were found within possum boxes on three occasions and within small owl boxes on two occasion and medium parrot on one occasion. On two occasions Brushtail possums were found in the same box during both the summer and winter monitoring events.

Lace Monitors were found on three occasions, all within small glider boxes. One of these boxes contained a lace monitoring in the summer and winter monitoring events. Diamond python, short-eared brushtail possum and antechinus sp. were all detected on one occasion. They were found within a possum box, small owl box and large glider box, respectively.

3.3. Signs of Fauna Usage

3.3.1. Summer

Including observed fauna, 88 or 47.1% (n=187) of the boxes inspected showed some sign of use by native fauna. The fauna signs of activity can in some cases be attributable to a species based on the available evidence such as nesting material, shape and size. Table 5 provides a list of species likely to be responsible for the signs of fauna usage and their frequency.

Table 5: Nest boxes with signs of fauna activity

Native fauna usage signs	Number of nest boxes
Fauna Present	20
Species unknown	5
Bird nest – species unknown	5
Sugar or Squirrel Glider	32
Brush-tailed possum or Ringtail possum	23
Possible Brush-tailed phascogale	3
Total	88

Of the 68 nest boxes with signs of fauna presence, 32 of these contained nests which are contributed to the sugar or squirrel glider. These nests typically contained eucalypt leaves arranged in a cylindrical bowl shape.

23 nest boxes had either a Brush-tailed or Ringtail possum nest present. These nests were relative flat nests consisting of leaves, bark and other plant material. Two of these nest contained scats likely belonging to the Brush-tailed possum.

Three nest boxes contained nests, which may have belonged to the Brush-tailed phascogale. The nests within these boxes typically contained bark (commonly paperbark), feathers and or fur.

Five nest boxes contained bird nests, four of which could not be assigned to a species level. Two of these boxes contained fragments of hatched bird eggs. One nest can be attributed to the Northern Mallard.

The species contributing to the signs of usage could not be determined in five of the nest boxes. These boxes contained degraded nesting material with no distinctive features.

3.3.2. Winter

Including observed fauna, 60 or 32.8% (n=183) of the boxes inspected showed some sign of use by native fauna. The fauna signs of activity can in some cases be attributable to a species based on the available evidence such as nesting material, shape and size. Table 6 provides a list of species likely to be responsible for the signs of fauna usage and their frequency.

Table 6: nest boxes with signs of fauna activity

Native fauna usage signs	Number of nest boxes
Fauna Present	21
Bird Eggs (species unknown)	1
Sugar or Squirrel Glider	8
Brush-tailed possum or Ringtail possum	2
Brush-tailed phascogale	1
Mammal leaf nest	16
Old mammal leaf nest	11
Total	60

Of the 60 nest boxes with signs of fauna presence, 16 contained mammal leaf nests and a further 11 contained old leaf nests. None of these could be attributed to a species.

Eight nest boxes contained nests which are contributed to the sugar or squirrel glider. These nests typically contained eucalypt leaves arranged in a cylindrical bowl shape.

Two nest boxes had either a Brush-tailed or Ringtail possum nest present. These nests were relative flat nests consisting of leaves, bark and other plant material. One of these nest contained scats likely belonging to the Brush-tailed possum.

One nest box contained nests, which may have belonged to the Brush-tailed phascogale. The nests contained bark with feathers.

One nest box contained bird eggs, which could not be assigned to a species level.

3.4. Pest Activity

3.4.1. Summer

Pest activity was recorded within 16 nest boxes or 8.5% (n=187) of the boxes inspected. European bees were observed either within or around six nest boxes. A further six boxes contained old bee combs (Figure 5). Small mud wasp nests were recorded on the walls of three nest boxes and Spiny Ants (Polyrhachis sp.) were found within one box.

Figure 5: Old bee comb

3.4.2. Winter

Pest activity was recorded within two nest boxes or 1.1% (n=183) of the boxes inspected. This pest activity included an old bee hive and termite/ ant activity. It was noted that the majority of boxes showing signs of pest activity during the summer monitoring event did not contain signs during the winter monitoring event. Some boxes containing European bees during the summer monitoring event showed signs of native fauna usage during the winter monitoring event.

3.5. Defunct boxes

12 and 13 nest boxes could not be located during the summer and winter inspections, respectively. These boxes were either not installed, have been removed by fence line or private property clearing or have been installed in the incorrect location. As discussed in Table 8, these have been replaced or relocated.

Discussion

The nest boxes have been installed as a mitigation measure for the loss of tree hollows from clearing for the Project. The rate of occupancy by native species was 11% during both the summer and winter monitoring events. A high number of nest boxes showed signs of usage (including those containing native fauna). This includes 47% and 34% of monitored nest boxes during the summer and winter monitoring events, respectively. 47% of boxes in the summer monitoring event and 66% of boxes in the winter monitoring event showed no signs of usage.

This monitoring event represents a snapshot of nest box usage with the results likely to alter over time. This report focuses on the first two monitoring events with a further four monitoring events scheduled. This will assist in identifying any trends occurring over time.

4.1. Nest box usage by target species

Two nest box types showed no signs of usage by native fauna. These next boxes include those designed for large owls (five installed) and microbats. No microbats, large owls or parrots were recorded during either survey. Bird nests and hatched eggs were observed, however these could not be attributed to a group or species. No signs of microbat activity were detected.

4.1.1. Small Glider

Small glider boxes were predominantly used by the target species Sugar Gliders. The design of this nest box also targets Feather-tail gliders. No feather-tail gliders were observed. Leaf nests including one indicative of the Brush-tailed Phascogale were recorded in a number of small glider boxes.

4.1.2. Large Glider

Leaf nests which attributed to the target species were found in large glider boxes, however no individuals were recorded. On one occasion Antechinus, Brush-tailed possum and a Green tree snake were observed in large glider boxes.

4.1.3. Scancorial Fauna

Target species including Antechinus and Brush-tailed phascogale were recorded within scancorial fauna boxes. However, sugar gliders were the most frequently recorded species utilising scancorial fauna boxes. An unoccupied bird nest was also observed.

4.1.4. Possum

Occupation of possum nest boxes was dominated by the target species Brushtail Possums. Ringtail Possums, which are another target species, were also observed occupying of possum boxes.

4.1.5. Medium Parrot

Brushtail Possums were the most frequent species recorded within nest boxes designed for medium parrots. No medium parrots were observed, however hatched bird eggs and unoccupied bird nests were observed within these boxes.

4.1.6. Large Parrot

Only Brushtail Possums were found to occupy large parrot boxes. No other signs of utilisation were observed in large parrot boxes.

4.2. Pest Activity

Feral European Honey Bees (*Apis mellifera*) is a common pest of nest boxes and tree hollows. As detailed in section 3.4, European bees were observed either within or around six nest boxes during the summer monitoring event. During the winter monitoring events none of the boxes previously containing European were found to continue to contain bees.

4.3. Compliance with performance measures

Table 7 assesses whether the performance measures identified in Section 1.3 are being met.

Table 7: compliance with performance measures

Performance measure	Compliance statement	Contingency measure
Use of the nest boxes by a wide range of native fauna	All of the nest box design types were utilised or showed signs of utilisation by native fauna with the exception microbat boxes	None, continue to monitor nest boxes to determine utilisation
Use of nest boxes designed for specific species by those species (i.e. Brush-tailed phascogales nests box being used by this species)	All nest box designs with the exception of microbat and large owl boxes were utilised or showed signs of utilisation by targeted species	None required
Low rates of exotic fauna using nest boxes	An exotic fauna occupancy rate of 8.5% was recorded during the summer survey, which dropped to 1.1% in the winter survey	None required
Reduced maintenance requirements (<10% requiring attention)	All nest boxes were in a good condition during both surveys	Contingency measures are not required. Some minor maintenance actions have been identified in table 8

Recommendations

Table 8 summarised the recommendations following 2015 summer and winter monitoring events and the corrective actions undertaken.

Table 8: summary of recommendations

Nest Box Number	Issue	Recommendation / corrective action undertaken
NBB SF 01	This tree facing box has been installed with the entrance facing outwards	Box rotated
NBC PO 02	Could not be located during monitoring events	Additional box installed
NBC SG 02	Could not be located during monitoring events	Additional box installed
NBE PL 02	No installation record	Box installed
NBE PO 02	Installed on private property without agreement	Box relocated to within Roads and Maritime property
NBE PO 03	Installed on private property without agreement	Box relocated to within Roads and Maritime property
NBE SF 03	Installed on private property without agreement	Box relocated to within Roads and Maritime property
NBF PO 05	Could not be located during monitoring events	Additional box installed
NBF PO 06	Could not be located during monitoring events	Additional box installed
MBJ PL 01	Boxes have been installed too high to enable monitoring	Lower on tree
MBJ PL 02	Boxes have been installed too high to enable monitoring	Lower on tree
NBJ PO 01	Could not be located during monitoring events	Additional box installed
NBJ SG 05	Could not be located during monitoring events	Additional box installed
NBK SG 02	Believed to have been removed by fence line clearing	Replacement box installed
NBK SG 03	Could not be located during monitoring events	Additional box installed
NBL MB 03	Could not be located during monitoring events	Additional box installed