



Transport
Roads & Maritime
Services

W2B-RMS-0-EF-PLN-00039

Flora Translocation Strategy

Pacific Highway Upgrade

Sections 3-11 excluding Early Works

Soft Soil Treatment Areas

Woolgoolga to Ballina

Version 3

February 2020

EXECUTIVE SUMMARY

New South Wales Roads and Maritime Services are upgrading the Pacific Highway between Woolgoolga and Ballina on the NSW North Coast (the Project). The preparation of a translocation strategy for impacted threatened flora species i.e. listed on schedules of the *NSW Threatened Species Conservation Act* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is a requirement of the conditions of approval.

The translocation strategy is complemented by an offset strategy offset package and offset status report. Impacts to threatened species will be fully offset. The translocation management actions detailed in this report are additional to offsets.

The translocation strategy has been submitted in stages. A Translocation Strategy for Sections 1 and 2 of the Project (part of Stage 1) - was approved on 12 May 2015 and a strategy for Early Works Soft Soils Treatment Areas three waves of construction packaging making up the remainder of Stage 1 of the highway upgrade) was approved on 9 June 2015. The current strategy covers Sections 3 to 11 (excluding Early Works Soft Soils Treatment Areas).

Sixteen species of threatened flora are identified as being directly impacted by the upgrade of Sections 3 to 11 (excluding Early Works Soft Soils Treatment Areas) and twelve are assessed as feasible for translocation. They are:

Four-tailed Grevillea *Grevillea quadricauda* (Vulnerable TSC Act EPBC Act).
Green-leaved rose walnut *Endiandra muelleri* subsp. *bracteata* (Endangered TSC Act)
Hairy joint-grass *Arthraxon hispidus* (Vulnerable TSC Act EPBC Act).
Red lilly pilly *Syzygium hodgekinsoniae* (Vulnerable TSC Act EPBC Act).
Rough-shelled bush-nut *Macadamia tetraphylla* (Vulnerable TSC Act EPBC Act).
Singleton mint bush *Prostanthera cineolifera* (Vulnerable TSC Act EPBC Act).
Slender screw-fern *Lindsaea incisa* (Endangered TSC Act)
Stinking Cryptocarya *Cryptocarya foetida* (Vulnerable TSC Act EPBC Act).
Tall knotweed *Persicaria elatior* (Vulnerable TSC Act EPBC Act).
Weeping paperbark *Melaleuca irbyana* (Endangered TSC Act)
White laceflower *Archidendron hendersoni* (Vulnerable TSC Act).
Yellow-flowered king of the fairies *Oberonia complanata* (Endangered TSC Act).

Suitable receiving sites have been identified in proximity to donor populations on Roads and Maritime-owned land, National Parks estate and private land under covenant. Impacted plants will be salvaged in order to safeguard possibly unique genetic material, to enhance existing populations and avoid an overall reduction in population numbers. Trialling of translocation methods will improve knowledge of biology and management for threatened flora species.

Suitably qualified and skilled operators will be responsible for translocation including collection of material for propagation nursery procedures receiving site preparation mitigation of threats direct transplant or planting out and post-translocation care. Monitoring will be carried out for up to five years and management adapted should performance fall below specified thresholds.

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Glossary and Abbreviations

Ameliorative enhancement	An attempt to increase population size by adding individuals to an existing population to ameliorate the loss of part or all of that population due to development.
BOS	Biodiversity Offset Site
CoA	Conditions of Approval
Compensatory introduction	The establishment of a population to compensate for the impact of a development. In the majority of cases such translocations will meet the definition of conservation introduction.
Conservation introduction	Attempts to establish a taxon for the purpose of conservation at a site where it is not known to occur now or to have occurred in historical times but which is considered to provide appropriate habitat for the taxon.
Construction footprint	The direct area of the design alignment (also referred to as the clearance limits)
DECCW	NSW Department of Environment Climate Change and Water (now known as OEH)
Direct impact	An impact that causes direct harm within the project boundary (i.e. clearing of vegetation)
DoE	Commonwealth Department of the Environment (previously known as the Commonwealth Department of Sustainability Environment Water Population and Communities)
DP&E	NSW Department of Planning and Environment (previously known as of Planning and Infrastructure)
DPI	NSW Department of Primary Industries
EPA	NSW Environment Protection Authority
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
Enhancement	An attempt to increase population size or genetic diversity by adding individuals to an existing population. This may be part of the process of restoration or reconstruction of a site where the taxon occurs but requires population manipulation to increase viability. Also referred to as re-enforcement re-stocking enrichment supplementation or augmentation.
Ex situ	Locations where plant populations would be translocated to or revegetated in a new area outside the project boundary
Indirect impact	An impact that causes harm outside of the project boundary (i.e. edge effects erosion etc.)
In situ	Locations where threatened plant populations already exist and occur naturally in the landscape and will be retained and managed. They are within the project boundary but outside the construction footprint.
MCoA	NSW Ministers Condition of Approval
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
Offset	An offset may be an area of land that is protected and managed to improve biodiversity values or an action that compensates for adverse impacts to biodiversity. Requirements for offsets are determined using an objective assessment of predicted loss of biodiversity at the development site and expected gain in biodiversity to be achieved at the offset site.
Performance threshold	This is a prescribed outcome that should it be reached an assessment as to why the objectives are not being met will be undertaken and then appropriate corrective actions implemented.
The Project	Refers to all the proposed works in all eleven sections which includes the construction footprint with a 10 metre construction buffer ancillary and compound sites and design changes.
Receival site	This is the site where plant populations would be translocated to or revegetated in a new area outside the project boundary.

Re-introduction	An attempt to establish a population in a site where it formally occurred where it is now extinct. This may be part of the process of restoration or reconstruction of a habitat where the taxon was previously known to occur. Also referred to as re-establishment.
Revegetation	The planting of native species post construction to stabilise areas and restore bushland in areas that were required to be cleared as a result of construction but not required for ongoing highway operations.
Roads and Maritime	NSW Roads and Maritime Services
Salvage dig	The transplantation of mature plants or soil stored seed bank to an area not affected by the development. Also referred to as transplantation or rescue dig.
Stochastic event	Natural phenomenon such as storms fires floods droughts etc. (random event)
Targeted surveys	Field surveys completed in 2014 for Sections 1 to 11 for threatened flora species listed under the EPBC Act and TSC Act.
TFMP	Threatened Flora Management Plan
Threatened species	Any organism listed as vulnerable endangered or critically endangered under State and/or Commonwealth legislation.
TSC Act	<i>Threatened Species Conservation Act 1995</i>
Translocation	Deliberate transfer of plant material from one area to another for conservation purposes
W2B	Woolgoolga to Ballina Pacific Highway Upgrade
Weeds	Plants that may threaten agricultural land adjacent to the Project have detrimental effects on the natural environment or impact human health. Includes noxious weed species under the <i>Noxious Weeds Act 1993</i> as categories W1 W2 W3 or W4.

1. Background

1.1 Project overview

New South Wales Roads and Maritime Services are upgrading the Pacific Highway between Woolgoolga to Ballina on the NSW North Coast. The Project was approved under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) by the NSW Minister for Planning on 26 June 2014. It was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 14 August 2014.

Key features of the upgrade include:

- Duplication of 155 kilometres of the Pacific Highway to a motorway standard (Class M) or arterial road (Class A) with two lanes in each direction and room to add a third lane if required in the future
- Split-level (grade-separated) interchanges at Range Road Glenugie Tyndale Maclean Yamba / Harwood Woombah (Iluka Road) Woodburn Broadwater and Wardell
- Bypasses of South Grafton, Grafton, Ulmarra Woodburn Broadwater and Wardell
- About 40 bridges over rivers creeks and floodplains including major bridges crossing the Clarence and Richmond rivers
- Bridges over and under the highway to maintain access to local roads that cross the highway
- Access roads to maintain connections to existing local roads and properties
- Structures designed to encourage animals over and under the upgraded highway where it crosses key animal habitat or wildlife corridors
- Rest areas located at about 50 kilometre intervals at Pine Brush (Tyndale) north of Mororo Road and north of the Richmond River at Old Bagotville Road
- A heavy vehicle checking station near Halfway Creek and north of the Richmond River.

New South Wales Roads and Maritime Services (Roads and Maritime) has approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project under Part 5.1 of the EP and A Act and the EPBC Act. In accordance with the NSW Minister's Conditions of Approval (MCoA) A8 the required translocation strategy will be submitted in stages. The Commonwealth MCoA require compliance with NSW conditions as they apply to species listed on schedules of the EPBC Act and assessed as likely to suffer a significant impact as result of the proposal.

Compliance with conditions of approval is demonstrated in Table 1. Responses to comments on a draft of this strategy are provided in Appendix 1.

The project is divided into 11 sections (Figure 1).

Translocation strategies have been prepared for two components of Stage 1 of the highway upgrade. The strategy for Sections 1 and 2 (Woolgoolga to Halfway Creek) was approved on 12 May 2015. In addition due to the presence of soft soils in the vicinity of the Clarence River and Richmond Floodplains initial works are required in advance of the main construction of the highway to consolidate the deep soft soils under the proposed highway alignment. Soft soil preload construction will be undertaken in three waves of construction packaging directly impacting on threatened flora species in Sections 4 5 and 8. Accordingly a translocation strategy for the Early Works Soft Soil Treatment Areas was approved on 9 June 2015.

This translocation strategy applies to Sections 3-11 excluding the Soft Soil Treatment Areas. Sections 3-11 extend from Halfway Creek to Ballina (153km).



Figure 1 Woolgoolga to Ballina Project Sections

1.2 Purpose of the strategy

This Translocation Strategy has been developed to meet the requirements of MCoA D7. This Translocation Strategy specifically addresses Sections 3-11 (excluding Early Works Soft Soil Treatments Works) which is due to commence construction the first half of 2016.

Table 1 sets out the requirements of MCoA and where each has been addressed in this strategy.

Table 1: Project approval requirements and where addressed

Approval requirement		Where addressed
NSW approval		
MCoA D7	<p>The Applicant shall prepare and implement Flora Translocation Strategy to determine the feasibility and potential efficacy of translocation measures (as identified in the threatened species management plans required under condition D8) prior to the commencement of construction work that would result in the disturbance of threatened flora species for which translocation is proposed. The strategy shall be prepared by a suitably qualified and experienced ecologist in consultation with the EPA and DoE and to the satisfaction of the Secretary. The Strategy shall include:</p> <ul style="list-style-type: none"> (a) a feasibility assessment of timeframe and staging requirements availability of expertise risk effectiveness analysis and availability/suitability of translocation sites; (b) detail of species specific information on the proposed methods of and discussion of results of past recorded responses to translocations; (c) a framework for the translocation process applicable to each affected species; and (d) consideration of appropriate compensatory habitat in the Biodiversity Offsets Package required under condition D5 where translocation is not reasonable for feasible. 	<p>The requirements of this condition are addressed in this plan. Details on the ecologist expertise for preparation of the strategy is provided in Section 1.3. The strategy has been informed by feedback from EPA and DoE on draft Translocation Strategies prepared for Sections 1 and 2 and Early Works Soft Soil Treatment Areas.</p> <p>(a) is addressed in Table 5, Table 7 Section 2.4 and Appendix 3.</p> <p>(b) is addressed in Table 8 and Appendices 5 and 6.</p> <p>(c) is addressed in Section 3 Table 8 and Appendix 6.</p> <p>(d) is addressed in Section 1.2 below.</p>

The Project Area is defined by mapped boundaries broadly encompassing a corridor of approximately 1 km in width. Within the Project Area a Clearing Boundary is also defined and mapped. Vegetation and individual plants of threatened flora species within the Clearing Boundary are considered to be directly impacted by the proposal.

At the time of the preparation of this translocation strategy for Sections 3-11 (excluding Early Works Soft Soil Treatment Areas) the project design for the relevant sections had not been finalized. Compilations of survey data were available to quantify estimates of impacts on threatened flora species (see also Threatened Flora Management Plan Sections 1 -11 and Soft Soil Work Areas (Roads and Maritime 2015a).

Translocation is defined as the “deliberate transfer of plant material from one area to another for conservation purposes” (Vallee *et al.* 2004). The purpose in this project is to apply a range of translocation techniques to impacted populations of threatened species so that declines in numbers and genetic diversity can be avoided to the best extent possible. The overall objective of threatened plant translocations is to establish populations that are self-sustaining over the long-term.

Despite the potential for translocation to make valuable contributions to conservation objectives and to mitigate some of the impacts of development it is recognised that translocations are generally experimental and success cannot be guaranteed, although every effort is made to maximize the chance of success. Accordingly translocation is not considered a mitigation measure under the EPBC Act and the flora individuals to be removed/translocated are considered to be impacted for the purposes of the EPBC Act. This impact will be compensated for with the provision of suitable offsets in accordance with the EPBC Act Offsets Policy. Roads and Maritime (2015b) have prepared a Biodiversity Offset Strategy.

Translocation of threatened plants is being considered for those threatened plants that are within the clearing boundary and would be undertaken for threatened species that have suitable life history traits that make translocation a viable option with monitoring to measure success.

1.3 Plan authors

The Strategy was prepared by:

Barbara Stewart of Landmark Ecological Services Pty Ltd. Barbara has a Ph D in forest ecology a B Sc (Hons) in botany and more than 20 years' experience in research consultancy and land management on the NSW north coast and more widely. Her research specialisations are in seed and seedling ecology.

In addition she has authored/co-authored Recovery Plans for threatened species and has extensive survey and management planning experience for flora species of conservation significance. Barbara was formerly the proprietor of a native plant nursery.

Rhonda James - Bushland Restoration Services Pty Ltd. Rhonda has a B Business M Env Man and Cert IV Bushland Restoration. Rhonda has 15 years' experience in ecological restoration specializing in the recovery of threatened species and endangered ecological communities. Rhonda co-authored the SEQ Ecological Restoration Framework.

She has extensive experience in habitat restoration translocation and monitoring of threatened species. These projects include Hairy Joint Grass at Koala Beach and Lennox Head Green-leaved Rose Walnut at Koala Beach RTA works at Alstonville bypass Sleepy Hollow Rest Area Banora Point bypass and Murnanes Bridge OEH Coastal Fontainea and Hairy Quandong and extensive works for Gold Coast City Council and SEQWater related to translocation of threatened species during construction of the Hinze Dam.

1.4 Consultation and updates

This strategy provides a framework for implementation of any translocation of threatened species impacted by the Project. The plan would be updated as required during pre-construction or during the construction stage of the Project. Any updates to the strategy would be undertaken in accordance with the Project Staging Plan submitted under Ministers Condition of Approval A7.

Roads and Maritime has consulted with the NSW Environment Protection Authority and Department of Environment and Planning and the Commonwealth Department of Environment during the development of this strategy. Agencies were provided a copy of the Draft Report on 27 October 2015. Feedback received and Roads and Maritime response to issues raised have been included in **Appendix 1** of this report.

Version 3 (this Plan) includes the following updates:

- Change of translocation receival site for *Melaleuca irbyana* (Weeping Paperbark) to Site 4 and 5 biobanking property at Tabbimoble Creek, see Appendix 6, section 6.19 and Appendix 7.
- Change of translocation receival site for Stinking Cryptocarya, Rusty Rose Green Walnut, Red Lilly Pilly, White Lacefloer and Rough-shelled Bush Nut from Site 8 Lumleys Lane to Site 12 Coolgardie Rd/Randles Creek, see Appendix 6, section 6.20.
- Inclusion of Green-leaved Rose Walnut Remediation Action Plan, see Appendix 8.

1.5 Previous studies

Section 2 of the Threatened Flora Management Plan includes a summary of the previous studies in the EIS, SPIR and baseline survey information since 2006.

The most recent relevant ecological studies that have been conducted for Sections 3-11, are as follows:

Surveys conducted in 2014-15 were:

Section 3	Geolink (2014a)
Section 4 and 5	Geolink(2014b)
Section 6	AECOM (2014)
Section 7	Biosis (2014)
Sections 8 and 9	Melaleuca Group (2014a)
Sections 10 and 11	Australian Museum Consulting (2014)
Preconstruction surveys	Jacobs (2014a)

A combined spatial database incorporating preconstruction survey data and data collected for the EIS preparation was used for the purposes of the current translocation strategy.

From these surveys it has been determined that sixteen (16) threatened flora are to be directly impacted in Sections 3-11 of the Woolgoolga to Ballina Upgrade (**Figure 1**):

- Four-tailed Grevillea (*Grevillea quadricauda*)
- Green-leaved rose walnut (*Endiandra muelleri* subsp. *bracteata*)
- Hairy joint-grass (*Arthraxon hispidus*)
- Maundia (*Maundia triglochinosoides*)
- Red lilly pilly (*Syzygium hodgkinsoniae*)
- Rough-shelled bush-nut (*Macadamia tetraphylla*)
- Sandstone rough-barked apple (*Angophora robur*)
- Siah's backbone (*Streblus brunonianus*)
- Singleton mint-bush (*Prostanthera cineolifera*)
- Slender screw fern (*Lindsaea incisa*)
- Stinking Cryptocarya (*Cryptocarya foetida*)
- Tall knotweed (*Persicaria elatior*)
- Water nutgrass (*Cyperus aquatilis*)
- Weeping paperbark (*Melaleuca irbeyana*)
- White laceflower (*Archidendron hendersoni*)
- Yellow-flowered king of the fairies (*Oberonia complanata*)

Recent taxonomic changes have affected Siah's backbone *S. pendulinus* a taxon which was originally restricted to Lord Howe Island. *Streblus pendulinus* is now considered by some authorities to include Whalebone tree *S. brunonianus* which occurs on the mainland. The Royal Botanic Gardens (Plantnet website accessed 15 February 2015) considers however that *S. pendulinus* has been incorrectly included in the synonymy of *S. brunonianus*. Whalebone tree is a relatively common and widespread rainforest tree.

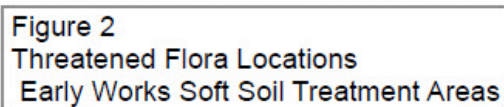
In NSW, *S. pendulinus* is not listed as threatened under the TSC Act. Siah's backbone *S. pendulinus* is however listed as threatened under the EPBC Act. The SPRAT profile advises that the listing status of *Streblus pendulinus* under Commonwealth legislation applies on mainland Australia.








The Federal Government's conditions of approval list threatened species requiring consideration. In addition species considered by the Australian government department responsible for administering the EPBC Act 1999 to be significantly impacted by the action require consideration. Siah's backbone/Whalebone is present in and around the project area and will suffer some direct and indirect impacts. A supplementary assessment of significance (Jacobs 2015) finds that the project is unlikely to have a significant impact on populations of Siah's Backbone.

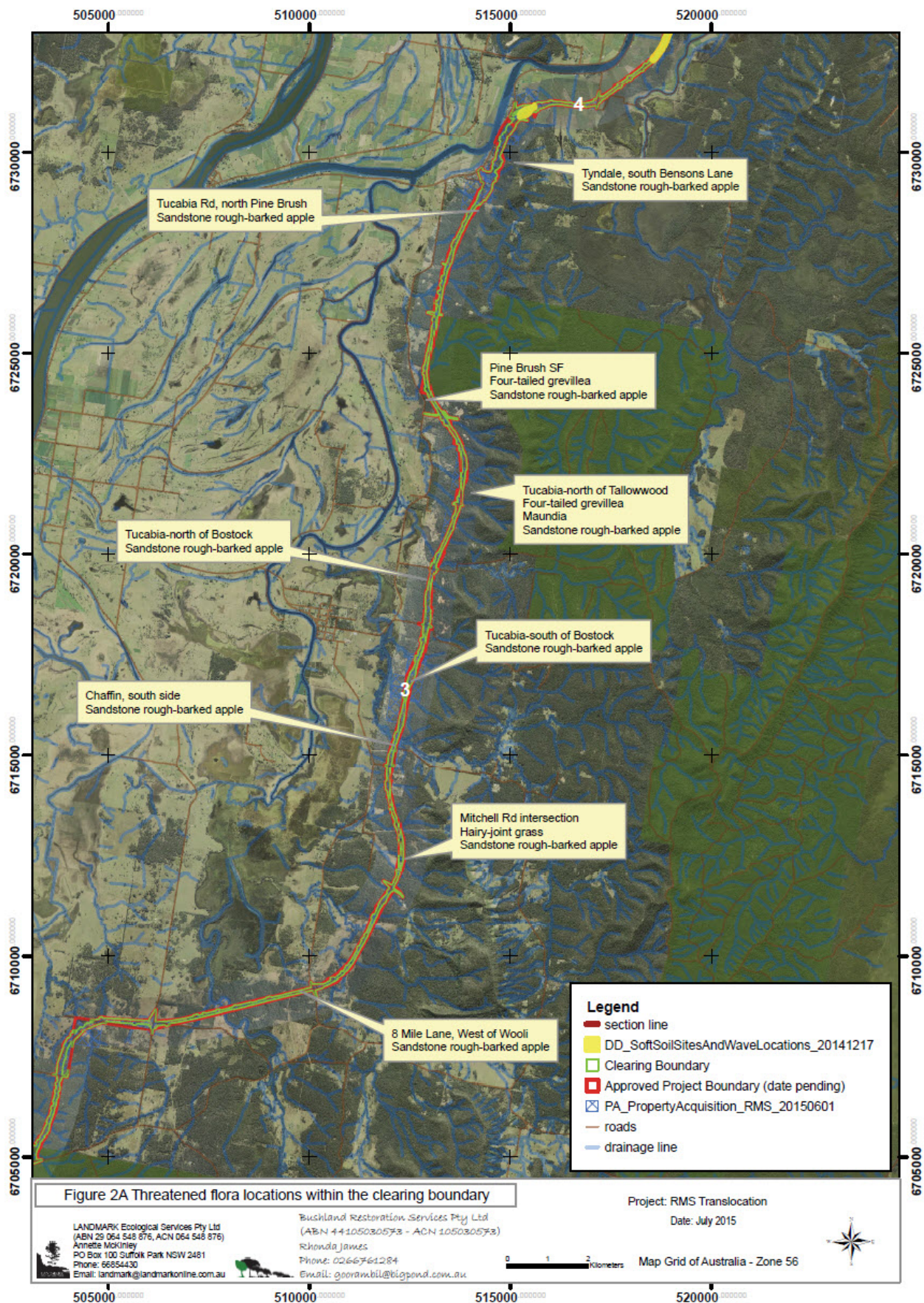
Accordingly Siah's backbone does not require consideration in the current translocation strategy beyond measures appropriate for all rainforest trees. Siah's backbone is not considered further in this strategy though trees identified during surveys are included in some tables and mapping as noted.

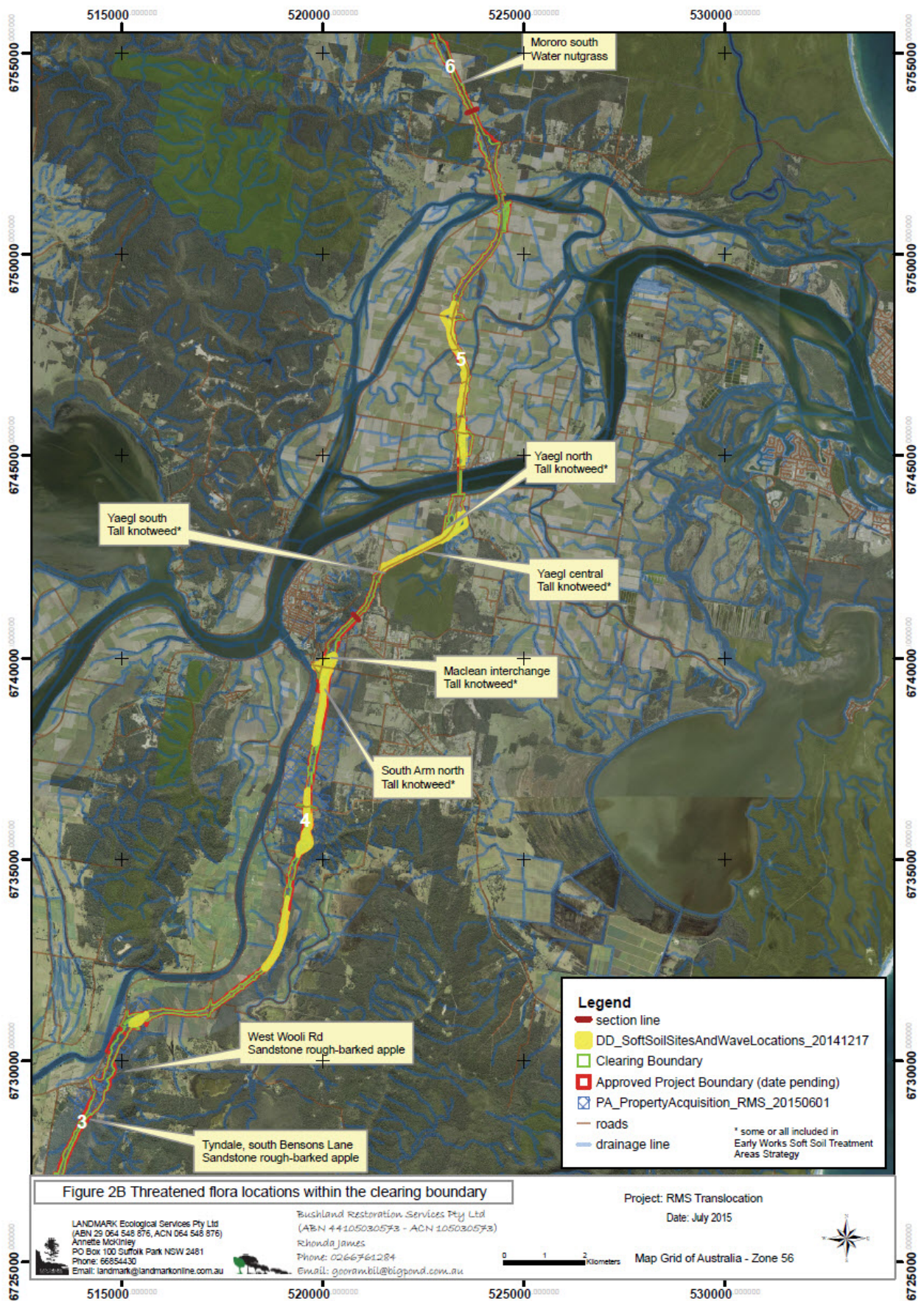
Figure 2 and 2A-D illustrate the locations of directly impacted threatened flora species.

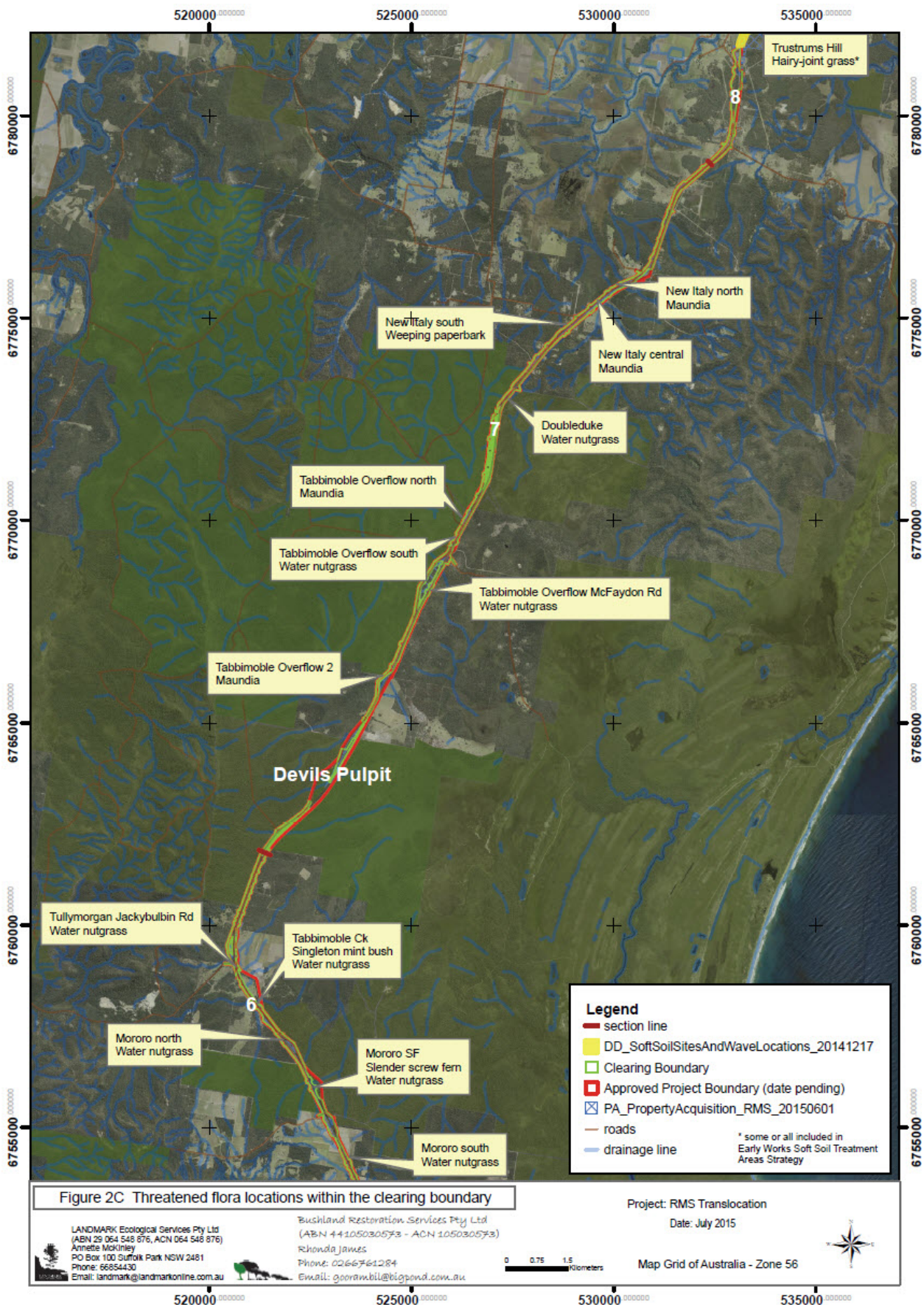
Not all of the threatened species are proposed for translocation. Sections 2.4 and 2.5 of this report discuss the feasibility translocation methodology and sites and justifications).

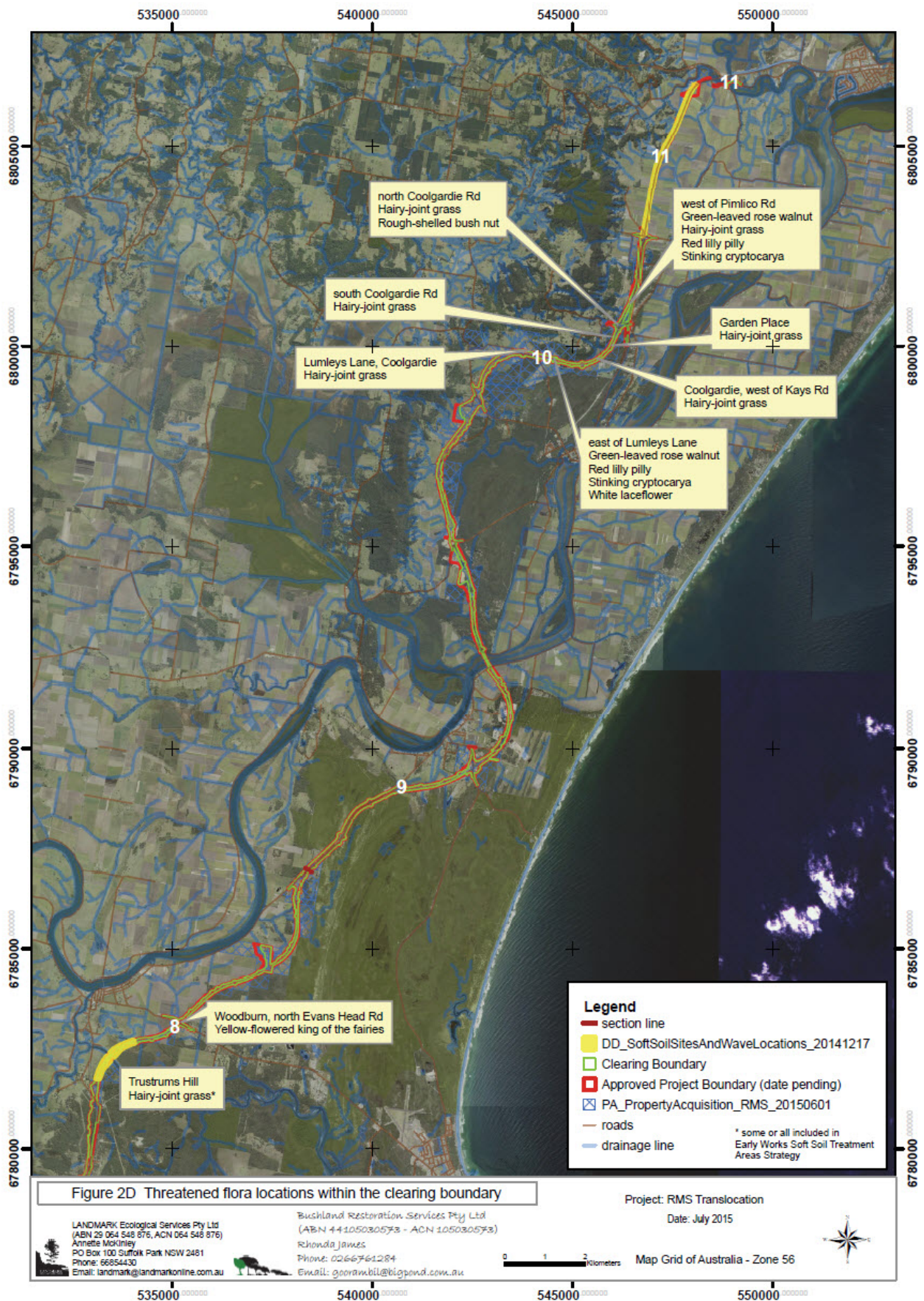


 major_drainage_lines
 DO_SoftSoilSitesAndWaveLocations_20141217
 Approved Project Boundary (date pending)
 PA_PropertyAcquisition_20150201
 road
 NSWStateForests
 NPWS estate









2 Translocation overview

2.1 Translocation background

Guidelines for translocation of flora species have been developed generally and in Australia over several decades e.g. Cropper (1993) ANPC (1997) and Vallee *et al.* (2004). The latter reference recognises the increasing role that translocation is now expected to play in the amelioration of the impact of development.

Section 5.3 and 5.4 of the Threatened Flora Management Plan outline the process and management measures for this Translocation Strategy.

Types of translocation action identified by Vallee *et al.* (2004) are as follows:

Translocation action undertaken for conservation purposes

- Enhancement
- Re-introduction
- Conservation introduction

Translocation action undertaken as an ameliorative measure for development

- Salvage dig
- Ameliorative enhancement
- Compensatory introduction (this type is noted to in the majority of cases; meet the definition of conservation introduction as above).

In addition recent translocation planning for Roads and Maritime's projects recognise the conservation benefits that suitably planned salvage operations can make to knowledge of the biology and ecology of threatened flora species and improved management of future translocations e.g. Benwell (2013).

The decision process to precede a translocation process (Vallee *et al.* 2004) is set out for species proposed for translocation (**Appendix 2**).

2.2 Translocation aims and objectives

The proposed translocations are guided by the overall aims set out by Vallee *et al.* (2004) as follows:

All translocations should aim to maintain or create a self-sustaining population.

Translocation may also lead to:

- Increased knowledge of the threatened plant species
 - Development of new management techniques
 - Initiation of debate on conservation policy
 - Education of the public
- (Pavlik 1996 quoted in Vallee *et al.* 2004)

In addition the Threatened Flora Management Plan (Roads and Maritime 2015) states that translocation should aim to achieve no net loss in local plant populations being impacted by the project.

For the proposed salvage translocation it is also appropriate to aim to make the best possible use of all plant material with potential conservation value.

2.3 Survey and assessment

Background information for each of the fifteen threatened flora species (Whalebone tree/Siah's backbone not included) detected within the Clearing Boundary in Sections 3-11 has been compiled and includes profiles and compilation of translocation history (**Appendix 3**). The background informed assessments of the feasibility of translocation and the risks associated with translocation.

This strategy identifies that translocation is feasible for twelve species (**Table 2**).

Table 2: Summary of translocation feasibility (directly impacted species only)

Common name	Scientific name	TSC Act	EPB C Act	Section	Translocation feasibility
Four-tailed Grevillea	<i>Grevillea quadricauda</i>	V	V	3	feasible
Green-leaved rose walnut	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	E		10	feasible
Hairy joint-grass	<i>Arthraxon hispidus</i>	V	V	3,8,10	feasible assuming seed and/or above ground plant material is available
Maundia	<i>Maundia triglochinosoides</i>	V		3,7	not feasible (compensatory habitat management will be conducted)
Red lilly pilly	<i>Syzygium hodgekinsoniae</i>	V	V	10	feasible
Rough-shelled bush-nut	<i>Macadamia tetraphylla</i>	V	V	10	feasible
Sandstone rough-barked apple	<i>Angophora robur</i>	V	V	3,4	not feasible
Singleton mint bush	<i>Prostanthera cineolifera</i>	V	V	6	feasible
Slender screw-fern	<i>Lindsaea incisa</i>	E		3,6	feasible
Stinking Cryptocarya	<i>Cryptocarya foetida</i>	V	V	10	feasible
Tall knotweed	<i>Persicaria elatior</i>	V	V	4,5	feasible assuming seed and/or above ground plant material is available
Water nutgrass	<i>Cyperus aquatilis</i>	E		6,7	not feasible (compensatory habitat management will be conducted)
Weeping paperbark	<i>Melaleuca irbyana</i>	E		7	feasible
White laceflower	<i>Archidendron hendersoni</i>	V		10	feasible
Yellow-flowered king of the fairies	<i>Oberonia complanata</i>	E		8	feasible

Note: Refer to **Table 4** for more detailed feasibility assessment.

The abundance and extent of the fifteen species has been detected during surveys and documented by way of counts of individuals and/or area of occurrence depending on the growth habit of the species and the nature of the occurrence (**Table 3**).

The detailed survey data collected for the Project Area is complemented by limited information about occurrences in immediately adjacent land. Whilst most of the corridor has been acquired by Roads and Maritime there is some remaining land within the corridor including possible translocation receiving sites for which access has not always been possible. Some broader contextual information about the occurrence of the threatened flora species is available from Atlas records.

Background information for each of the fifteen threatened flora species to be directly impacted by works in Sections 3-11 (excluding Early Works Soft Soil Treatment Areas) has been compiled and includes profiles and compilation of translocation history (**Appendix 3**). The background informed assessments of the feasibility of translocation and the risks associated with translocation.

Table 3: Survey results for threatened flora species within Section 3-11 project area

Species	Clearing area		Project area (not including clearing area)	
	No individuals	Area (ha)	No individuals	Area (ha)
Four-tailed Grevillea	3	0.020	55	0.057
Green-leaved rose walnut	3		16	
Hairy-joint grass	348	1.271	58	0.968
Maundia	20	0.064	8	0.194
Red lilly pilly	6		4	
Rough-shelled bush nut	10		4	
Sandstone rough-barked apple	6,414	35.369	2,531	94.821
Singleton mint bush	609	0.424	62	0.439
Slender screw fern	6,295	0.370	215	0.025
Stinking Cryptocarya	41		2	
Tall knotweed	20	0.210	302	0.693
Water nutgrass	121			
Weeping paperbark	1,721	2.761		0.002
White laceflower	1		10	
Yellow-flowered king of the fairies	18	0.033		0.000

The abundance and distribution data obtained from surveys require interpretation depending on growth form and survey methods. Ephemeral annuals (Hairy joint-grass and Tall knotweed) vary in their distribution and abundance within and between years depending on seasonal conditions.

- Point data for species such as Hairy joint-grass are likely to underestimate the number of individuals present since GPS points recorded in a meandering survey will have documented only a small proportion of the plants. Individuals can be difficult to distinguish and usually occur in clumps.
- Abundance data for Slender screw fern are counts of individual fronds, which will be connected by below-ground rhizomes. The counts over-estimate individual plants.
- Polygons for species such as Hairy joint-grass and Tall knotweed have usually been drawn to enclose the individual points and can be considered to represent an area where the soil stored seed density is relatively high.
- Some polygons do not include points while polygons have not always been drawn around groups of points.

Details of survey data for plants recorded within the project boundary are provided in **Appendix 4**. **Appendix 5** consists of maps for plants within the clearing boundary.

2.4 Feasibility and risk assessment

The feasibility of translocation is based on:

- biological characteristics of species of relevance to translocation
- practicality of propagule collection and other techniques to potentially be employed for translocation
- prospects for successful establishment
- availability of suitable receiving sites (appropriate habitat and tenure)
- past translocation success

An assessment of risk considers:

- extent that mixing of populations may result in outbreeding depression
- introduction of pathogens and disease
- displacement of other species
- impacts to other species from translocation activities including site preparation and monitoring (Vallee *et al.* 2004)
- crossing of hybrids with genetically pure individuals of threatened flora species.

Appropriate sampling of propagule sources hygiene nursery protocols and vegetation management will be employed as standard practice and will mitigate against the risks. Appropriately skilled personnel will be employed.

Other risks include:

- climatic stochasticity and unpredicted extreme weather events to the species in the recipient sites (adverse impacts of newly created edges and disruption to connectivity marsupial and stock grazing)
- failure to understand the ecological requirements of the target species
- inadequate timeframes for establishment and ongoing management.

The risk to individual species depends on:

- the importance of the local population for the species
- the extent of the local population (will numbers be critically reduced?)
- the likelihood that unique genetic material may be lost
- context of the plants proposed for translocation (isolated or connected to plants on adjacent lands).

Table 4 summarises the process of translocation feasibility assessment for threatened flora within the construction footprint of Sections 3-11 (excluding Early Works Soft Soil Treatment Areas).

Table 4: Translocation feasibility

Species	Relevant biological and ecological characteristics	Seasonal constraints	Previous translocations	Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6)	Translocation feasibility	Risk assessment
Four-tailed Grevillea	seed production and germination likely to be reliable cutting propagation likely to be successful	Seed collection may need multiple visits, late spring	No information but assumed to grow readily as for other Grevilleas	Road reserve adjacent to donor populations	Feasible, likely to be successful though poor condition of donor plants may be limiting	Occurrences known in the locality are small. If translocation fails numbers and genetic diversity may be reduced.
Green-leaved rose walnut	seeds produced only intermittently taxonomy and identification needs resolution to guide future genetic management slow growing	Wet conditions preferred for transplant	Limited information suggests poor success rate for cutting strike and slow growth	Wardell-Coolgardie rainforest sites	Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest.	Unique genetic material could be lost and numbers reduced if transplant and cutting propagation fails
Hairy joint-grass	seeds can be collected and germinated readily Individual plants or clumps can be transplanted seepage or swamp habitat is required	Above ground material visible during wet season dies back April-May seed collection summer autumn Plant out/ transplant during growing season (in wet conditions).	Nursery grown seedlings have been planted out direct seeding has been successful turf transplant establishment and persistence depends on site suitability management to maintain competitive biomass at low levels and recruitment microsites	Suitable sites available in the Wardell-Coolgardie area and in a section 1 receiving site.	Technically feasible though success will be dependent on management that maintains biomass reduction and habitat suitability.	Hairy joint-grass can be difficult to maintain whether natural or artificial populations. Large populations are known adjacent to northern donor you sites. Failure of translocation is not likely in itself to jeopardise the sustainability of the population in the broader locality.

Species	Relevant biological and ecological characteristics	Seasonal constraints	Previous translocations	Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6)	Translocation feasibility	Risk assessment
Maundia	seeds difficult to germinate seeds stored in soil lateral vegetative spread patch extent changes with hydrology	detectable all year round but die back in dry conditions seeds December and January	Translocations have been unsuccessful. An alternative approach to population enhancement through hydrological management at locations where soil stored seed and/or mature plants are present is preferred.	n/a	Compensatory actions other than translocation are preferred – hydrological management to enhance another existing population.	Maundia is considered to be relatively secure in the Mid North Coast region to the south of the project. Occupied habitat lies to the east of the project boundary at Tabbimobile Creek.
Red lilly pilli	grows and establishes from seed cuttings and transplant will be experimental	collect seeds from August to November wet conditions required for transplant	Regularly grown and established from seed in horticultural and rainforest restoration contexts	Wardell-Coolgardie rainforest sites	Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest	Unique genetic material could be lost and numbers reduced if translocation actions fail
Rough-shelled bushnut	grows and establishes from seed transplant will be experimental	collect seeds from January to May wet conditions required for transplant	Regularly grown and established from seed in horticultural and rainforest restoration contexts	Wardell-Coolgardie rainforest sites	Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest	Unique genetic material could be lost and numbers reduced if translocation actions fail
Sandstone rough-barked apple	seed propagation likely to be easy and reliable donor populations in hybrid zone	seeds likely to be available in late spring	Angophoras in general are regularly and successfully grown from seed	n/a	Not feasible. Translocation from a hybrid phone may pose a threat to the species. Alternative management is preferred.	n/a

Species	Relevant biological and ecological characteristics	Seasonal constraints	Previous translocations	Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6)	Translocation feasibility	Risk assessment
Singleton mintbush	seed collection may be possible though viable seed probably not reliably produced cuttings likely to be successful	seed may be available in late spring	None documented but related taxa grow and establish successfully.	Suitable sites available in the vicinity of donor population	Feasible. The cutting based translocation actions will be experimental.	Moderately abundant in the vicinity of the donor plants. Unlikely that unique genetic material will be lost should translocation be unsuccessful.
Slender screw-fern	lateral vegetative spread adversely affected by disturbance	dies back in dry conditions but is claimed to be detectable planting out of slabs/clumps requires wet conditions	Generally difficult to cultivate. Short term translocation success reported from transplant conducted in wet season (recent Roads and Maritime's project). Possibility for transplant. May also recommend salvage of material for nursery trials.	Receiving sites with suitable microsite conditions available.	Short term success reported for one trial but generally regarded as a difficult candidate for translocation. Trialling of value for research purposes.	Population appears to continue into adjacent State Forest in the vicinity of the donor site, but requires confirmation. Unique genetic material may be lost and extent of occurrence may be reduced should translocation be unsuccessful.
Stinking Cryptocarya	seeds germinate reliably naturally spreads through seed dispersal development to maturity less reliable	collect seed june-September or as late as November wet conditions required for transplant	Regularly grown and established from seed in horticultural and rainforest restoration contexts	Wardell-Coolgardie rainforest sites	Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest	Unique genetic material could be lost and numbers reduced if translocation actions fail.

Species	Relevant biological and ecological characteristics	Seasonal constraints	Previous translocations	Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6)	Translocation feasibility	Risk assessment
Tall knotweed	seeds can be collected and germinated readily Individual plants or clumps can be transplanted seepage or swamp habitat is required	seeds produced in autumn (may be variable) cuttings possible during growing season clump/soil transplant any time (mark plant locations before they die back) nursery production from soil seedbank any time transplant nursery grown stock in reliably wet conditions or provide watering	Success reported from seed grown plants in south-east Qld	Yaegl Nature Reserve adjacent and within known habitat (similar to donor site conditions)	Translocation is technically feasible and a suitable donor site is available	If translocation fails the numbers or individuals remaining may be too small to constitute a self-sustaining population.
Water nutgrass	ephemeral recorded sparsely and intermittently in known habitat soil-stored seed presumed primarily water-dispersed	seasonally wet habitat conditions required for development	Limited no successful examples	n/a	It is not practically feasible to translocate a species of uncertain occurrence and extent where above ground plants are rarely observed.	Water nutgrass is sparsely distributed in the vicinity of the project area (though extensive unsurveyed suitable habitat is available). Unique genetic material may be lost.
Weeping paperbark	seeds retained in woody capsules likely to develop to maturity relatively quickly	collect seeds any time	Successful establishment of a population at Tucabia – community project	Several suitable sites identified	Feasible, likely to be easy to propagate from seed and establish	Relatively large sections of the donor populations will remain adjacent to the project area. It is unlikely that unique genetic material will be lost in the event of translocation failure. Alternative seed sources will be available for back-up.

Species	Relevant biological and ecological characteristics	Seasonal constraints	Previous translocations	Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6)	Translocation feasibility	Risk assessment
White laceflower	grows and establishes from seed, though slow growing cuttings and transplant will be experimental	collect seeds from June to January wet conditions required for transplant	Regularly grown and established from seed in horticultural and rainforest restoration contexts, but slow in early stages of development	Wardell-Coolgardie rainforest sites	Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest	Unique genetic material could be lost and numbers reduced if translocation actions fail
Yellow-flowered king of the fairies	epiphytic/lithophytic range of host trees vegetative expansion to form clumps "dust" seeds produced, wind-dispersed	re-locate mature epiphytes at any time, avoiding dessicating conditions in establishment stage seed collection likely spring	Orchids in the genus are amenable to cultivation and mature plants likely to re-locate successfully, but no specific information for translocation of the species	Suitable site with host trees of same species as donor site is available	Feasible, likely to relocate successfully as mature plants	Very rare in NSW. Loss of unique genetic material and reduction in population numbers may have serious implications for the species at State level. Research into life cycle and propagation required as back up.

2.5 Receiving sites

Receiving sites have been identified on Roads and Maritime owned and public land and on land remaining within the project boundary. In addition, several of the potential Biodiversity Offset Sites are in private ownership with draft covenant configurations imminent. Multiple options are available for most species, and include alternatives in all instances where incorporating sites into the Biodiversity Offset Strategy and covenanting are not finalized. Details of the receiving sites (**Table 5**), maps (**Appendix 5**) and descriptions and management requirements and actions (**Appendix 6**) are provided.

Table 5: Receiving sites

Species	Receiving Site	Translocation type	Tenure	Suitability	Threats/Risks
Four-tailed Grevillea (Tucabia north of Tallowood)	Tucabia north of Tallowood road reserve	Seed and cutting propagation ameliorative enhancement	Roads and Maritime	Adjacent to current occurrence of Four-tailed Grevillea	Close to new highway, edge effects.
Four-tailed Grevillea (Pine Brush SF)	Pine Brush SF road reserve	Seed and cutting propagation ameliorative enhancement	Roads and Maritime	Adjacent to current occurrence of Four-tailed Grevillea	Close to new highway edge effects. Poor condition of existing plants.
Green-leaved rose walnut	Lumleys Lane BOS 22	Cutting and seed propagation, salvage dig, ameliorative enhancement	Roads and Maritime owned draft covenant configuration imminent	Regrowth rainforest provides suitable habitat close to current occurrence of Green-leaved rose walnut	Weed competition
	Meridian Drive BOS 23	As above	Privately owned draft covenant configuration imminent	As above	As above
	Buckombil BOS 17	As above	Privately owned draft covenant configuration imminent	As above	As above
	Coolgardie Rd/ Randles Creek	As above	Roads and Maritime	As above	As above
Hairy joint-grass (Mitchell Road intersection)	Kangaroo Trail	Salvage dig compensatory introduction	Roads and Maritime Project area	35km from Mitchell Road intersection donor site. Suitable habitat – drainage line provides suitable hydrological conditions. Donor material from Section 1 also to be received.	Weed competition, vehicles, motorbikes. Requires appropriate management to maintain biomass at suitable levels (grazing, slashing/raking). Maintain suitable hydrology.
Hairy joint-grass	Lumleys Lane	Salvage dig compensatory	Roads and Maritime owned	Open grassland/sedgeland adjacent to current location of Hairy joint-grass	Weeds. Requires appropriate management to maintain biomass at

Species	Receiving Site	Translocation type	Tenure	Suitability	Threats/Risks
(Coolgardie-Wardell sites)	BOS 22	introduction	draft covenant configuration imminent	(includes exotic grasses)	suitable levels (grazing, slashing/raking). Maintain suitable hydrology.
Hairy joint-grass (Coolgardie-Wardell sites)	Coolgardie Road BOS 24	Salvage dig compensatory introduction	Roads and Maritime owned draft covenant configuration imminent	Open grassland/sedgeland adjacent to current location of Hairy joint-grass	Weeds. Requires appropriate management to maintain biomass at suitable levels (grazing, slashing/raking). Maintain suitable hydrology.
Red lilly pilly	Lumleys Lane BOS 22	Seed propagation salvage dig ameliorative enhancement	Roads and Maritime owned draft covenant configuration imminent	Regrowth rainforest provides suitable habitat close to current occurrence of Red lilly pilly	Weed competition
	Meridian Drive BOS 23	As above	Privately owned draft covenant configuration imminent	As above	As above
	Buckombil BOS 17	As above	Privately owned draft covenant configuration imminent	As above	As above
	Coolgardie Rd/ Randles Creek	As above	Roads and Maritime	As above	As above
Rough-shelled bush-nut	Lumleys Lane BOS 22	Seed propagation salvage dig ameliorative enhancement	Roads and Maritime owned draft covenant configuration imminent	Regrowth rainforest provides suitable habitat close to current occurrence of Rough-shelled bushnut	Weed competition
	Meridian Drive BOS 23		Privately owned draft covenant configuration imminent	As above	As above
	Buckombil BOS 17		Privately owned draft covenant configuration imminent	As above	As above
	Coolgardie Rd/ Randles Creek	As above	Roads and	As above	As above

Species	Receiving Site	Translocation type	Tenure	Suitability	Threats/Risks
			Maritime		
Singleton mint-bush	Tabbimobile Triangle (Priority 1)	Cutting and seed propagation, salvage dig, ameliorative enhancement	Roads and Maritime acquisition	Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population	Inappropriate fire regime, straying cattle, weeds, edge effects from new highway edge.
	Jackybulbin Offset BOS 13 (Priority 2)	Cutting and seed propagation, salvage dig ameliorative enhancement	Private RMS negotiating NP	Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population	Inappropriate fire regime, straying cattle, weeds.
	Tabbimobile Bundjalung NP (priority 3)	Cutting and seed propagation, ameliorative enhancement	NP	Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population	Inappropriate fire regime, weeds.
Slender screw fern	Bundjalung NP east of Mororo SF donor site (Priority 1)	Salvage dig, ameliorative enhancement		Effectively an extension of donor site, on same creek system. Slender screw fern likely to be already present.	Disturbance from weed invasion
	Mahogany Drive (BOS 25) (Priority 2).	Salvage dig, ameliorative enhancement	Roads and Maritime owned draft covenant configuration includes proposed receiving site.	~ 50km from Mororo SF donor site. Suitable habitat present adjacent to known location of Slender screw fern	Disturbance from weed invasion
Stinking Cryptocarya	Lumleys Lane BOS 22	Seed propagation salvage dig, ameliorative enhancement	Roads and Maritime owned draft covenant configuration imminent.	Regrowth rainforest provides suitable habitat close to current occurrence of Stinking Cryptocarya	Weed competition
	Meridian Drive BOS 23	As above	Privately owned draft covenant configuration imminent	As above	As above
	Buckombil BOS 17	As above	Privately owned draft covenant configuration imminent	As above	As above
	Coolgardie Rd/ Randles Creek	As above	Roads and	As above	As above

Species	Receiving Site	Translocation type	Tenure	Suitability	Threats/Risks
			Matime		
Tall knotweed	Yaegl Nature Reserve south	Salvage dig, ameliorative enhancement	NR	Adjacent or close to donor sites where suitable low-lying conditions are present.	Disturbance from weed invasion change of hydrological conditions, close to highway
Weeping paperbark	Bungawalbin offset (Priority 1)	Seed propagation, compensatory introduction	Roads and Maritime owned – expected to transfer to NPWS	Large areas of floodplain swamp forest and related habitat present	Lantana, groundsel
	Yurringully NR (Priority 2)	Seed propagation, compensatory introduction	NR	Clearing, likely to regenerate naturally, suitable open conditions for development. Floodplain sclerophyll forest surrounding..	Straying cattle pigs and hunting, weed competition
	Tabbimobile Bundjalung NP (Priority 3)	Seed propagation, compensatory introduction	NP	Moist sclerophyll forest (Blackbutt dominant)	Inappropriate fire regime, weeds
	Tabbimobile Creek (Site 4 and 5)	As above	Roads and Maritime (biodiversity offset)	As above	As above
White laceflower	Lumleys Lane BOS 22	Seed propagation salvage dig ameliorative enhancement	Roads and Maritime acquisition	Regrowth rainforest provides suitable habitat close to current occurrence of White laceflower	Weed competition
	Meridian Drive BOS 23	As above	Privately owned draft covenant configuration imminent	As above	As above
	Buckombil BOS 17	As above	Privately owned draft covenant configuration imminent	As above	As above
	Coolgardie Rd/ Randles Creek	As above	Roads and Maritime	As above	As above
Yellow-flowered king of the fairies	Gummigurrah Trail picnic area Bundjalung NP	Salvage clumps of epiphyte, compensatory introduction future augmentation with seedlings	NP	Swamp oaks present (same host species as found at donor site). Additional rainforest host trees present.	Fire (low risk), illegal collection

2.6 Translocation planning

Planning for each translocation operation commences with a statement of aims for each and identification of objectives. Performance criteria to guide monitoring and the evaluation of success of the translocation are developed from the objectives and corrective actions are specified for the adaption of management (**Table 6**).

Table 6: Translocation planning

Species	Four-tailed Grevillea	Green-leaved rose walnut	Hairy joint-grass
Aim	Maintain or improve the functioning and condition of existing populations	Maintain or enhance existing demographic function and genetic variability	Create a self-sustaining population (Kangaroo Trail) or augment existing populations (Coolgardie-Wardell sites)
Objectives	Plants improve in condition so that flowering fruiting and regeneration is successful.	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Plants complete their lifecycle and regenerate successfully
Performance criteria	Threats identified and addressed. New growth documented on 80% of existing plants flowers and fruit observed by Year 3. Improvement maintained to Year 5.	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained to Year 5.	At least 50 plants germinate and set seed each year
Threshold	New growth on <50% of existing plants no flowers nor fruit by Year 3. Improvement not maintained to Year 5.*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 30 plants germinate and set seed in any one year*
Corrective action	Re-assess threats and address. Consider augmentation from seed propagated plants from alternative donor sites.	Augment with nursery stock from (likely cutting grown) back up stock.	Undertake searches for suitable local donor populations (in case of isolated southern occurrence) or source from receiving site populations. Collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. threat identification and amelioration detail of growth and seeding periods and results of nursery tasks.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.

Species	Four-tailed Grevillea	Green-leaved rose walnut	Hairy joint-grass
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project
Objectives	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals and area re-established
Performance criteria	Compare with donor site. 70% of original number of plants established in Year 1 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5
Threshold	>50% of original number of plants established in Year 1 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent years*
Corrective action	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant.
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	All available cutting material and seed harvested and grown on for transplant to best extent practical.	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	Soil associated with above-ground plants transplanted
Performance criteria	No unsalvaged material present on ground inspection	Trees translocated and cutting material collected to best extent practical for nursery propagation	No unsalvaged material present on ground inspection
Threshold	More than 10% of the original material present	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	More than 10% of the original material present.
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors

Species	Red lilly pilly	Rough-shelled bushnut	Singleton mintbush
Aim	Maintain or enhance existing demographic function and genetic variability	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population adjacent to and in the vicinity of the Tabbimobile Creek donor population.
Objectives	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Translocated plants complete their lifecycle and regenerate successfully
Performance criteria	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5.	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established.	At least 30 plants establish and set seed each year from Year 3
Threshold	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 20 plants establish and set seed in any one year from Year 2*
Corrective action	Augment with nursery stock from (likely cutting grown) back up stock.	Augment with nursery stock from (likely cutting grown) back up stock.	Augment with nursery back up stock and if required collect additional seed and cuttings from seed; nursery propagate and plant out.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Aim	Achieve no net loss in local plant populations being	Achieve no net loss in local plant populations being	Achieve no net loss in local plant populations being

Species	Red lilly pilly	Rough-shelled bushnut	Singleton mintbush
	impacted by the project	impacted by the project	impacted by the project
Objectives	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals re-established
Performance criteria	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5
Threshold	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent year*
Corrective action	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed/cuttings following guidelines for sampling
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	All available seed collected cutting material harvested to an extent predicted to cover predicted requirements x 2.
Performance criteria	Trees translocated and cutting material collected to best extent practical for nursery propagation	Trees translocated and cutting material collected to best extent practical for nursery propagation	No seed present on ground inspection
Threshold	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Uncollected seed present on 10 or more plants
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors

Species	Slender screw fern	Stinking Cryptocarya	Tall knotweed
Aim	Create a self-sustaining population	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population.
Objectives	Maintain or create a self-sustaining population (augment an existing patch)	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Plants complete their lifecycle and regenerate successfully
Performance criteria	Plants complete their lifecycle and regenerate successfully	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5.	At least 30 plants germinate and set seed each year
Threshold	Spore production observed each year (compare with control populations). Lateral vegetative growth observed from all transplants.	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 20 plants germinate and set seed in any one year.*
Corrective action	No spore production lateral growth from <50% of transplants	Augment with nursery stock from (seed or cutting grown) back up stock.	Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. detail of growth and spore production.	Reporting to include observations of new growth on translocated trees results of nursery tasks. Progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project

Species	Slender screw fern	Stinking Cryptocarya	Tall knotweed
Objectives	Original number of individuals and area re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Original number of individuals and area re-established
Performance criteria	Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5
Threshold	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years.*	>50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.*
Corrective action	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	All available plants and associated soil harvested and transplanted to best extent practical	Trees and saplings transplanted. Suitable cutting material for predicted requirements x 2 harvested seeds if available for nursery propagation.	All available plants and associated soil harvested and transplanted to best extent practical
Performance criteria	No unsalvaged material present on ground inspection	Trees translocated no seed left unharvested.	No unsalvaged material present on ground inspection
Threshold	More than 10% of the original material present	Trees not translocated. Less than 15 cuttings transferred to nursery facilities	More than 10% of the original material present
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors

Species	Weeping paperbark	White laceflower	Yellow-flowered king of the fairies
Aim	Create self-sustaining populations (two sites)	Maintain or enhance existing demographic function and genetic variability	Maintain a self-sustaining population.
Objectives	Plants complete their lifecycle and regenerate successfully	Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability	Translocated clumps and individuals establish on new hosts flower set seed.
Performance criteria	At least 50 plants germinate and set seed each year from Year 2	Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established.	At least 20 plants establish flower and set seed each year from Year 2
Threshold	Less than 30 plants germinate and set seed in any one year from Year 2*	Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.*	Less than 15 plants establish and set seed in any one year from Year 2*
Corrective action	Use stored seed or collect additional seed from remaining source population nursery propagate and plant out. Re-evaluate site conditions to best target suitable planting sites.	Augment with nursery stock from (likely cutting grown) back up stock.	Evaluate host sites of any plants not functioning as required and assess benefits of re-location.
Aim	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species	Increased knowledge of the threatened plant species
Objectives	Relevant project results and observations documented.	Relevant project results and observations documented.	Relevant project results and observations documented.
Performance criteria	Reporting to Include e.g. results of nursery tasks records of establishment and development.	Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant.	Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks.
Threshold	Reporting incomplete	Reporting incomplete	Reporting incomplete
Corrective action	Project manager to address with sub-contractors	Project manager to address with sub-contractors	Project manager to address with sub-contractors
Aim	Achieve no net loss in local plant populations being impacted by the project	Achieve no net loss in local plant populations being impacted by the project	Improve options for augmentation through seedling production

Species	Weeping paperbark	White laceflower	Yellow-flowered king of the fairies
Objectives	Original number of individuals re-established	Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost.	Research program for seed propagation established and propagation underway.
Performance criteria	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5	Specialist propagation facility engaged and liaison with field personnel established. Consultation with OEH SOS program.
Threshold	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	>50% of original number of plants established in Year 2 or similar levels below target in subsequent years*	Insufficient understanding of seedling production techniques achieved by Year 3 production not underway
Corrective action	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from remaining plants adjacent to donor population collect additional seed following guidelines for sampling	Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling	Consider options for alternative research partners
Aim	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value	Make the best possible use of all plant material with potential conservation value
Objectives	Available seed is harvested for nursery propagation.	Trees and saplings are transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation.	All available plants translocated to new hosts
Performance criteria	Trees translocated and cutting material collected to best extent practical for nursery propagation (at least 20 cuttings)	Trees and saplings translocated and cutting material collected to best extent practical for nursery propagation	No unsalvaged material present on field inspection
Threshold	Tree not translocated. Less than 15 cuttings transferred to nursery facilities	Tree and saplings not translocated. Less than 15 cuttings transferred to nursery facilities	Plants remain on host trees
Corrective action	Project manager to address with contractors	Project manager to address with contractors	Project manager to address with contractors

* where performance falls between the target and the threshold, corrective action to be at discretion of expert translocation contractor to allow for environmental variability and species specific consideration.

Corrective actions will be undertaken when any threshold is reached.

Note that monitoring is scheduled to continue over a 5 year timeframe. Should targets not be met at 5 years, the program is to be reviewed by Roads and Maritime and translocation contractors in conjunction with EPA.

2.7 Timeframe schedule and staging

The schedule for steps in translocation is set out in **Table 7**.

Table 7: Translocation Schedule (part 1)

Year	1												2												3												4												5											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D												
Four-tailed grevillea																																																												
Seed collection/cuttings*/collection of individual plants	x	x																																																										
Germination/nursery growing on	x	x	x	x	x	x	x	x	x	x	x	x	x																																															
Receiving site preparation	x											x																																																
Transplant seedlings/cuttings into receiving site		x											x																																															
Habitat maintenance														x	x					x				x																																				
Monitoring measurements		x			x			x			x									x																																								
Reporting													x																																															
Hairy-joint grass																																																												
Seed collection*/collection of individual plants	x	x																																																										
Germination/nursery growing on	x	x	x	x	x	x	x	x	x	x	x	x	x																																															
Receiving site preparation	x											x																																																
Remove transplant slab/clump		x																																																										
Transplant/Plant into receiving site		x											x																																															
Habitat maintenance					x			x			x			x					x				x																																					
Monitoring measurements		x			x			x			x									x																																								
Reporting													x																																															
Singleton mint bush																																																												
Seed collection*/cuttings*/collection of individual plants	x	x																																																										
Germination/nursery growing on	x	x	x	x	x	x	x	x	x	x	x	x	x																																															
Receiving site preparation	x											x																																																
Transplant/Plant into receiving site		x											x																																															
Habitat maintenance			x			x			x			x								x				x																																				
Monitoring measurements		x			x			x			x									x																																								
Reporting													x																																															
Slender screw-fern																																																												
Receiving site preparation		x	x																	x	x																																							
Remove transplant slab/clump		x	x	x																x	x																																							
Transplant slab into receiving site		x	x	x																x	x																																							
Habitat maintenance				x				x			x			x						x				x																																				
Monitoring measurements			x			x			x			x								x																																								
Reporting														x																																														

Table 7: Translocation Schedule (part 2)

Year	1	2	3	4	5
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
Tall knotweed					
Seed collection*/cuttings*/collection of individual plants	x x				
Germination/nursery growing on	x x x x x x x x x x x	x			
Receiving site preparation	x				
Remove transplant slab/clump	x				
Transplant/Plant into receiving site	x	x			
Habitat maintenance	x x x x x	x x x x x	x x x x	x	x x x
Monitoring measurements	x x x x x	x x x x	x x x	x	x x x
Reporting		x	x	x	x
Weeping paperbark					
Seed collection*/collection of individual plants	x x				
Germination/nursery growing on	x x x x x x x x x x x	x			
Receiving site preparation	x				
Transplant/Plant into receiving site	x	x			
Habitat maintenance	x x x x x	x x x x x	x x x	x	x x x
Monitoring measurements	x x x x x	x x x	x x	x	x x x
Reporting		x	x	x	x
Yellow-flowered king of the fairies					
Collection of individual plants	x			x	
Transplant into receiving site	x			x	
Monitor condition of plants	x x x x x	x x x x	x x	x x	x x
Monitoring measurements	x x x x	x x x	x x	x	x x
Reporting		x	x	x	x
Green-leaved rose walnut Seed/cuttings/transplant					
Red lilly pillly Seed/cuttings/transplant					
Rough-shelled bush nut Seed/transplant					
Stinking Cryptocarya Seed/cuttings/transplant					
White laceflower Seed/transplant					
Seed collection*/cuttings*/Collection of individual plants	x x				
Germination/nursery growing on	x x x x x x x x x x x	x			
Receiving site preparation	x				
Transplant/Plant into receiving site	x	x			
Habitat maintenance	x x x x x	x x x x	x x	x	x x x
Monitoring measurements	x x x x	x x x	x x	x	x x x
Reporting		x	x	x	x
*Seed collection/cuttings timing dependant on individual species					
Scheduling dependant on timing of construction/access/season					

3 Translocation procedures

3.1 Guidelines

Florabank Guidelines and Model Code of Practice (www.florabank.org.au) will guide seed collection storage and basic germination techniques. The guidelines are designed for general revegetation and will be especially relevant to plantings required for general habitat restoration. Deviations from the guidelines may be appropriate when genetic management is required for threatened species and Vallee *et al.* (2004) s. 5.2.1 recommend greater restrictions on the percentages of seed to be collected from individual plants when dealing with threatened species. Reference is also made to RTA Seed Collection QA Specification R176 (also more appropriate for general habitat plantings).

The collection of seed of threatened flora species will also be guided by NSW OEH's Checklist For Bush Regeneration Activities in Habitats Including Threatened Species Endangered Populations and Endangered Ecological Communities.

For a salvage operation however there is no imperative to limit collection from plants proposed for destruction.

Hygiene protocols consistent with standard requirements for works in OEH sensitive areas will be employed.

Site protection protocols are required to limit the transfer of pathogens such as Myrtle rust, *Phytophthora cinnamomi* and Chytrid fungus into sensitive areas.

Footwear must be thoroughly cleaned and disinfected at the commencement of fieldwork and between sites. Any vehicles and equipment or personal effects used off road, trail or track must be thoroughly cleaned and disinfected. For Myrtle rust, disinfect further by spraying head to toe including hats and boots.

Disinfecting agents:

- Chloramine and Chlorhexidine based products such as Halamid©, Halasept© or Hexifoam© are effective against both bacteria and fungi. These products are suitable for use on hands, footwear, instruments and other equipment. Manufacturer's instructions should be followed when preparing these solutions .
- Medical standard 70% isopropyl alcohol wipes - Isowipes© can be used on hands and personal effects like sunglasses, phones, GPS etc and on hand tools, and inside vehicles.
- Bleach and alcohol (ethanol or methanol), diluted to appropriate concentrations can be effective against bacteria and fungi. However, these substances may be less practical because of their corrosive and hazardous nature.
- 70% methanol (methylated spirits).
- Fresh bleach (5% concentration), may be also effective against other frog pathogens such as Rana Virus.

3.2 General methods

Three methods would be employed in translocating the subject species (**Table 8**):

- transplanting individuals clumps or slabs from the project footprint to the receiving sites; relocation of epiphytic orchids;
- propagation of individuals from locally collected seed; and
- propagation from cuttings.

Two species - Hairy joint-grass and Tall knotweed are annual species with life cycles that are driven by seasonal soil moisture variations. Accordingly seeds may not be reliably available even during documented seeding periods. Two or multiple translocation options are presented for such species for adoption depending on the availability of seed and above-ground plant material when translocation is scheduled. Generally speaking the preferred option is to slab/clump translocate those species where this is viable (Hairy-joint grass, Slender screw fern and Tall knotweed). It should also be noted that seed is available for all species suited to seed collection from other populations in proximity, except in the case of southern locations for Hairy joint-grass.

In terms of translocation schedule the work will be done in close consultation with the construction contractor with a view to prioritising actions to meet with construction timetables and species requirements.

Table 8: Translocation methods

(addressed for species for which translocation is assessed as feasible)

Species	Seed	Individual or clump/slab transplant	Cuttings
Four-tailed Grevillea	Yes	Dig, pot and grow on seedlings if present, or transplant directly	Yes
Green-leaved rose walnut	If available	Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees	Yes
Hairy joint-grass	If available	Clump/slab transplant	No
Red lilly pilly	Yes, if available	Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees	Yes
Rough-shelled bush-nut	Yes	Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees	No
Singleton mintbush	If available	No	Yes
Slender screw fern	n/a	Slab transplant	n/a
Stinking Cryptocarya	Yes, if available	Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees	Yes
Tall knotweed	If available	Clump/slab transplant	Yes if suitable material available
Weeping paperbark	Yes	No	No
White laceflower	Yes	Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees	Yes
Yellow-flowered king of the fairies	Undertake research into lifecycle and propagation, use seedlings for augmentation and back up should relocation fail	Relocate orchid individuals or clumps	No

3.3 Seed collection and propagation

Seed collection will be conducted with reference to available information of likely seeding times for the target species (**Table 9**).

Table 9: Seed availability for threatened flora species

Species	Time for collection	Notes
Four-tailed Grevillea	Oct-Nov (likely but not documented)	Likely to be shed quickly. Collection may require multiple site visits and bagging of some developing follicles
Green-leaved rose walnut	Nov-May also other times	Irregular within and between years
Hairy joint-grass	Late autumn to early winter.	Timing of seed production is poorly documented and assumed variable as life cycle depends on timing of summer rains
Red lilly pilli	Aug-Nov	
Rough-shelled bush-nut	Jan-Apr	
Singleton mint-bush	Not documented. Probably in Oct-Nov	Following spring flowering
Stinking Cryptocarya	June to September or sometimes as late as November	
Tall knotweed	Summer-autumn	Depending on rains
Weeping paperbark	Any time	Persistent capsules
White laceflower	Jun-Jan	
Yellow-flowered king of the fairies	Not documented possibly spring	Green capsules observed in July

Individual plants or clumps for translocation should be selected from donor site. The aim should be to maximize the capture of the genetic variation from the donor site using spatial spread as a surrogate for genetic variation in absence of specific genetic studies or biological characteristics that suggest otherwise. In general no constraints to collection of seed (where available) from plants proposed for destruction are necessary. Additional seed collections from adjacent populations may be undertaken to supplement seed collected from directly impacted plants where judged necessary to achieve numbers and genetic diversity as required to meet targets.

The biology of Hairy joint-grass and Tall knotweed indicates that fine scale genetic structuring within populations and between nearby populations (e.g. on the same floodplain) is unlikely. Seeds will disperse in floodwaters (and via other dispersal mechanisms) and can be predicted to result in constant genetic mixing over short to relatively long distances. Genetic research reported by Benwell (2012) concluded that there is low genetic variation between populations in Hairy joint-grass from the Ballina-Byron region.

For Hairy joint-grass supplementary seed collection from adjacent populations can take place from available sources regardless of spacing of the source plants but should be spread to avoid local depletion of seeds. The total will be restricted to 10% of the available crop.

Labelling

Batches of seed will be labelled to identify origin collector and date of collection (Vallee *et al.* 2004 s.5.2.3).

Seed storage

Seeds will usually be sown fresh and no special storage arrangements are required.

Nursery propagation from seed

Seeds will be sown in suitable commercial seed raising mix. As no specific information is available to suggest that the inoculation with soil mycorrhizae is essential for successful nursery raising of the species for which nursery propagation and growing on is proposed, natural soil from the collection site will not be added to the seed-raising and potting mix. The receiving sites are usually within or adjacent to known occurrences of the translocated plants and can be expected to contain appropriate soil fungi.

Unnecessary soil introduction may conflict with nursery hygiene protocols. Soil in seedling mixes will introduce weeds that will be difficult to distinguish from the target species when small seedlings.

- Large seeds to be sown in trays and covered to approximately the diameter of the seed.
- Medium seeds are to be sown in trays and lightly covered.
- Fine seed – use the ‘saturated soil medium method’ whereby the pot containing the seeds is placed into a container of water until germination occurs.

Label according to species origin and date of sowing.

In the event that translocation of epiphytic orchids require supplementation with propagated seedlings specialised techniques and facilities will be required and are well documented in e.g. Jones (1993).

3.4 Pre-translocation receiving site preparation

Identify the location of the sites for planting or clump/slab/tree transplant and mark with bamboo stake and flagging tape. In addition and to insure against loss of stakes and flags metal pegs will be employed for later location with a metal detector. Site preparation will include control of weeds through the whole of the mapped area and a 5m buffer area so that site is weed free when material is introduced. Identify the location of the sites for planting or slab/clump and mark with bamboo stake and flagging tape. Prior to arrival of slab or clump transplants areas slightly larger than the slab/clump to be excavated ready for receipt. If undertaken during drought conditions or where recipient site is dry, a wetting agent is recommended, and will be considered regardless of conditions to assist post translocation management. Watering may be necessary depending on the season. In the case of planting seedlings the holes will be dug on the planting day.

Where impacts from stock or feral animals are likely then fine mesh fencing is to be erected around the translocation site. Individual strong plastic tree guards will be required where browsing by wallabies or kangaroos is possible.

3.5 Cuttings

Stem and cuttings will be rooted with hormone treatment in specialist misting facilities. Cuttings may be employed for threatened flora species Four-tailed Grevillea, Green-leaved rose walnut, Red lilly pilly, Singleton mintbush, Stinking Cryptocarya, Tall knotweed and White laceflower (depending on prospects for success using alternative methods and also availability of suitable material).

All cutting material should be labelled to indicate plant of origin (Vallee *et al.* 2004).

3.6 Potting and growing on

Seedlings or rooted cuttings will be transplanted to pots or tubes. All plants will be labelled with ID indicating origin.

All species (seedlings)

Transplant to pots or tubes.

Seedlings should be pricked out when 0.5 to 2 cm tall. Grow on in nursery until about 10 cm tall (herbs and grasses).

For tree and shrub species, seedlings should be potted on when 3-5cm tall.

Tree species (cuttings)

Remove from mist for one week when new leaves are produced and pot on. Grow on until plants exhibit vigorous above-ground growth and have a strong root system. Some species may be very slow growing.

Tall knotweed (cuttings)

Remove from mist for one week when new leaves are produced and pot on. Grow on until plants exhibit vigorous above-ground growth and have a strong root system.

3.7 Digging, potting or direct transplant of seedlings

Identify the location of the seedlings for removal and flag and number. Seedlings from donor sites to be directly transferred to receiving site if in close proximity or alternatively transported to a suitable nursery for potting. Dig around the seedling at a distance that will cause minimum disturbance to the roots system. Carefully place the seedling and soil into a tray or pot or wrap in plastic or hessian for transfer to receiving site or nursery.

3.8 Transplant of saplings and mature trees

Identify location of saplings and trees for translocation and flag and number. Excavate an area larger than the rootball in readiness for the translocation. Excavation should be undertaken as appropriate for the size of the plants, with hand tools or machines as small as possible for the task (bobcat) and undertaken or supervised by an ecologist or bush regenerator. Water well and keep moist. When receiving site is prepared remove the whole root ball (excavator or hand tools). Prior to transplanting (excavation), each plant needs to be lightly pruned to reduce transpiration stress.

All pruned material should be placed into a damp plastic bag and labelled as per Vallee *et al.* 2004 s.5.2.3. Bags should then be placed in a cool storage device (esky) for transport to nursery for cutting propagation.

3.9 Clump/slab transplant

Identify the location of the sites for clump/slab removal and flag and number. The source points for donor clumps/slabs will be identified by GPS location, abundance data recorded as appropriate for the species and a map prepared. Clumps and slabs will be dug and placed in tubs or trays for transportation. All clumps and slabs will be labelled as per Vallee *et al.* 2004 s.5.2.3, either as individuals or, where material is to be pooled, by general location. Clump and slab material will be kept moist by watering, covering with wet newspaper, enclosing in tubs and/or covering with tarpaulin during transport.

3.10 Relocation of epiphytic orchids

Clumps and individuals will be prised carefully from the host trees and kept moist. Clumps will be divided where there are clear divisions between individual plants and cutting with a sharp knife can separate plants without undue disturbance. Some plants may be best retained in small clumps.

Plants will be attached to the new host tree using jute ties. A host tree of the same species of the donor site tree will be chosen.

3.11 Transport to field and planting

Preliminary

Sun-harden all nursery stock – seedlings and established cuttings of trees, herbs and vines.

Transport to receiving site

Nursery stock to be protected from wind and desiccation during transport (well watered at starting point and in covered tubs or under secure tarpaulin).

Slabs/clumps will be transported in plastic tubs or trays manually or by utility to the site and where possible planted on the same day. In the case of large areas of Hairy joint-grass and tree transplants the clumps/trees will be transported by excavator. The transplant material is to be kept moist and protected from wind during delivery.

Planting

Place in excavated hole or depression and back fill with local soil as necessary.

The translocated species generally do not require fertiliser to be added on planting.

Weed free mulch may be required for the planted tree species to assist in retaining moisture and suppress weed.

Watering will be necessary on planting and may be ongoing depending on the season.

Consider use of wetting agent.

After transplanting individuals will be tagged with their ID code. A map of the receiving site showing the transplanted individuals identified by ID code will be prepared.

3.12 Post translocation management

After translocation all sites will require regular inspections to identify if plants require watering or protection from impacts such as grazing, fence repairs, drainage, exposure or weed invasion. If threats are identified they are to be rectified immediately. A regular weed control program is required for all receiving sites.

The timing of inspections, watering and weed control will vary depending on the season and time passed since the translocation. Inspection will be required on a fortnightly basis for the first month to assess if the plants require watering or other maintenance. Inspections during year one will depend on time of year and establishment of the translocations. During winter when plant growth is slow three monthly weed control is recommended whereas during

summer weed control may be required on a six-eight weekly basis. Watering should only be required during the first month of establishment unless extremely dry weather conditions are encountered. During following years inspections can be incorporated with the weed control and the period between visits extended as plants become established and weed invasion reduced.

A schedule for inspections is incorporated into **Table 7**.

4 Personnel expertise and resources

Personnel expertise and resources have been identified and sourced to ensure the best possible outcome from the translocations (**Table 10**).

The translocations will be managed by a restoration ecologist and supervising bush regenerator who are experienced in the translocation of threatened species within the region.

Site preparation will be undertaken by a team of experienced bush regenerators who are familiar with the native and weed species which occur on the sites.

Personnel engaged to undertake the translocations will hold:

- Certification at Levels 3-4 in Conservation and Land Management
- Licences to undertake seed collection other translocation tasks and bush regeneration (Section 132C NPW Act)
- Chemical Users Certificates.
- White card

Works will be supervised by a suitably qualified restoration ecologist.

Table 10: Personnel and resources

Action	Personnel	Equipment and materials
Weed management at receiving sites	Supervising bush regenerator	Spray packs drills and injectors hand tools
Traffic control signage and protective barriers/fencing	Ecologist and Principal contractor	Signs webbing or fencing
Locate and identify receiving sites and access	Ecologist and Supervising bush regenerator	GPS Bamboo stakes and flagging tape
Map access extent of receiving site and locations for transplanting	GIS operator	ArcGIS
Collect propagation material seed and/or cuttings	Ecologist	Secateurs bags labels esky spray bottle water spray bottle disinfectant.
Propagation of seed or cuttings	Certified nursery personnel and Ecologist	Nursery facilities Pots containers labels
Receiving site preparation	Ecologist and Bush regeneration team	Bush regeneration tools and chemical Fencing – pest exclusion or protective barrier – if required
Transplanting	Ecologist and Bush regeneration team Excavator contractor Principal contractor – if required	Shovels saws secateurs plastic tubs Utility Excavator Watering system – water cell and hoses Mulch and fertiliser – if required Bamboo stakes and tags
Receiving site maintenance	Ecologist and Bush regeneration team	Bush regeneration tools Watering system
Monitoring	Ecologist	IPad data sheets and maps

5 Monitoring evaluation and reporting

5.1 Background

Monitoring involves detecting changes and patterns overtime. This requires identifying the parameters to be monitored gathering information and interpreting the information gathered. Monitoring will enable the identification of problems and allow early response to any problems or threats. Monitoring is also vital for evaluating translocation success (Vallee *et al.* 2004).

Translocations have been evaluated by measuring:

- vital rates (survival growth fecundity) of propagules (seeds transplants)
- completion of the life cycle through flowering fruiting dispersal and subsequent seedling recruitment
- modelling population viability of translocated populations (Menges 2008)

The monitoring data collection outlined below will serve to measure vital rates in the relatively short timeframe (5 years) generally allocated to monitoring and evaluation tasks in a typical highway construction project.

Monitoring would include the documentation of the following information as a minimum:

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

Hairy joint-grass and Tall knotweed have good potential to complete their life cycles in the same timeframe and suitable monitoring data can be usefully evaluated. Menges recommends that comparisons with reference populations be incorporated into the evaluation.

Ideally Menges' recommends long-term perspectives on success and an experimental framework that can provide both practical and basic knowledge. He notes that demographic data collection and analysis in restorations has great potential to elucidate causes of translocation failure and improve the prognosis of future restorations.

In drawing conclusions about the success or failure of translocations the following factors should be considered:

- bio-physical site characteristics
- stochastic weather events and ability to control or supplement e.g. water availability during establishment
- genetic issues (affecting the likelihood of inbreeding depression achievement of reproductive viability retention of local adaptation and maintenance of evolutionary potential of translocated populations.
- ecological factors including herbivory disturbance and competition
-

Timeframe

Monitoring of the translocations would be conducted during and after construction for a minimum of 3 years a total of approximately 5 years.

Independent oversight

Monitoring and reporting will be conducted (or overseen) by personnel independent of those undertaking the on-ground works.

Record of translocation actions and results

- Record of collection of propagules/transplants
- Germination time and % cutting strike rate and time required
- Nursery conditions
- Growing on period
- Planting out
- Post-planting care
- Baseline measurements of translocated plants as below.

Receiving site

- Biophysical description
- Threats (e.g. weeds grazing)
- Management actions
- Regeneration/planting of habitat components

Reference populations

Identify and mark a sample of a reference population that can be used to compare growth and development of plants that have been translocated.

Monitoring data

Monitoring would include the documentation of the following information as a minimum:

- Identification

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

Note that for species with growth forms not suited to counts and measurements of individual stems eg Hairy joint-grass growth and development will be tracked using area- and density-based measurements.

Baseline surveys

Monitoring will commence with baseline surveys of the donor populations as an additional check on the numbers or areas of each species to be impacted and therefore to be replaced. The results will be compared with the earlier survey results and the larger of the two results adopted as the basis of numerical targets.

Monitoring frequency

Monitoring of the translocations would be conducted as follows: every 3 months for the first year; every 6 months in the second year and once a year thereafter.

Monitoring would be conducted during construction and after construction for a minimum of 3 years.

5.2 Performance criteria and adaptive management

The following performance criteria are derived from Vallee *et al.* (2004) with adaptation to suit the circumstances of the current project.

Propagation and record keeping

Criteria for successful propagation would include:

- the required number of transplants was available for the translocation
- correct labelling and documentation was maintained through cultivation
- techniques for successful propagation are determined
- a genetically representative collection was maintained (Vallee et al. 2004).

Salvage

All material with potential conservation value is salvaged prior to construction works having direct impact on the plants. The material is available for:

- backup in the case of failed translocation establishment
- seed banking (note additional seed can be sourced from other populations in proximity)
- trialling and research.

Short Term Criteria (to 5 years)

The translocation of each species:

- at least 70% of the transplants and enhancement introductions are surviving after the first year and 60% after five years (and arrangements for replacement from backup stock are underway in case of failure to meet this target);
- germination from freshly shed or soil-stored seed of Hairy joint-grass and Tall knotweed occurs following suitable seasonal rainfall
- flowering and seed production (or spore production) occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)
- the translocated populations display similar growth development and vigour to naturally occurring populations
- regeneration occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)

Habitat and threat management:

- good quality habitat restored in and surrounding the receival site;
- maintenance carried out at suitable intervals; and
- threatening processes including weed invasion controlled or eradicated.

Long Term Criteria (decades)

The timeframe of the current project will not permit the development of slow-growing species i.e. Green-leaved rose walnut to be followed to reproductive maturity. Annual plants however will complete many life cycles in timeframes of a decade or more. Details of long-term criteria are provided for information and adoption where feasible.

- translocated individuals survive to reproductive maturity;
- new seedlings or vegetative offspring are established;
- the number of individuals in the population is sustained or increased by natural recruitment;

- adequate levels of genetic fitness are maintained through generations;
- reproduction including the production of flowers and fruit (or spores) and seed viability (spore viability) is consistent with levels in naturally occurring plants;
- natural habitat conditions are restored or maintained at the receival site.

The practical difficulties in maintaining surveillance and management over ecological timeframes contribute to uncertainties in predicting translocation success. The establishment and continuing development of plants over a period of 5 years is a realistic goal for long-lived species. Species-specific performance criteria thresholds signaling the need for adaptation of management and actions to correct divergence from progress towards targets are identified in **Table 6**.

5.3 Translocation monitoring report

An annual translocation monitoring report will be prepared and submitted to the Environment Protection Authority, Department of the Environment and Department of Planning and Environment.

The report will include: -

- Background and description of the translocation project (initial report)
- Translocation methods (initial report)
- Monitoring methods
- Monitoring results
- Evaluation of translocation success to date
- Identify any corrective actions required
- Recommendations for immediate and ongoing management
- General recommendations for future translocation projects

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Four-tailed Grevillea	Profile last updated: 07 Sep 2012
Green-leaved rose walnut	Profile last updated: 04 Aug 2014
Hairy joint-grass	Profile last updated: 07 Sep 2012
Maundia	Profile last updated: 30 May 2014
Red lilly pillly	Profile last updated: 22 Apr 2014
Rough-shelled bush-nut	Profile last updated: 22 Apr 2014
Sandstone rough-barked apple	Profile last updated: 11 Aug 2014
Singleton mintbush	Profile last updated: 30 May 2014
Slender screw fern	Profile last updated: 07 Sep 2012
Stinking Cryptocarya	Profile last updated: 05 Aug 2014
Tall knotweed	Profile last updated: 31 Jan 2014
Water nutgrass	Profile last updated: 07 Sep 2012
Weeping paperbark	Profile last updated: 22 Apr 2014

White laceflower

Profile last updated: 11 Aug 2014

Yellow-flowered king of the fairies

Profile last updated: 07 Sep 2012

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Appendix 1 Translocation strategy comments table

Pacific Highway Upgrade – Woolgoolga to Ballina

Flora Translocation Strategy Sections 3-11
(excluding Early Works Soft Soil Treatment Areas)
May 2015



Transport
Roads & Maritime
Services

AGENCY REVIEW COMMENTS –

- 1) Commonwealth Department of the Environment (DoE) 6 November 2015
- 2) Environment Protection Authority (EPA) 9 November 2015
- 3) Department of Planning and Environment (DPE) 25 November 2015

No.	Agency	Comments	Where addressed in report
1.	DoE	<p>The Department has no specific comments to raise regarding this document.</p> <p>Please note <i>Streblus</i> subpopulations on mainland Australia and in Melanesia, Micronesia and Polynesia have variously been included with <i>S. pendulinus</i>. More recently, <i>Streblus brunonianus</i> has been reinstated for non-Norfolk Island subpopulations. For more information see the link below.</p> <p>http://www.environment.gov.au/biodiversity/threatened/nominations/comment/streblus-pendulinus</p>	Noted

No.	Agency	Comments	Where addressed in report
2.	EPA	<p>Six Translocation receiving sites are BOS sites. There are two issues of concern relating to this:</p> <p>1) Are these sites assured of perpetual preservation considering the offset package is in its infancy. The status of these sites, and the ramifications if they are not included in the biodiversity offset package, needs to be addressed in the translocation strategy.</p> <p>2) Any additional threatened species area generated on these sites as a result of translocations is not to be included in offset calculations</p>	<p>1) Section 2.5 includes statement that alternative options are listed in all instances where covenanting of sites is not finalised. Status of sites clarified in Appendices 6.8, 6.17 and 6.18.</p> <p>2). Noted. To be addressed in the Biodiversity Offsets Strategy.</p>
3.	EPA	<p>Table 6 contains several issues to be addressed.</p> <p>Performance criteria, thresholds and corrective actions are often not coherent.</p> <p>1) Performance criteria are often much higher than threshold criteria. Performance criteria reflect the literature (eg. Vallee <i>et al.</i> 2004) and are the temporal academic goals of translocation, whereas the threshold reflects the on the ground trigger for corrective action. For example for red lilly pilly 70% (of original population) is the performance criteria after 2 years whereas 50% is the threshold. The EPA suggests that when on the ground results lie within this bracket, i.e. between 70% and 50% in this example (and between performance criteria and threshold generally), the trigger for corrective action be at the discretion of the expert translocation contractor. This allows for environmental variability and species specific consideration.</p> <p>2) Often thresholds do not include a temporal parameter. For e.g Red Lilly Pilly again, Threshold (for aim of maintaining demographic function/genetic variability) is 80% of original measure but has no time parameter for monitoring or effective corrective action. Need to include a timeframe for these type of thresholds.</p> <p>3) There may then be a conflict between differing thresholds for corrective action for different aims for the same species. If this is the case then the EPA suggests text be included to the effect that corrective action will follow any threshold being reached.</p>	<p>1) Table 6 Translocation planning. Annotations to reflect EPA suggestion.</p> <p>2) Time parameters added where required.</p> <p>3) Statement following Table 6</p>
4.	EPA	<p>What are the triggers for continuing/stopping monitoring after 3 years, I infer that it is the achievement of the 100% replacement figure of the original population, but this isn't mentioned anywhere. What is to happen if the 100% replacement goal isn't reached within 5 years? This possible outcome needs to be addressed in the strategy.</p>	<p>Table 6 adjusted to note that Year 3 achievements to be maintained though to Year 5.</p> <p>Statement re Year 5 review, if required, follows Table 6.</p>
5.	EPA	<p>The annual monitoring report should be submitted to the EPA not OEH as stated in the strategy.</p>	<p>Corrected in s5.3 Translocation monitoring report, see also Comment 10.</p>

No.	Agency	Comments	Where addressed in report
6.	EPA	The tables are listed erroneously, e.g. table 6 is Translocation planning not receiving sites as in table of contents etc.	Corrected in Table of Contents
7.	DPE	Provide list of recent ecological reports and surveys which informed the identification of the directly impacted threatened flora.	Provided, s1.5
8.	DPE	The aims, objectives and performance criteria and corrective actions for the Green-leaved rose walnut individuals in section 10 are different to the actions approved for the species (individual tree) in the approved Flora Translocation Strategy Early Works Soft Soil Treatment Areas (Version 3 June 2015). Explanation of the different approach for sections 3-11 should be provided.	The risks of inbreeding depression should multiple plants be propagated and established from the isolated tree is discussed in Appendix 3 of the Soft Soils Strategy. The special case of the subject tree affected by Soft Soils Early Treatment Works required modifications to translocation objectives.
9.	DPE	Monitoring of translocations would be conducted during and after construction for a minimum of three years for total of approximately 5 years. Are these timeframes realistic for slow growing species (Green-leaved rose walnut) grown in a nursery (from seeds or cuttings) and when growth of the seedling is suitable for transplant to the recipient site. Will this occur within two years and allow three year monitoring period post translocation?	Rates of development are difficult to predict but are likely to be slow for Green-leaved rose walnut. A review of progress may be required at Year 5, see also Comment 4.
10.	DPE	Annual monitoring report to be submitted to EPA, Department of the Environment and DPE.	Section 5.3
11.	DPE	Update references to Table 4. <u>Hairy joint-grass</u> In the section titled "Distribution" reference is made to Table 4. Table 4 describes translocation feasibility not records of the threatened species. <u>Maundia</u> Reference to Table 4 in paragraph 3 of the section titled "Habitat and ecology"	Corrected in Appendix 3

Appendix 2 Compliance with translocation guidelines

Checklist for determining whether to translocate (Vallee *et al.* 2014)

A decision regarding whether or not to translocate should not be made until all the following questions have been answered:

Have all alternative management options been attempted or considered?	Alternative route options have been investigated and design refinements have minimized impacts on threatened species
Is the taxonomic status of the taxon certain?	Green-leaved rose walnut has been mis-determined in the past making assessment of its conservation status and the context of any individual plant or population difficult to assess. Singleton mintbush – the status of the taxon is doubtful (OEH profile) but specimens located during surveys for Roads and Maritime have been assigned to this taxon following herbarium determination. Sandstone rough-barked apple. Specimens have required herbarium determination to separate hybrids and genetically pure individuals. The status of other taxa is considered certain.
Is the distribution of the taxon adequately understood?	The study area has been surveyed intensively. Atlas records provide local context and the broader distributions of the species are adequately understood from survey and herbarium records. Green-leaved rose walnut has however been mis-determined – hence its distribution is poorly understood. Genetically pure specimens of Sandstone rough-barked apple have been incompletely separated from hybrids (translocation from hybrid zone is not proposed).
Are threatening processes understood and can they be controlled?	Clearing and changes to hydrology are two relevant threatening processes. Management of hydrology in particular will be a focus of management for Hairy joint grass and Tall knotweed. Weed management will be a routine management action.
Have potential suitable recipient sites been identified?	Yes
If considering population enhancement do you have evidence of population decline and have you considered or attempted alternative means of increasing population size?	Population enhancement is considered here as a component of salvage translocations. Local populations of all taxa proposed for translocation will decline at least temporarily as a result of impacts of the Project. Population enhancement is proposed in conjunction with habitat management hydrological management (where applicable) and other threat mitigation measures to increase population size.
Have you considered the success of any previous translocation programs?	Documented in Appendix 3. Long term success of translocation programs has rarely been demonstrated.
Have you determined the cost of implementing the translocation program including post translocation monitoring and management and have sufficient funds been secured?	Roads and Maritime will be responsible for funding.

If the answer to any of the above questions is no then the benefits and risks of proceeding without that information are to be assessed prior to making a decision to translocate.

In the context of a series of salvage translocations the translocation is an alternative to destruction of plant material with conservation value and benefits will accrue even if all translocation objectives cannot be met. For example trialing of methods will provide new information about the species and improve prospects for future translocation success.

Appendix 3 Background for threatened flora species

Species are listed alphabetically by common name. All species to be directly impacted are included excepting Whalebone tree/Siah's backbone).

Four-tailed Grevillea

(Section 3)

Scientific name: *Grevillea quadricauda*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Photo Hugh Nicholson

Description

This is a bushy shrub with yellow-green foliage growing to 2 m in height and spread. New growth is pink or purple especially on the tips of the leaves and the branchlets are matted with hairs. The leaves are up to 1.8 cm long tapered at both ends and often rolled under along the sides. Silky white hairs are sparse on the upper side and denser on the lower side. The hairy flowers are in groups of two to four and are pink or red with a green base. Each 'petal' bears a distinct pointed 'tail' at its tip. The dry fruit has a long projection bent sharply backwards (OEH profile). Flowering is August to September (Commonwealth Conservation Advice). Probably takes about 6 weeks for fruits to ripen so that seed is likely to be available around October-November (G. Errington Australian Botanic Garden Mount Annan pers. comm. July 2015).

Distribution

In NSW Four-tailed Grevillea is found to the north-west of Whiporie in Mount Belmore State Forest and Mount Neville Nature Reserve and at Tucabia east of Grafton. It also occurs near Toowoomba in south-east Queensland (OEH profile).

Habitat and ecology

Grows in gravelly loam in the understorey of dry eucalypt forest usually along or near creeks (OEH profile).

Results of preconstruction surveys

Section 3

Geolink (2014a) found 18 Four-tailed Grevilleas associated with an area of riparian rainforest on the eastern side of the alignment (outside the clearing limits).

Small numbers of plants are now recognized as subject to direct impact in the Tucabia area. Jacobs (2014a) found Four-tailed Grevillea within and adjacent to the alignment. There were no major changes from previous surveys. Plants in the southern population of the alignment were observed as damaged and regenerating.

Translocation history

No information specific to the species is available but Grevilleas in general grow readily from seed and cuttings and are commonly grown in horticultural or ecological restoration situations.

Implications for translocation

It is reasonable to assume that Four-tailed Grevillea can be feasibly translocated from seed and/or cutting propagated plants. The poor condition of the donor plants may limit prospects for success.

Green-leaved rose walnut

(Section 10)

Scientific name: *Endiandra muelleri* subsp. *bracteata*

Conservation status in NSW: Endangered

Commonwealth status: Not listed



Photo Hugh Nicholson

Taxonomy and identification

As reported in the Recovery Plan (DECC 2004) Green-leaved rose walnut is difficult to distinguish from Rusty Rose Walnut *Endiandra hayesii* and many herbarium determinations prior to 2004 were found to be in error when re-assessed. Accordingly some background information and survey records that are not supported by recently verified herbarium specimens cannot be confidently accepted. All information provided below should be interpreted in this light.

Description

A tree up to 30 m tall with brown bark often in loose round plates. Twigs and branchlets are covered in hairs. The moderately glossy leaves are oval or drawn out towards the tips and measure 6 – 12 cm long and 3 – 5 cm wide with three to five pairs of side veins. Flushes of new growth are pinkish-green. Flowers are small yellowish and hairless and are held in small clusters. The fleshy fruits are egg-shaped 2.5 – 3 cm long and black when ripe (OEH profile).

The characteristics of the hairs on the twigs and leaves and the presence or absence of hairs in the floral sheath distinguish Green-leaved rose walnut and Rusty rose walnut (Hyland 1989).

Distribution

Occurs in Queensland and in north-east NSW south to Maclean. It is sparsely distributed within this range (OEH profile).

Habitat and ecology

Occurs in subtropical and warm temperate rainforests and Brush box forests including regrowth and highly modified forms of these habitats.

Records are usually from poorer soils derived from sedimentary metamorphic or acid volcanic rocks.

The species is generally recorded at lower altitudes.

Flowering and fruiting has been observed from November to May (OEH profile) though other times of the year are possible (DECC 2004).

Results of pre-construction surveys

Section 4

A tree was recorded adjacent (western edge) to the Wave 3 soft soil area (Jacobs 2014) at Maclean Interchange. The tree was assessed in the Early Works Soft Soil Treatment Areas Translocation Strategy and is excluded from consideration in the present strategy. A small number of additional plants are known from the vicinity.

Section 10

Australian Museum Consulting (2014) recorded seven individuals of Green-leaved rose walnut within the study area growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway.

Translocation history

Green-leaved rose walnut was translocated during the Pacific Highway Upgrading Program between Yelgun and Chinderah (DECC 2004).

An augmentation program was planned for Koala Beach in the Tweed Local Government where isolated trees were to be supplemented with plantings of cutting-grown plants from the local area in order to increase the genetic variation of the Koala Beach occurrence (Benwell 2002).

Cutting propagation was likely to be preferred (seed collection unlikely) but a low strike rate in cutting material collected during the Yelgun to Chinderah highway project (Possum Creek Nursery pers. comm. quoted in Benwell 2002).

Cuttings that successfully struck were to be grown-on in pots until at least 30cm high which may take two years in this slow growing species and inoculated with native soil mycorrhizae when potted-on (Benwell 2002). No evaluation of the effects of inoculation with mycorrhizae was conducted during this translocation.

Implications for translocation

Trees and saplings to be transplanted seedlings potted up for growing on in nursery. If seeds are available seed propagation to be conducted together with cuttings. Plants developing through any of these methods are likely to be slow to establish and develop. The identification of all plant material should be checked given ongoing difficulty in distinguishing from Rusty rose walnut.

Hairy joint-grass

(Sections 3,10)

Scientific name: *Arthraxon hispidus*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Description

Hairy joint grass is a creeping grass with branching erect to semi-erect purplish stems. Leaf-blades are 2–6 cm long broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk (OEH profile). This source considers Hairy joint grass to be a perennial which tends to die down in winter. In contrast others believe that Hairy joint grass is predominantly an annual plant species on the North Coast of NSW and completes its life cycle in one year (Benwell 2012, Geolink 2007). Other detail of phenology and development is provided by Geolink (2007). Seed germinates in late winter after a short dormant period. Growth occurs mainly during the summer wet season with flowering in autumn before the whole plant dies.

Distribution

Occurs over a wide area in south-east Queensland and on the northern tablelands and north coast of NSW. Also found from Japan to central Eurasia (OEH profile). Although the OEH source states that Hairy joint-grass is never common where found in NSW relatively large areas have been recorded within the project area (Table 3) and the grass has been found to be locally common around Lennox Head (e.g. Landmark Ecological Services 2008).

Habitat and ecology

Moisture and shade-loving grass found in or on the edges of rainforest and in wet eucalypt forest often near creeks or swamps (OEH profile).

Benwell (2012) notes however that Hairy joint-grass now appears to have adapted to agricultural habitat occurring mainly in grazing pasture dominated by exotic grasses. Hairy joint-grass commonly persists under a grazing regime which keeps co-occurring exotic pasture grasses low in height. In forest understorey situations Hairy joint-grass appears to require high light levels and occurs under sparse canopies or forest edges.

Results of pre-construction surveys

Section 3

An isolated record by Jacobs in January 2014 recorded as a single plant.

Section 10

Australian Museum Consulting (2014) recorded nine individuals within the study area growing in cleared land often adjacent to Lowland Rainforest and areas prone to flooding. Jacobs (2014) recorded several additional populations within Section 10 and noted that some previously mapped populations were not present potentially due to altered management regimes and below average rainfall.

Translocation history

Hairy joint-grass has been the subject of a number of translocations most of which have been from pasture situations with receiving sites also in open grasslands.

Large clumps of Hairy joint-grass and exotic grasses using an excavator were successfully transplanted into a prepared receiving site at Lennox Head (B. Smeuninx pers.comm).

Benwell and Mallee (2014) report successful establishment through direct seeding (limited by the availability of required seed volume) and through transplant of nursery-raised seedlings.

Trials of grazing and or slashing regimes to reduce competitive biomass produced mixed results which were confounded by an overall reduction in abundance during the dry years experienced during the trials. As well as a recognition that biomass must be maintained at a low level the need to generate gaps in dense turf to facilitate recruitment was recognised.

Implications for translocation

Translocation and management of Hairy joint-grass remains experimental and approaches will vary depending on the detectability of above-ground plants. Transplant of slabs or clods is the recommended approach when feasible including the transfer of soil-stored seed from locations where plants are known to have died back. Options for seed collection and planting are also available and tested for circumstances in which transplant is not feasible or when results are not optimal.


Any management regimes will need to be site and condition specific and adapt to climatic variables.

Maundia

(Sections 3, 7)

Scientific name: *Maundia triglochinoides*

Conservation status in NSW: Vulnerable

Commonwealth status: Not listed 

Description

Perennial with rhizomes about 5mm thick and emergent tufts of leaves arising along their length. Leaves are spongy inflated and triangular in cross section to 80 cm long sometimes longer 5 - 10mm wide. Inflorescence to 10cm long and 2.5cm wide. Carpels (female parts of flower) 6 - 8mm long sessile each with a spreading beak. The fruit is 1cm long to 8mm wide (OEH profile).

Distribution

Restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct (OEH profile).

Habitat and ecology

Grows in swamps lagoons dams channels creeks or shallow freshwater 30 - 60 cm deep on heavy clay low nutrients (OEH profile).

- Flowers generally November to January (Benson and McDougall 2002). Northern populations rarely flower and are thought to reproduce largely vegetatively and to have limited dispersal capacity (S. Jacobs Royal Botanic Gardens quoted in Parsons Brinkerhoff 2006).
- Flowering is in November-January and flowers are thought to be wind pollinated (Benson and McDougall 2002).
- Numerous seeds are produced between December and January in a smooth shiny dehiscent capsule (Benson and McDougall 2002).
- Diaspore is the seed and root tubers which are probably dispersed by water (OEH 2014).
- Spreads vegetatively with tufts of leaves arising along rhizome. Populations expand following flood events and contract to more permanent wetlands in times of low rainfall (OEH profile).
- Associated with wetland species e.g. *Triglochin procerum* (OEH profile).

Maundia has been reported to form dense stands rapidly and be invasive under some conditions (Romanowski 1998). The colonization and spread through a constructed drain at Port Stephens has been documented (Section 91 license application TSC Act NEHUO46) and rapid change in the distribution of Maundia has been reported in staged surveys conducted for the present highway upgrade project.

Benwell (2013) notes that recent surveys in the mid north coast have found Maundia to be more common than previously thought. The surveys investigated changes to the Maundia populations since surveys conducted by Pressey (1989) in the Lower Macleay and found local gains and losses relating largely to changes in hydrology. Craig Harré (OEH pers. comm. 8 Aug 14) advised that the sites surveyed included 30 wetlands where Maundia had been present. The surveys indicated that Maundia is apparently quite secure on the NSW Mid North Coast albeit a little south of the current project. Similar intensive targeted surveys have not been conducted in the same way in the vicinity of the current Project Area but numerous records are included in Table 3 and a large occurrence is known from adjacent land at Tabbimobile (Jacobs 2014). An additional large occurrence is adjacent to the project at Halfway Creek In Section 1.

Implications for translocation

The biological and ecological characteristics of Maundia would appear to facilitate translocation from seed collection and nursery propagation or transplant of clumps. However sources quoted in Benwell (2013) describe difficulties in germinating seeds and there are practical difficulties in transplanting into a swamp environment.

Results of pre-construction surveys

Section 3

Jacobs (2014b) recorded within Section 3. Within the alignment the species was observed in low to moderate abundance at several locations in comparison to previous observations most likely due to the below average rainfall received in the study area. Some populations were in better condition than others. There were no major changes from previous surveys in terms of distribution and abundance.

Section 7

Biosis (2014) recorded two populations although additional populations had been previously documented. Differences in distribution and abundance were attributed to changes in the wet/dry cycle of suitable habitat (i.e. drainage lines) as well as dispersal of individuals throughout the area.

Jacobs (2014a) recorded *Maundia* in low to moderate abundance at several locations, though less than previously observed. Changes were attributed to the below average rainfall received in the study area.

Translocation history

There is limited previous translocation experience to draw from. Practical difficulties of transplanting into aquatic environments have been used as a basis for not attempting translocation in a location where *Maundia* was found to be relatively abundant locally (Warrell Creek to Urunga)

Parsons Brinkerhoff (2006) prepared a translocation assessment for *Maundia* as part of the Pacific Highway upgrade Kempsey to Eungai. By way of background they noted that

- no translocations of this species have been successful in the past (S. Jacobs Royal Botanic Gardens personal communication 4/4/07)
- previous attempts at cultivation of *Maundia triglochinos* have failed (Sainty and Jacobs 2003).
- previous attempts have included collection and germination of seed with subsequent death of seedlings when transplanted.
- mature plants that have been translocated have also failed to survive. germination of seed has proved difficult (S. Jacobs Royal Botanic Gardens personal communication 4/4/07).

While there have been trials including digging of rhizomes a focus on seed in soil and water dispersal has appeared more fruitful. The extent of shading has also proved to influence the distribution of *Maundia*. The conclusion from ongoing observations of contraction in dry periods and later expansion is that the best approach may be to design hydrology carefully rather than translocating. Local surveys may also be advisable – many of the large populations documented lie to the south of the current Project Area.

Red lilly pilly

(Section 10)

Scientific name: *Syzygium hodgekinsoniae*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Photo Hugh Nicholson

Description

This is a small tree to about 11 m tall. Its paired leaves are oval shaped or slightly elongated 8 - 15 cm long with a short blunt point at the tips. The flowers are off-white fluffy and honey scented about 25 mm in diameter and are held in clusters at the ends of stems. The fruit are 4 cm in diameter round

and bright red. A thin layer of flesh with a distinctive smell like that of an ashtray encloses a single large seed (OEH profile). Fruit ripe August to November (Floyd 2008).

Distribution

A restricted range from the Richmond River in north-east NSW to Gympie in Queensland. Locally common in some parts of its range but otherwise sparsely distributed (OEH profile). Plants recorded in the vicinity of the route are a little south of the Richmond River.

Habitat and ecology

Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils (OEH profile).

Pre-construction surveys

Section 10

Australian Museum Consulting (2014) recorded five individuals within the study area growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway and further south.

Translocation history

No information is available for transplant or cutting propagation. The plants is commonly and successfully grown from seed and included in rainforest plantings however. Nicholson and Nicholson (1985) note that seed germinates easily and often as multiple shoots. When very young plants go through a stage of almost zero growth coupled with bunching of the new shoots. It is worth maintaining plants in a tub for two years until the stage is passed. Syzygium species can be successfully grown from cuttings and it will be worth trialling cutting propagation of Red lilly pilly.

Implications for translocation

Seed propagation is expected to be reliable and transplanting existing standing plants will be appropriate for salvage and to trial techniques.

A combination of planting of seed-propagated plants together with transplanted seedlings (pot up and grow on before planting out) and direct transplant of larger stems is proposed. If seeds cannot be collected in the required timeframe cuttings should be trialled also in order to secure the genetic material, and to make best use of material trimmed from plants identified for direct transplant.

Rough-shelled bush nut

(Section 10)

Scientific name: *Macadamia tetraphylla*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Photo Hugh Nicholson

Description

The Rough-shelled Bush Nut is a small to medium-sized usually densely bushy tree growing up to 18m tall. The leaves are 7 – 25 cm long and oblong or slightly lance-shaped. The leaf-margins are toothed and prickly. Creamy pink to purplish flowers hang in long strings among the leaves. The fruit is woody brown and globular 2 – 3 cm in diameter. The edible seeds are enclosed in a hard wrinkled brown shell inside a round green husk (OEH profile). Seeds are ripe January to April (Floyd 2008). Moderate to high genetic diversity has been recorded within the species and its populations however very low genetic differentiation between populations has been recorded at a regional scale (references cited in Southern Macadamia Species Recovery Plan, Costello *et al.* 2009).

Distribution

Confined chiefly to the north of the Richmond River in north-east NSW extending just across the border into Queensland. Many records particularly those further south are thought to be propagated (OEH profile). The plants reported in the Coolgardie area are a little south of the Richmond River and appear to be naturally occurring.

Habitat and ecology

Found in subtropical rainforest usually near the coast (OEH profile).

Pre-construction surveys

Section 10

Australian Museum Consulting (2014) recorded 10 individuals within the study area growing in Lowland Rainforest west of the intersection of Coolgardie Road with the Pacific Highway.

Translocation history

Regularly grown from seed and used successfully in rainforest restoration for bush food and as a root stock for grafted horticultural hybrids.

Seeds germinate in two weeks and grow rapidly. Deep mulching is most beneficial. Grows moderately fast into a bushy ornamental tree to 10 m in height preferring deep rich soils with plenty of summer moisture but will tolerate slightly less favourable conditions (Nicholson and Nicholson 1985).

Implications for translocation

Seedlings are likely to be produced and establish readily. Transplants of mature plants will be experimental.

Sandstone rough-barked apple

(Sections 3, 4)

Scientific name: *Angophora robur*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Description

This tree is one of the 'apples' eucalypt-like trees with paired leaves and often gnarled limbs. It grows up to 10 m tall and is smaller and more twisted than most angophoras (OEH profile). This species forms a lignotuber (woody swelling below or just above the ground containing adventitious buds from which new shoots develop if the top of the plant is cut or burnt) (CPBR 2006). It has rough grey bark and is distinguished by its unusually large leaves up to 18 cm long and 7.5 cm wide. The leaves may be rather bristly and are paler below. The white clustered flowers are followed by large ribbed fruits up to 1.6 cm long and wide (OEH profile).

Generally *Angophora* spp. flower in late summer-early autumn but this can be variable according to the season. Seed set follows but timing can vary from season to season (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

Sandstone rough-barked apple is known to hybridise with *A. subvelutina* and *A. woodsiana*.

Distribution

Occurs in a band from around Glenreagh north-west of Coffs Harbour to the Coaldale area north-west of Grafton with an isolated occurrence farther west near Nymboida. It can be locally common (OEH profile).

Habitat and ecology

Dry open forest in sandy or skeletal soils on sandstone or occasionally granite with frequent outcrops of rock (OEH profile). During surveys for Roads and Maritime Jacobs (2014c) noted that *A. robur* was recorded on sandy slopes and ridges and to a lesser degree in some areas where sandy soils adjoined the edges of swamps drainage lines and floodplains in the localities of Pillar Valley Tucabia and Tyndale. *Angophora robur* was most abundant in elevated areas usually with deeper sandy soils and some rocky outcrops often replaced by *A. woodsiana* in higher elevated areas with skeletal soils..

Pre-construction surveys

Section 3

Geolink (2014a) identified an estimated 500+ individuals within an area to the north of Section 3 associated with areas of Dry Sclerophyll forest. Broad-leaved Apple *A. subvelutina* was also present and clear identification of species and hybrids was not possible.

Jacobs (2014c) undertook surveys in combination with herbarium determinations. A large proportion of hybrids were indicated.

Section 4

Geolink (2014b) recorded approximately 245 individuals within an area to the south of Section 4. associated with an area of Angophora Dry Sclerophyll forest.

Jacobs (2014) undertook surveys including herbarium determinations which indicated a large proportion of hybrids.

Translocation history

Angophoras are generally and reliably propagated from seed and establish easily. While rooted shoot cuttings can be used to propagate many eucalypts provided that cutting material is taken from young wood i.e. from seedlings or from young shoots from lignotubers (Ahuja 1993) information is not available for angophoras. Any attempts to propagate angophoras from cuttings would be experimental. As for eucalypts successful cutting propagation is likely to require a dry atmosphere propagation facility in order to avoid fungal disease.

Implications for translocation

Transplant of seedlings saplings or conceivably lignotubers of larger trees after felling of the trunk could be trialed but vegetative propagation from individuals confirmed as pure *A. robur* will be the only way to ensure that hybrids are not included in translocated plants.

Plant conservationists working in the field suspect that hybridization is threatening a large number of rare plants with extinction (Van Dyke 2008).

It appears that the project corridor passes through a hybrid zone between *A. robur* *A. subvelutina* and to a more limited extent *A. woodsiana*. The presence of hybrids poses difficulties for the design of a translocation that aims to improve the status of *A. robur*. Propagation from seed of an identified pure *A. robur* will not guarantee purity in the progeny as pollination from neighbouring trees of other species is likely. Planting of further hybrids is likely to exacerbate the threats to *A. robur*.

Other propagation methods may prove impractical as suitable wood from confirmed *A. robur* may not be available for cuttings. Transplant trials will be similarly difficult in terms of locating sufficient material that can be identified with confidence.

A better alternative to attempting to collect translocation material from the clearing corridor would be to augment an existing population with greater genetic purity. Such a population is present on the BOS site 25 at Mahogany Drive Pillar Valley. *Angophora robur* is extensive across this property. *Angophora subvelutina* is not recorded and *A. woodsiana* is present in apparently low abundance and fairly localized within the property. Jacobs (2014c) provides details of habitat preferences of the three species which would help to guide selection of habitats likely to support genetically pure *A. robur*. It is proposed that population augmentation at this site using seeds collected from the same property would produce a better outcome than translocation from and within a hybrid zone.

The Mahogany Drive property would benefit from assisted natural regeneration as much of the property has a history of logging. Gaps and disturbed areas are present and management would hasten recovery to the benefit of Sandstone rough-barked apple.

Singleton mint bush

(Section 6)

Scientific name: *Prostanthera cineolifera*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Description

Erect shrub 1 - 4 m high strongly aromatic; branches moderately to densely covered with short curled hairs and more or less sessile glands. Leaves more or less narrow-ovate 12 - 50 mm long 4 - 12 mm wide; apex obtuse; base cuneate to obtuse; margins entire; surfaces light green mostly hairless sparsely to densely hairy on midrib on lower surface densely glandular with more or less sessile glands. Flowers clustered at the ends of branches; bracteoles not persistent 1 - 2 mm long. Sepals 3 - 4 mm long; tube 2 - 2.5 mm long; upper lobe 1 - 2 mm long not enlarged in fruit. Petals 8 - 11 mm long pale mauve to dark purple-mauve darker in throat. The taxonomic status of this species is uncertain (OEH profile).

Distribution

Until recently regarded as restricted to only a few localities near Walcha Scone Cessnock and St Albans (OEH profile) but plants documented in the current project area have been confirmed as belonging to this taxon.

Habitat and ecology

Grows in open woodlands on exposed sandstone ridges.

Usually found in association with shallow or skeletal sands.

Fire response is unknown but other *Prostanthera* species are fire sensitive with recruitment occurring from the soil seed bank following a fire.

Life span is unknown but is expected to be in the vicinity of 10-20 years while the estimated minimum time to produce seed is approximately 3-4 years (OEH profile).

Probably flowers in spring with a period of six weeks for likely to be required for fruits to ripen (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

Pre-construction surveys

Section 6

Aecom (2014) found that Singleton Mintbush was confined to the banks of Tabbimoble Creek amongst stands of Paperbark Swamp Forest of the Coastal Lowlands of the North Coast. Approximately 200 individuals were recorded across two sub-populations found either side of the highway.

Jacobs (2014a) confirmed the location with no major changes.

Translocation history

Specific information is not available for Singleton mintbush but generalisations from closely related taxa are informative. Most Lamiaceae are notorious for producing mostly empty seeds. Cutting propagation should be relatively easy (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

Implications for translocation

Planting out of cutting propagated plants is predicted to be the most likely method for successful translocation. Seed collection should be undertaken if possible.

Slender Screw Fern

(Sections 6)

Scientific name: *Lindsaea incisa*

Conservation status in NSW: Endangered

Commonwealth status: Not listed 



Photo by Hugh Nicholson

Description

Slender screw-fern is a delicate-looking ground fern with a creeping underground root. The light-green fronds are slender up to 30 cm long and stand erect or tangled through other vegetation. Divided fan-shaped leaflets are spaced along the stems often in pairs. The leafless part of the stem is straw-coloured darker at the base and is much shorter than the frond length. The spores are produced under membranous flaps on the lobes of some of the leaflets (OEH profile).

Translocation could involve transplants from the field and/or propagation from spores. To collect spores for propagation place a mature frond in a folded sheet of paper and keep in a warm dry position for a few days (Jones and Clemesha 1989). The same reference provides details for germination and growing on (there are many other references and specialist nurseries or research institutions with necessary facilities must be engaged). These are general methods. No specific information for *Lindsaea* species is available.

Distribution

In NSW Slender screw fern is known only from a few locations between Woombah and just south of Coffs Harbour. Also occurs in north and south-east Queensland (OEH profile). The fern is fairly widely distributed though in restricted habitat being quite abundant around Glenreagh the south end of Yuraygir National Park and at Tucabia. There are scattered occurrences further north.

Habitat and ecology

Dry eucalypt forest on sandstone and moist shrubby eucalypt forest on metasediments. It is usually found in waterlogged or poorly drained sites along creeks where ferns sedges and shrubs grow thickly (OEH profile).

Although endangered individual populations can be very large with thousands of individuals growing amongst sedge- and grass-dominated communities close to creeks and gullies. As the species is small and grows amongst dense and taller rush and sedge communities it can be difficult to detect (Ecosure 2014). Roads and Maritime's EIS found that the species was readily detectable irrespective of season and reproductive status. Slender Screw Fern dies off during times of drought and re-grows following rain events.

Results of pre-construction surveys

Section 6

Aecom (2014) recorded twelve discrete sub-populations with an estimated population area of 0.37ha to be disturbed. The distribution of Slender Screw Fern was consistent with the results of previous assessments throughout the study area.

Jacobs (2014a) also recorded Slender screw fern within Section 6. However habitat conditions were not ideal for the species at Mororo State Forest until the end of the survey period (May 2014) with very few plants recorded in March 2014.

Translocation history

Background references suggest that members of the genus generally do not tolerate disturbance and are difficult to cultivate (Jones and Clemesha 1989). For the Tugun bypass (SMEC 2011) translocation was attempted for *Lindsea ensifolia* – 18 plants were salvaged and grown in nursery pots for an unspecified time. Of 15 plants planted out in 2005 none were surviving in 2011.

Ecos Environmental has however recently successfully translocated Slender Screw Fern. The translocation was conducted in a very wet period and it is too early to evaluate (Craig Harré OEH pers. comm. 8 August 2014). The methods are set out in Ecos Environmental (2010) with evidence of early expansion of some transplanted clumps provided in Benchmark (2013).

Implications for translocation

Clump/slab transplant in wet conditions is likely to produce good results on the basis of early results from recent trials.

Stinking Cryptocarya

(Section 10)

Scientific name: *Cryptocarya foetida*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable 



Photo Hugh Nicholson

Description

Stinking Cryptocarya is a small to medium-sized tree growing to 20 m tall with a dark green crown and brown slightly fissured bark. The leaves are oval-shaped with a bluntly pointed tip 5 – 12 cm long and 2 – 6 cm wide dark green on the upper surface and paler below. The main leaf vein is prominent yellow and characteristically crooked. The species is named from the offensive odour of the small creamy flowers which are borne in small clusters. The purplish to black fleshy globular fruits are about 1 cm in diameter and enclose a single round seed (OEH profile) Fruit ripe June to September or sometimes as late as November (Floyd 2008).

Distribution

Coastal south-east Queensland and north-east NSW south to Iluka (OEH profile).

Habitat and ecology

Found in littoral warm temperate and subtropical rainforest wet sclerophyll forest and Camphor laurel forest usually on sandy soils but mature trees are also known on basalt soils.

The seeds are readily dispersed by fruit-eating birds and seedlings and saplings have been recorded from other habitats where they are unlikely to develop to maturity.

Though seedlings can be fairly numerous few mature trees are known (OEH profile).

Pre-construction surveys

Section 10

Australian Museum Consulting (2014) found 47 individuals within the study area growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway and further south. 25 of these were juvenile species and therefore their identification was difficult to confirm. A conservative approach has been taken and they have been treated as *Cryptocarya foetida* for the purposes of estimating impacts to the species.

Translocation history

No information is available for transplant or cutting propagation. The plants are commonly and successfully grown from seed and included in rainforest plantings, however. As *Cryptocarya* species have been successfully grown from cuttings, trials are recommended using standard nursery procedures.

Implications for translocation

Seed propagation can be expected to be reliable and transplanting existing standing plants will be appropriate for salvage and to trial techniques.

A combination of planting of seed-propagated plants together with transplanted seedlings (pot up and grow on before planting out) and direct transplant of larger stems is proposed. If seeds cannot be collected in the required timeframe, cuttings should be trialled also in order to secure the genetic material and make best use of material trimmed from plants identified for direct transplant.

Tall knotweed

(Section 4)

Scientific name: *Persicaria elatior*

Conservation status in NSW: Vulnerable

Commonwealth status: Vulnerable



Photo by Glenn Leiper

Description

Tall knotweed is an erect herb to 90 cm tall with stalked glandular hairs (i.e. they are knobbed when seen under a lens) on most plant parts. Its leaves are up to 11 cm long and 30 mm wide. A sheath encircles the stem at the base of each leaf which is characteristic of its plant family. Its tiny flowers are in long narrow spikes to 5 cm long. The pink flower-segments are less than 4 mm long (OEH profile). Fruits are lenticular nuts 2-2.5 mm long (Wilson 1990).

Distribution

Tall knotweed has been recorded in south-eastern NSW - Mt Dromedary (an old record) Moruya State Forest near Turlinjah the Upper Avon River catchment north of Robertson Bermagui and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests) (OEH profile). The NSW Wildlife Atlas shows additional locations at Maclean near Wardell and in the Richmond Range. In Queensland Tall knotweed occurs in the Brisbane area and on South Stradbroke Island (SPRAT profile).

Habitat and ecology

This species normally grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (OEH profile). At a southeastern Queensland wetland Tall knotweed grows around the edge of *Melaleuca quinquenervia* communities but rarely inside these. It grows in association with dense communities of *Eleocharis equisetina* *Leersia hexandra* *Hemarthria uncinata* *Blechnum indicum* *Cyclosorus interruptus* *Cyperus exaltatus* *Juncus usitatus* *Echinochloa telmatophila* *Persicaria strigosa* *Persicaria orientalis* and *Persicaria attenuata* (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Tall knotweed appears to be a short-lived herbaceous species surviving for up to two years. It germinates readily from seed on bare ground that has been wetted by rain and will grow rapidly flower and set seed within six months of germinating. The plants have been observed to succumb quickly when dry conditions follow regular rain (Leiper 2008).

At an 8 ha wetland site in southeast Queensland Tall knotweed population numbers have been observed to fluctuate annually with annual counts of mature flowering plants ranging from single digit numbers to more than 100 (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Tall knotweed is relatively easy to grow from seed. It will also grow readily from cuttings. It will grow partially submerged in water (often poorly) but will not tolerate total inundation even for a short while. It appears to be highly intolerant of any hint of salinity (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Swamp Wallabies will eat new shoots of some plants (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Implications for translocation

The biological and ecological characteristics of Tall knotweed would appear to facilitate translocation from seed collection and/or cuttings and nursery propagation or transplant of clumps or slabs.

A range of observations (above and within RMS survey reports) indicate fluctuating populations of the plants consistent with soil storage of seed. It seems safe to assume that seed persists in and on the soil from one growing season to the next and it is possible that soil-stored seed retains viability for longer periods (cannot rely on this without further investigation).

Selection of a suitable receiving site in terms of hydrological regime will be critical and any doubt accommodated by spreading translocated plants across moisture gradients so that at least a proportion of the plants will be placed in optimal conditions.

An advantage of clump/slab transplant will be the transfer of soil-stored seed of Tall knotweed along with above-ground plant material. In addition plants and seeds of habitat species will be carried within the clumps though weeds will inevitably accompany.

Results of pre-construction surveys

Section 4

Geolink (2014b) recorded approximately 157 individuals within a number of areas of Paperbark swamp (dominated by *Melaleuca quinquenervia*) along the floodplain in proximity to Maclean.

During pre-construction surveys (Jacobs 2014a) small populations of this species were recorded both within and adjacent to the construction footprint at Yaegl NR and vicinity and South Arm.

Part of the occurrences were considered as part of the translocation strategy for Stage 1 Early Works Soft Soil Treatment Areas but some of the plants lie outside the Soft Soil impact zone and require consideration in the current strategy.

Translocation history

Leiper (2008) recounts personal experience of finding and then growing the plant from South Stradbroke Island in 1997 and then seeing it cultivated and used in revegetation projects on the island by Couran Cove Resort staff.

Implications for translocation

Translocation options are to propagate from seed or cuttings and/or to clump/slab transplant to include the transplant of soil likely to contain soil-stored seed. The season of works and seasonal conditions should guide the choice of methods all of which can be predicted to be successful assuming appropriate management.

Water nutgrass

(Section 6, 7)

Scientific name: *Cyperus aquatilis*

Conservation status in NSW: Endangered

Commonwealth status: Not listed 



Photo by Hugh Nicholson

Description

Sedge that appears as an annual during the wet summer period. It grows to 10 – 30 cm tall and has weak triangular stems. The leaves are 1 – 3 mm wide and shorter than the flowering stem. The flower- and seed-head is made up of several branches radiating from the top of the stem. Each branch has one to eight flattened spikelets 3 mm wide with 10 – 30 green flowers. The seeds are three-sided nuts whitish to pale brown (OEH profile).

Distribution

In NSW known only from a few sites north from Grafton. Also occurs in Queensland Northern Territory

Flora Translocation Strategy Sections 3-11

Woolgoolga to Ballina Pacific Highway upgrade Version 3 April 2017

Western Australia and New Guinea (OEH profile).

Habitat and ecology

Grows in ephemerally wet sites such as roadside ditches and seepage areas from small cliffs in sandstone areas (OEH profile).

Results of pre-construction surveys

The results of surveys illustrate the variable occurrence of Water nutgrass in space and time.

Section 6

Aecom (2014) recorded 8 sub-populations with a total population size of approximately 100 individuals noting differences in numbers and distribution from previous surveys.

Jacobs (2014a) did not record Water nutgrass despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period.

Section 7

Biosis (2014) recorded a number of individuals and small populations in drainage lines and periodically inundated areas encompassed by the study area.

Jacobs (2014a) did not record any previously known occurrences despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period.

Translocation history

Water nutgrass was translocated during the Tugun Bypass using soil seedbank translocation techniques incorporating smoke water and/or fertiliser treatments as well as untreated controls. The translocation was unsuccessful partly attributed to run-off impacts during construction as well as weed competition (SMEC 2011).

Implications for translocation

The transient nature of occurrences and difficulty of translocating into aquatic habitat indicate that alternative measures such as hydrological management will be preferred to translocation.

Weeping paperbark

Scientific name: *Melaleuca irbyana*

Conservation status in NSW: Endangered

Commonwealth status: Not listed 



Photos Hugh Nicholson

Description

Weeping Paperbark (formerly *Melaleuca tamariscina* subsp. *irbyana*) has thick spongy papery bark and grows to about 8 m tall. It has a dense rounded canopy of very fine weeping foliage. The tiny stalkless pointed leaves are less than 4 mm long smaller than any other NSW *Melaleuca* species and are pressed close to the branchlets wrapping around them slightly. In summer profuse white brushes made up of groups of flowers in threes appear and are followed by tight clusters of woody fruits (OEH profile). Seeds are retained in capsules.

Distribution

Found in only a few places in north-east NSW including near Coraki Casino and Coutts Crossing south of Grafton. Also occurs in near Ipswich in south-east Queensland. Only two populations are recorded in conservation reserves in NSW these are Warragai Creek Nature Reserve and Bungawalbin National Park (OEH profile).

Habitat and ecology

Open eucalypt forest in poorly drained usually clay sandstone or alluvial soils (OEH profile).

Pre-construction surveys

Section 7

Biosis (2014) recorded one relatively large population within the study area just south of the New Italy Rest Area.

Jacobs (2014a) confirmed the record.

Translocation history

A planting project for Weeping paperbark has been in progress at Tucabia. Plants propagated from seed have established and developed successfully.

Implications for translocation

As the species can be grown easily from seed and reaches maturity relatively quickly seed propagation and planting out of nursery-grown stock is preferred to transplant of trees and saplings.

White laceflower

(Section 10)

Scientific name: *Archidendron hendersonii*

Conservation status in NSW: Vulnerable

Commonwealth status: Not listed 



Photo by Hugh Nicholson

Description

White laceflower is a tree to 18 m tall with light-brown bark. Its leaves are divided twice into glossy hairless leaflets separated unequally by the midvein. Up to ten fragrant fluffy creamy-white flowers are bunched in heads. Woody orange pods develop splitting and curling to reveal glossy black seeds displayed against the red or yellow interior of the pod (OEH profile). Fruit ripe June to January (Floyd 2008).

Distribution

From north Queensland south to the Richmond River in north-east NSW (OEH profile).

Habitat and ecology

White laceflower occurs in riverine and lowland subtropical rainforest littoral rainforest coastal cypress pine forest and their ecotones.

It is found on a variety of soils including coastal sands and those derived from basalt and metasediments (OEH profile).

Although White laceflower flowers and fruits well it is often represented by only single trees per stand and seedlings are rare (Scientific Committee's determination).

Pre-construction surveys

Section 10

Australian Museum Consulting (2014) found 15 individuals of White laceflower growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway and further south.

Translocation history

White laceflower is grown in nurseries and regularly included in rainforest restoration plantings. Seed germinates rapidly but seedlings in pots grow poorly. (Nicholson and Nicholson 2000).

Implications for translocation


If seed can be collected nursery grown seedlings should be planted into suitable rainforest regrowth habitat. Cuttings and transplant of saplings and trees should be trialled.

Yellow-flowered king of the fairies

(Section 8)

Scientific name: *Oberonia complanata*

Conservation status in NSW: Endangered

Commonwealth status: Not listed 



Description

Yellow-flowered king of the fairies is a small orchid which grows on trees or rocks. Each plant possesses one to many shoots in a tight iris-like clump. There are 3-8 leaves per shoot. The leaves are spear- to oblong-shaped 3-15 cm long 10-15 mm wide and yellow-green in colour. About 150 to 300 tiny cream to yellowish flowers are borne on erect to drooping stems up to 20 cm long in spring and summer (OEH profile).

Distribution

Within NSW there are several historical collections (all pre 1917) of this species from Byron Bay and Lismore and a collection from Coffs Harbour from 1961. More recent observations of this species have been made from Lismore and Wollumbin (OEH profile).

Habitat and ecology

This species grows on trees and rocks in littoral rainforest subtropical rainforest dry rainforest wet or dry eucalypt forests dunes (including stabilised sands) stream-side areas swampy forests and mangroves (OEH profile). Jones (1993) notes its tolerance of a wide range of exposure from almost complete shade to very exposed sunny positions on trees and rocks. Melaleuca Group (2014b) provide detail of the habitat at the current donor site described as degraded Swamp oak forest.

Preconstruction surveys

Section 8

Melaleuca Group (2014b) identified in clumps of orchids on the southern side of three senescent swamp oak trees a total 26 individuals.

Jacobs (2014a) described the occurrence as a total of 22 individuals observed in a range of age classes.

Translocation history

Jones (1993) notes that Oberonias are generally easy to grow and can be long living in cultivation. Roots are very fine and rot easily if overwatered or smothered by a potting mix that is not sufficiently coarse. Plants can be grown in pots but better growth is achieved on treefern etc. hung in cool humid conditions where there is free air movement.

Implications for translocation

The relative ease of growing Oberonias in cultivation suggests that relocation of plants to new host trees is likely to be successful.

In view of the very small numbers of plants known to exist in NSW, additional tasks to enable seed banking propagation and further development of a translocation plan are set out by Melaleuca Group (2014b). The additional tasks include:

- investigations of the lifecycle of this species
- Liaison with OEH in regard to the Save Our Species (SOS) program for this species.

Appendix 4 Site summary

Section	Northing	Site/species	Clearing area		Project area (outside clearing)		Receiving site
			No individuals	Area (ha)	No individuals	Area (ha)	
3	6708552	Coldstream River crossing					
		Maundia				0.07	
3	6709031	8 Mile Lane, west of Wooli					
		Sandstone rough-barked apple	301	4.051523	96	1.589077	
3	6711960	Mitchell Rd intersection					
		Hairy-joint grass	1				
		Sandstone rough-barked apple	1591	1.2412	362	22.367	
3	6715223	Chaffin, south side					
		Sandstone rough-barked apple	495	4.5446	445	2.5267	
3	6717623	Tucabia-south of Bostock					
		Sandstone rough-barked apple	369	5.7881	281	3.6961	
3	6718866	Tucabia-north of Bostock					
		Sandstone rough-barked apple	244	3.0427	41	1.3365	
		Slender screw fern			1	0.007	
3	6721564	Tucabia-north of Tallowwood					
		Four-tailed Grevillea	1	0.0078	53	0.0555	
		Maundia	3	0.0266		0.0855	
		Sandstone rough-barked apple	982	0.0266	264	19.3086	
3	6723624	Pine Brush SF					
		Four-tailed Grevillea	2	0.0126	2	0.0011	
		Sandstone rough-barked apple	124	1.9597	48	1.5497	
		Slender screw fern			1		
3	6727462	Tucabia Rd, north Pine Brush					
		Sandstone rough-barked apple		1.5966		20.5222	
3	6727023	Tyndale, south Bensons Lane					
		Sandstone rough-barked apple	1533	1.8518	926	20.1941	
4	6730163	West Wooli Rd					
		Sandstone rough-barked apple	775	11.2665	68	1.7306	

Section	Northing	Site/species	Clearing area		Project area (outside clearing)		Receiving site
			No individuals	Area (ha)	No individuals	Area (ha)	
4	6738700	South Arm south					
		Tall knotweed			157	0.4712	
4	6739200	South Arm north					
		Tall knotweed	31	0.0874	37	0.0418	
4	6739996	Maclean interchange					
		Green-leaved rose walnut			1		
		Tall knotweed	8	0.047	9	0.0063	
4	6742120	Yaegl south					
		Tall knotweed	1	0.00049	11	0.02051	
4	6742600	Yaegl central					
		Tall knotweed	2	0.013	2	0.127	
4	6743300	Yaegl north					
		Tall knotweed	9	0.02	137	0.026	
6	6754230	Mororo south					
		Water nutgrass	10				
6	6755866	Mororo SF					
		Slender screw fern	6295	0.3701	213	0.0176	
		Water nutgrass	55				
6	6757130	Mororo north					
		Water nutgrass	20				
6	6758083	Tabbimoble Ck					
		Singleton mint bush	609	0.4238	62	0.4387	
		Water nutgrass	11				
6	6759117	Tullymorgan Jackybulbin Rd					
		Rotala			2		
		Water nutgrass	17				
7	6766115	Tabbimoble Overflow 2					
		Maundia	4	0.0139	6	0.0386	
7	6768274	Tabbimoble Overflow					
		McFaydon Rd					
		Water nutgrass	5				

Section	Northing	Site/species	Clearing area		Project area (outside clearing)		Receiving site
			No individuals	Area (ha)	No individuals	Area (ha)	
7	6769590	Tabbimoble Overflow south					
		Water nutgrass	2				
7	6769996	Tabbimoble Overflow north					
		Maundia	5	0.0154		0	
7	6773010	Doubleduke					
		Water nutgrass	1				
7	6774778	New Italy south					
		Weeping paperbark	1721	2.7611		0.0019	
7	6775379	New Italy central					
		Maundia	6	0.0028	2	0	
7	6775743	New Italy north					
		Maundia	2	0.0049		0	
8	6781563	Trustums Hill					
		Hairy-joint grass			2	0.2726	
8	6783155	Woodburn, north Evans Hd Rd					
		Yellow-flowered king of the fairies	18	0.0326		0	
8	6785073	Woodburn, Lang Hill					
		Rough-shelled bush nut			1		
		Whalebone tree			3		
10	6798430	Wardell Rd					
		Whalebone tree	1				
10	6799844	Lumleys Lane, Coolgardie					
		Hairy-joint grass	20	0.32		0	
10	6799694	east of Lumleys Lane					
		White laceflower	1		2		
		Stinking Cryptocarya	1				
		Green-leaved rose walnut	1		1		
		Whalebone tree	3		1		
		Red lilly pilli	2				
10	6799766	Coolgardie, west of Kays Rd					

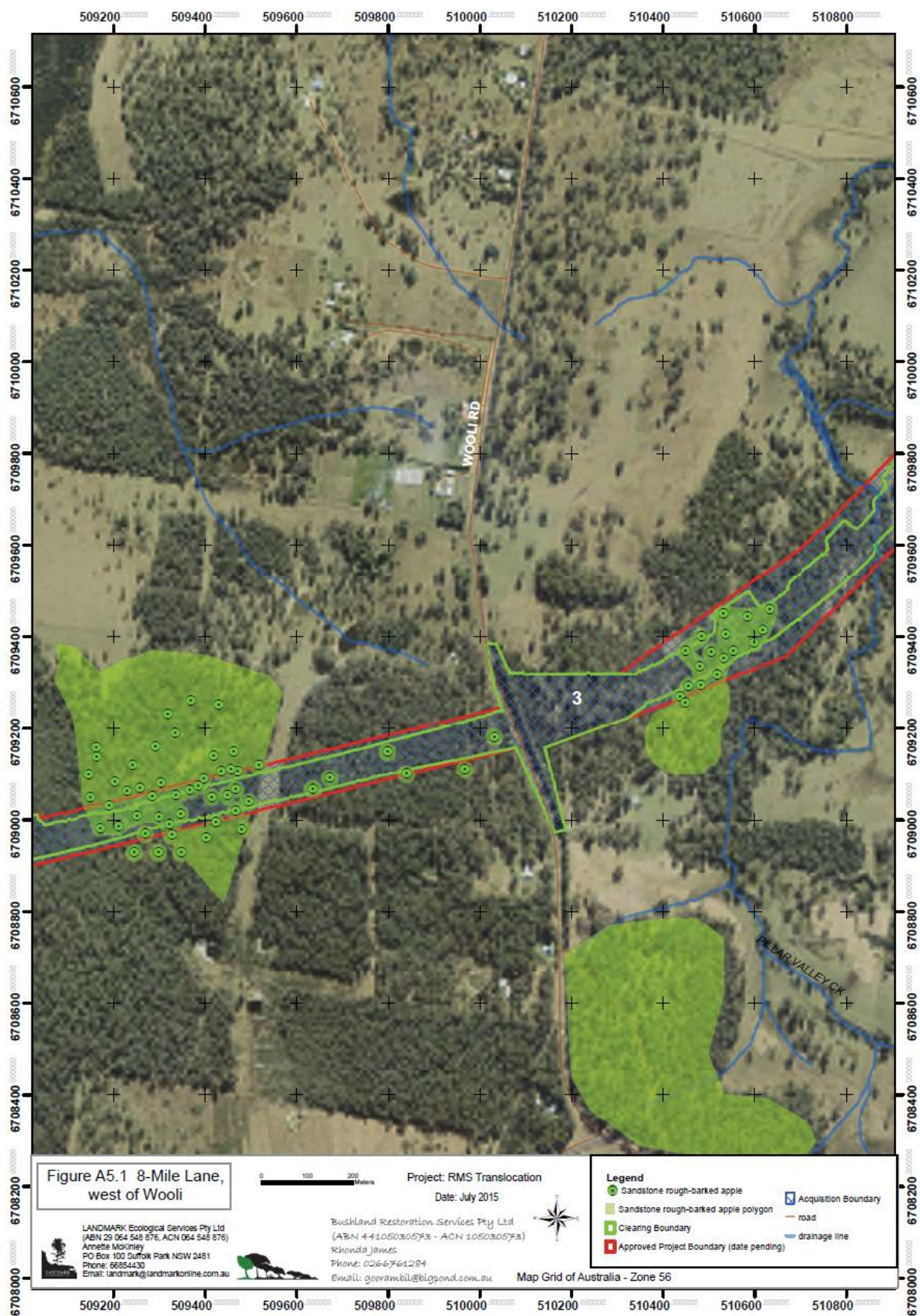
Section	Northing	Site/species	Clearing area		Project area (outside clearing)		Receiving site
			No individuals	Area (ha)	No individuals	Area (ha)	
10	6800011	Hairy-joint grass					
		Garden Place					
		Hairy-joint grass	8	0.1685	12	0.3515	
10	6800421	south Coolgardie Rd					
		Hairy-joint grass	313	0.7126	23	0.1874	
10	6801032	Davidsons Plum			1		
		Coolgardie, north of Coolgardie Rd					
		Hairy-joint grass	1	0.04	5	0	
		Rough-shelled bush nut	10		3		
		Whalebone tree			1		
10	6800954	west of Pimlico Rd					
		White laceflower			8		
		Hairy-joint grass	5	0.03	16	0.1768	
		Stinking Cryptocarya	40		2		
		Green-leaved rose walnut	2		15		
		Red lilly pilli	4		4		
11	6801662	south of Laws Rd					
		Whalebone tree			1		

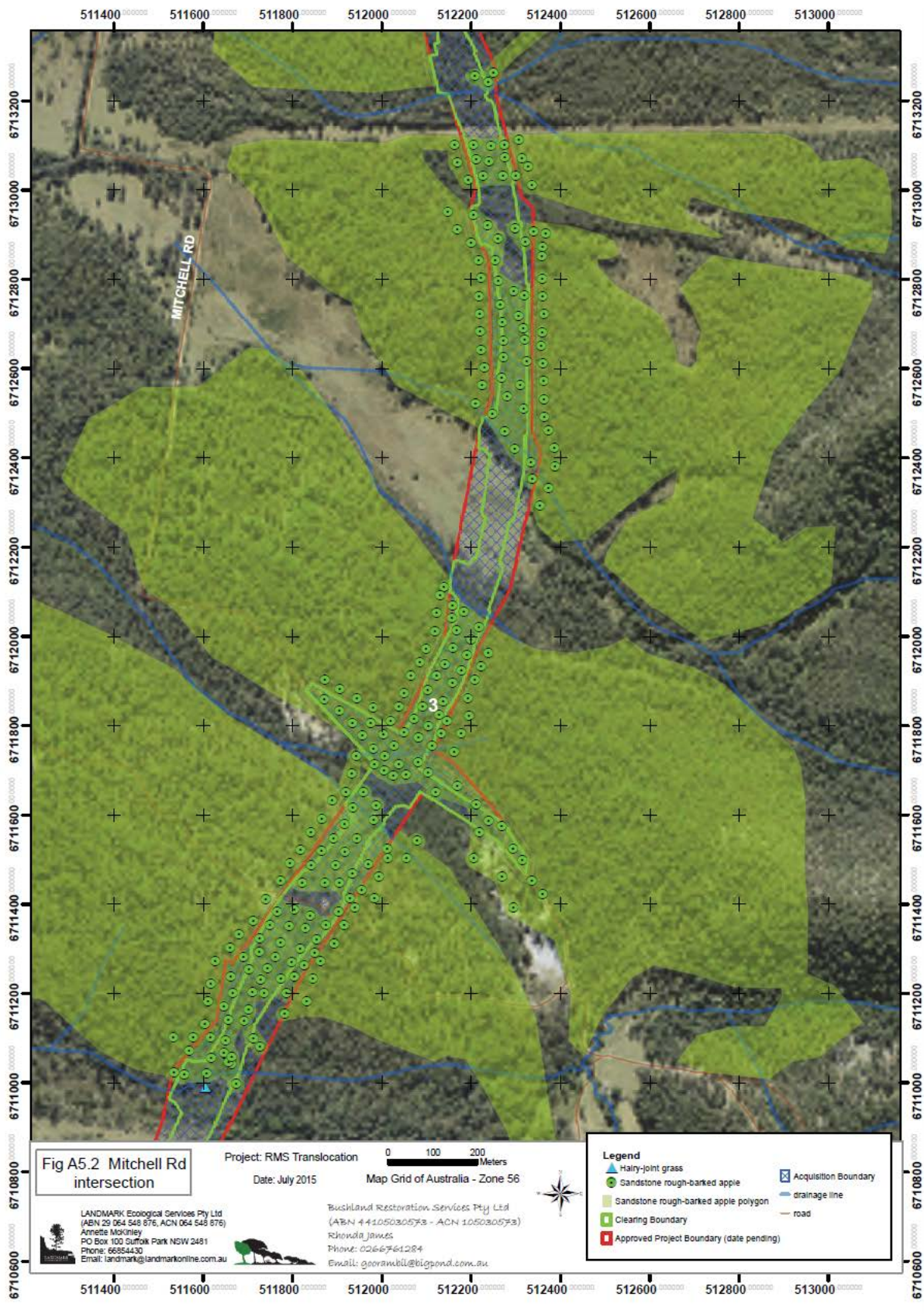
Appendix 5 Maps of donor and receiving sites

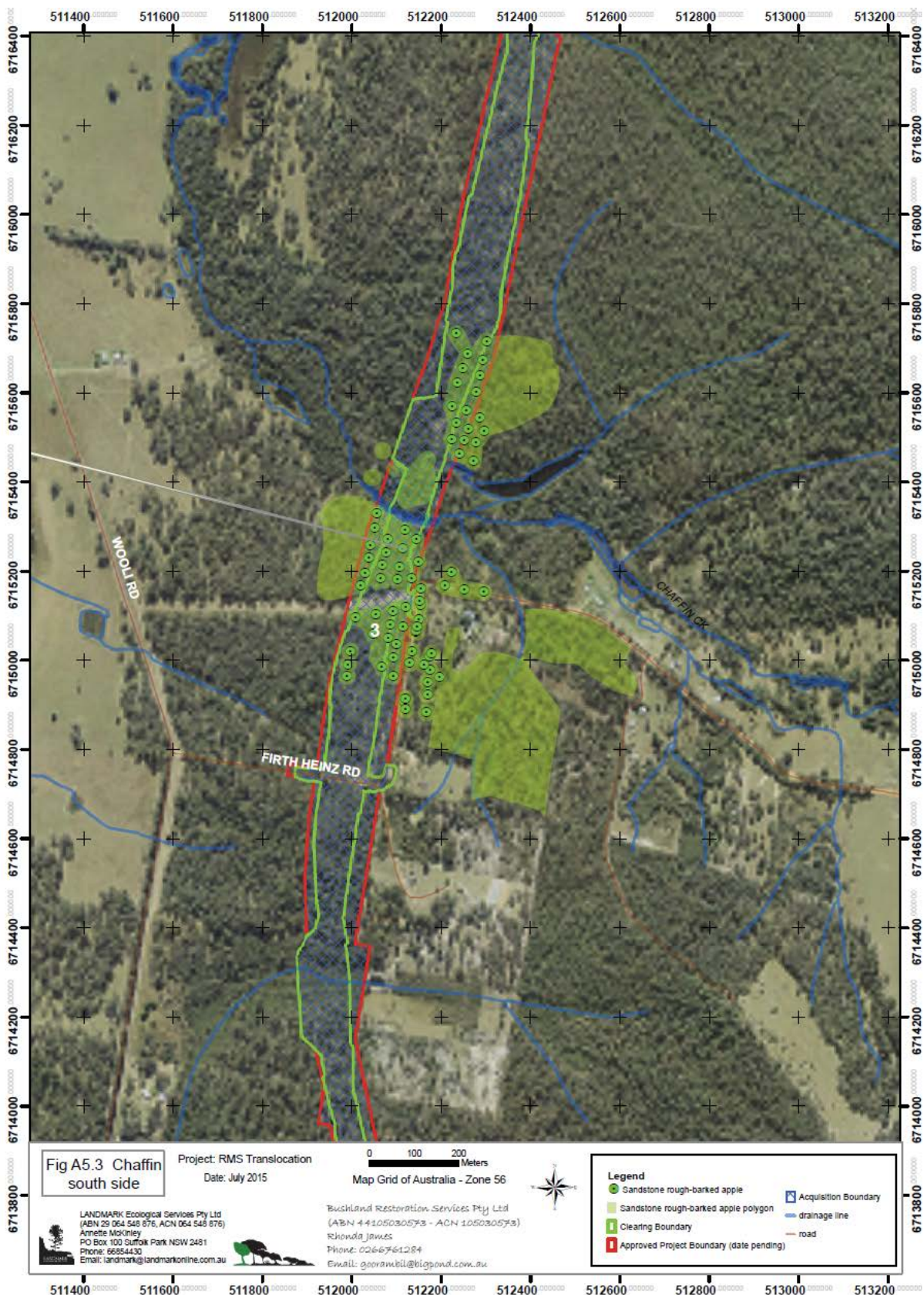
Maps illustrate the occurrence of specimens (represented by points or polygons) to be directly impacted by the project i.e. within the clearing boundary. Whalebone tree/Siah's backbone and additional specimens located within the project boundary but outside the clearing boundary are shown only when they are included in the map view. Receiving sites located in the vicinity of the route are also shown (receiving sites beyond map view of the route are indicated by map or description in Appendix 6).

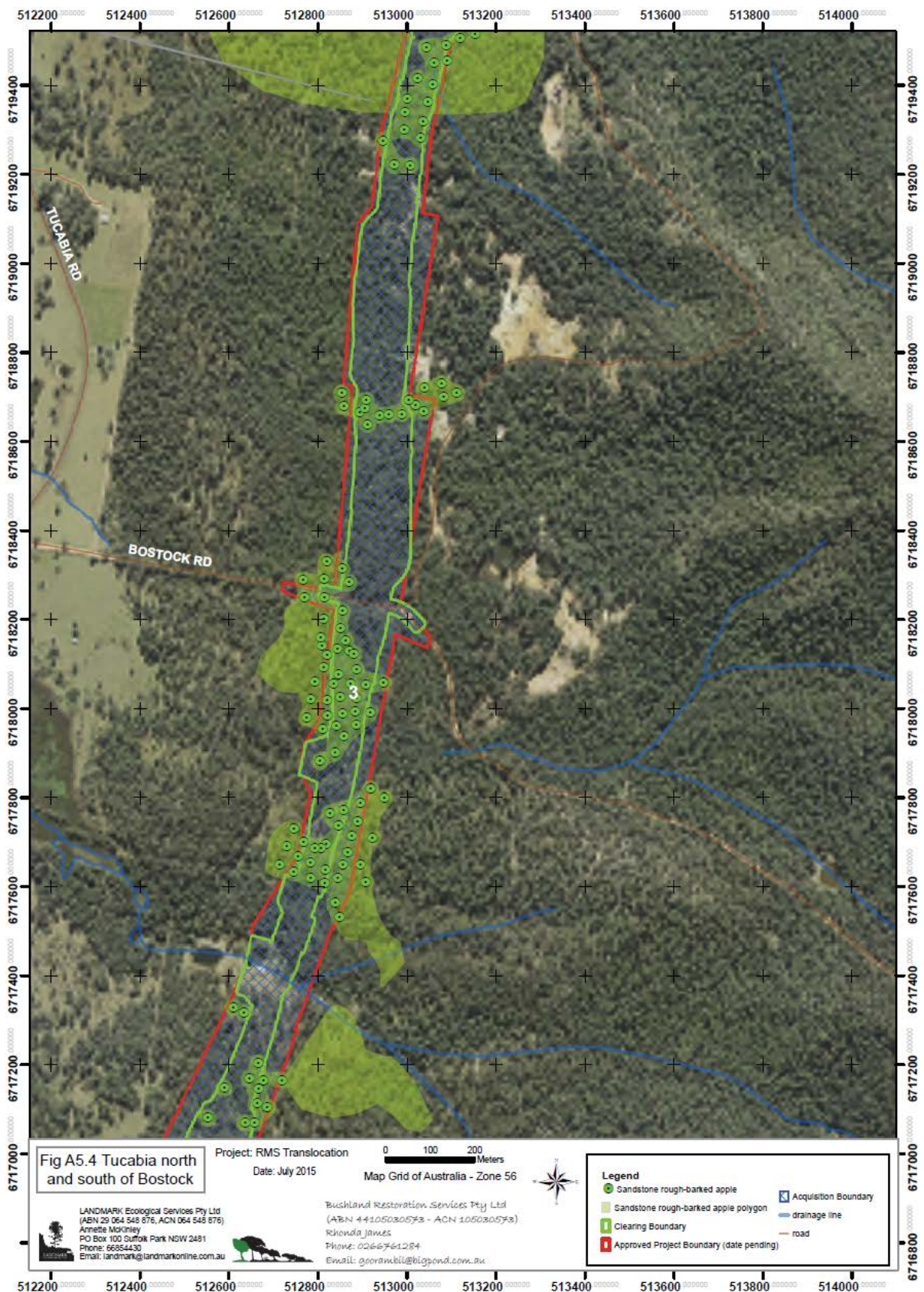
Maps are arranged south to north. * = some plants included in Early Works Soft Soils Treatment Areas Strategy

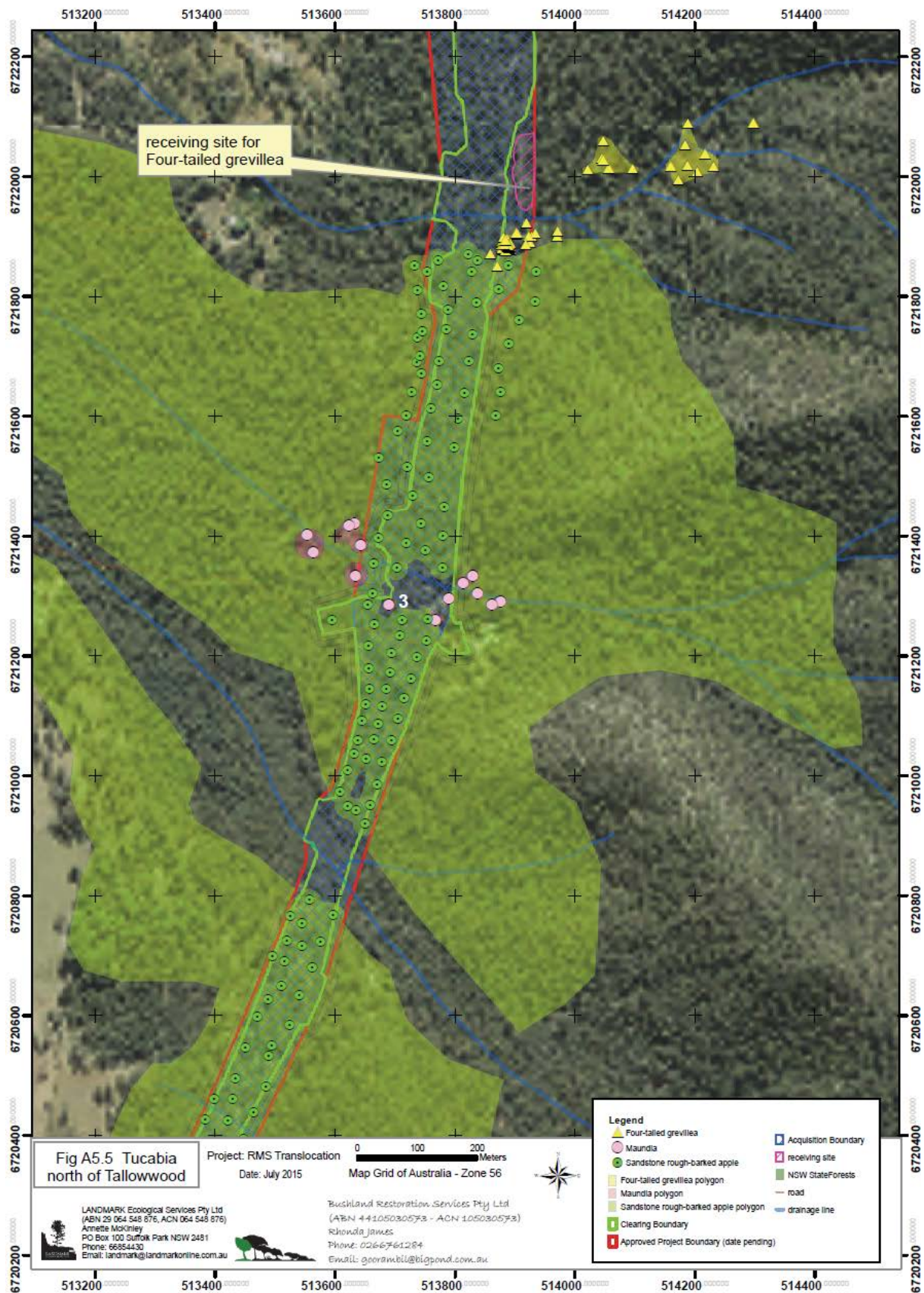
Map no and site name	Donor site	Donor species	Receiving site	Candidate species for receiving site	Other species (not to be translocated or outside clearing boundary)
A5.1	8-Mile Lane, west of Wooli				Sandstone rough-barked apple
A5.2	Mitchell Rd intersection	yes			Sandstone rough-barked apple
A5.3	Chaffin south side				Sandstone rough-barked apple
A5.4	Tucabia north & south Bostock				Sandstone rough-barked apple
A5.5	Tucabia north of Tallowwood	yes	Four-tailed Grevillea	yes	Four-tailed Grevillea
A5.6	Pine Brush SF	yes	Four-tailed Grevillea	yes	Four-tailed Grevillea
A5.7	Tyndale, sth Bensons				Sandstone rough-barked apple
A5.8	West Wooli Rd				Sandstone rough-barked apple
A5.9	South Arm north*	yes	Tall knotweed		
A5.10	Maclean Interchange*	yes	Tall knotweed		
A5.11	Yaegl central and south*	yes	Tall knotweed	yes	Tall knotweed
A5.12	Yaegl north*	yes	Tall knotweed		
A5.13	Mororo south				Water nutgrass
A5.14	Mororo SF	yes	Slender screw fern	yes	Slender screw fern
A5.15	Tabbimoble Ck & Mororo north	yes	Singleton mintbush	yes	Singleton mintbush, Weeping paperbark
A5.16	Tullymorgan-Jackybulbin				Water nutgrass, Rotala
A5.17	Tabbimoble overflow 2				Maundia
A5.18	Tabbimoble overflow McFaydon Rd				Water nutgrass
A5.19	Tabbimoble overflow north and south				Water nutgrass, Maundia
A5.20	Doubleduke				Water nutgrass
A5.21	New Italy, north & south	yes	Weeping paperbark		Maundia
A5.22	Woodburn, north Evans Head Rd	yes	Yellow-flowered king of the fairies		
A5.23	Lumleys Rd, Coolgardie	yes	Hairy joint-grass	yes	Hairy joint-grass
A5.24	east of Lumleys Lane	yes	Green-leaved rose walnut, Red lilly pilly, White laceflower, Stinking Cryptocarya		
A5.25	Garden Place	yes	Hairy joint-grass		Davidsons plum
A5.26	North and South Coolgardie Rd	yes	Hairy joint-grass, Rough-shelled bushnut	yes	Hairy joint-grass
A5.27	west of Pimlico Rd	yes	Hairy joint-grass, Stinking Cryptocarya, Green-leaved rose walnut		Red lilly pilly, White laceflower

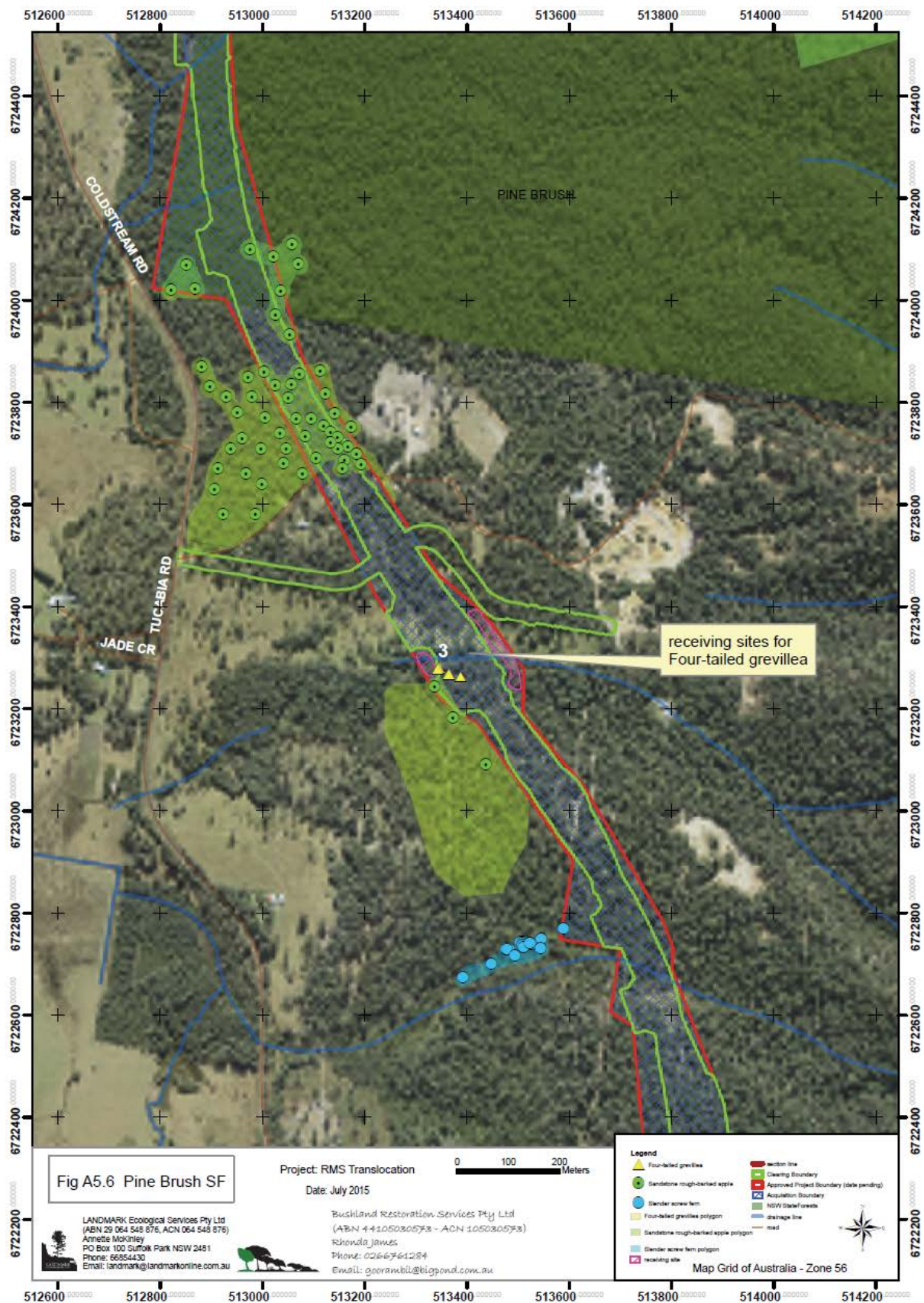


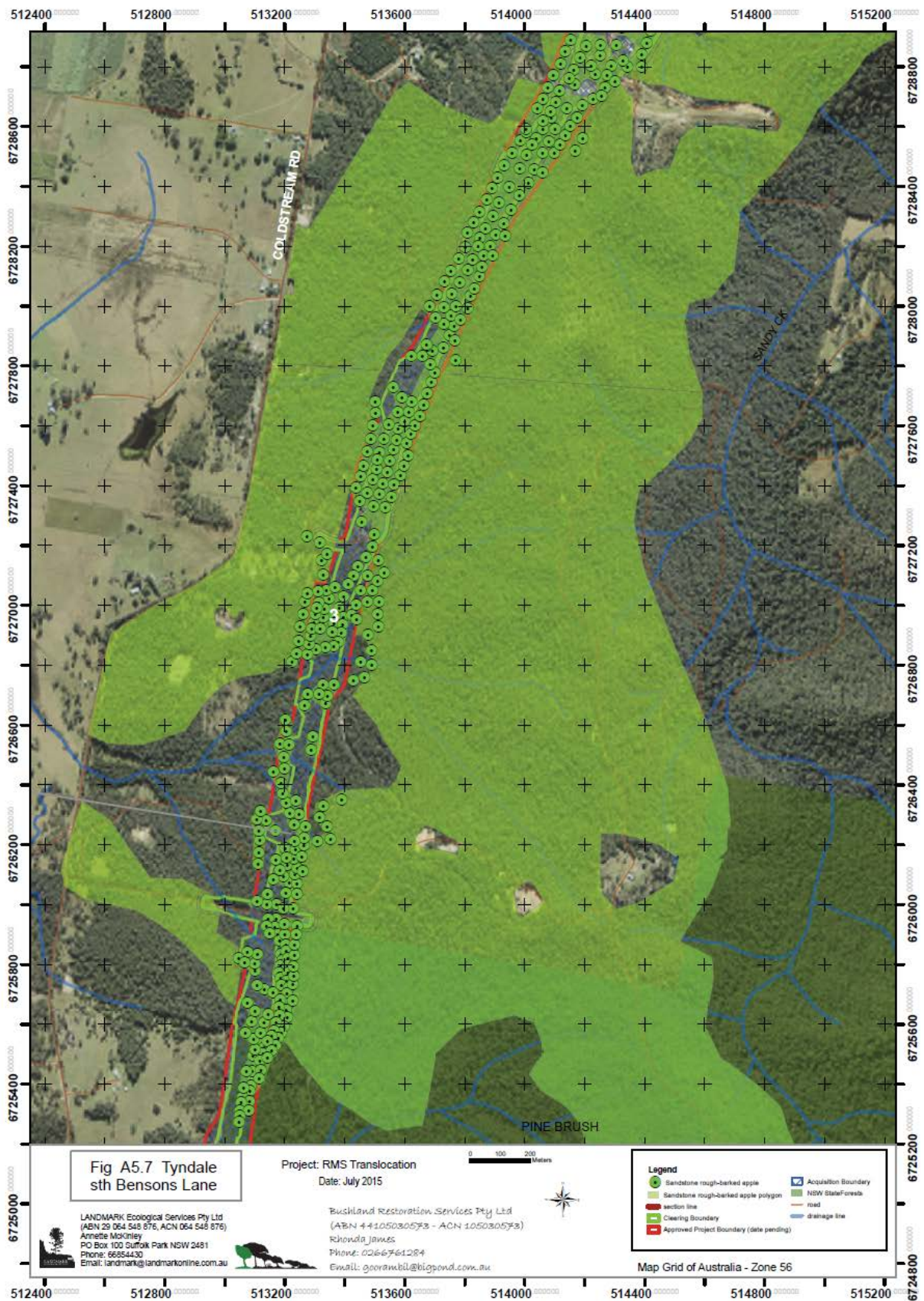


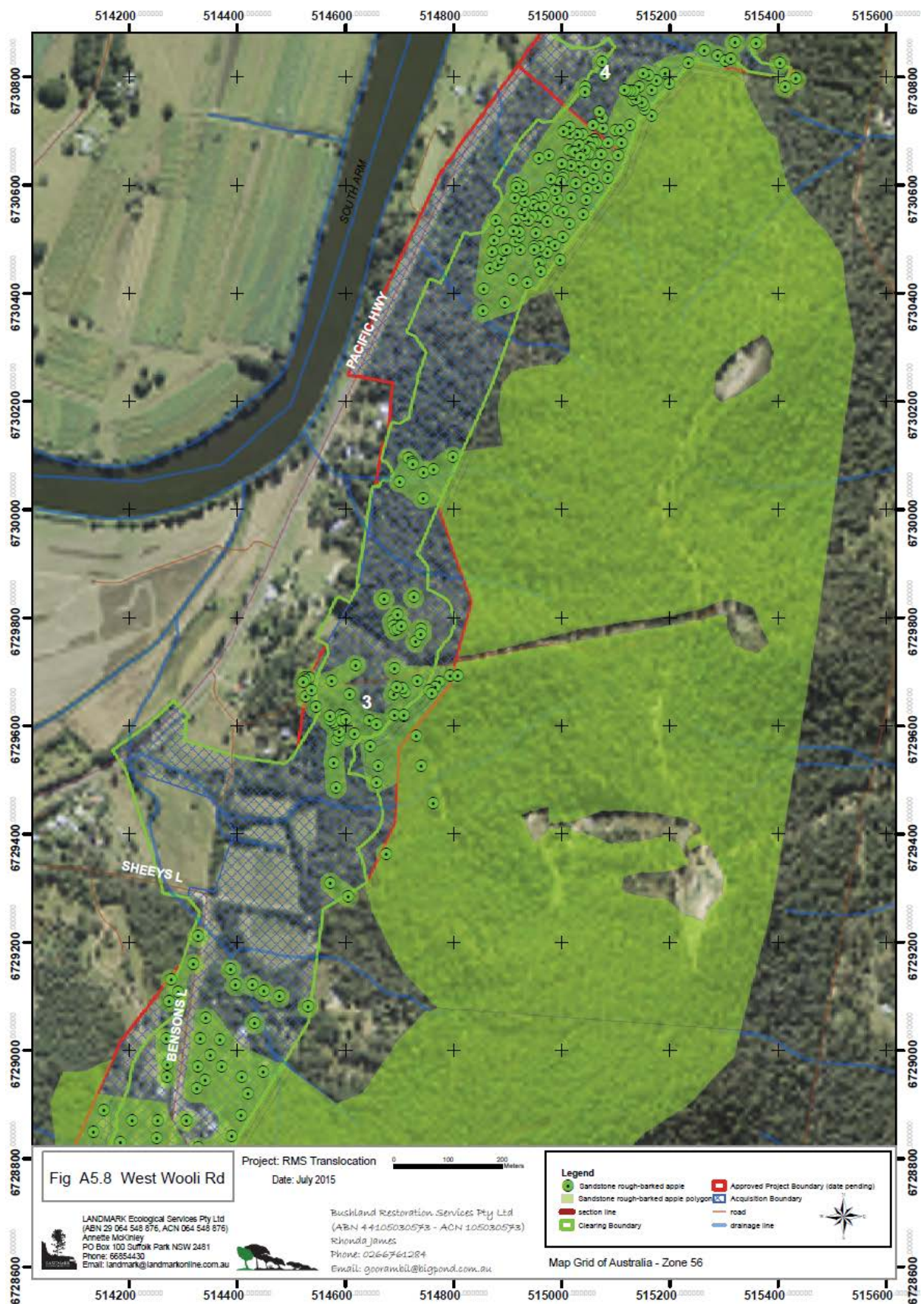


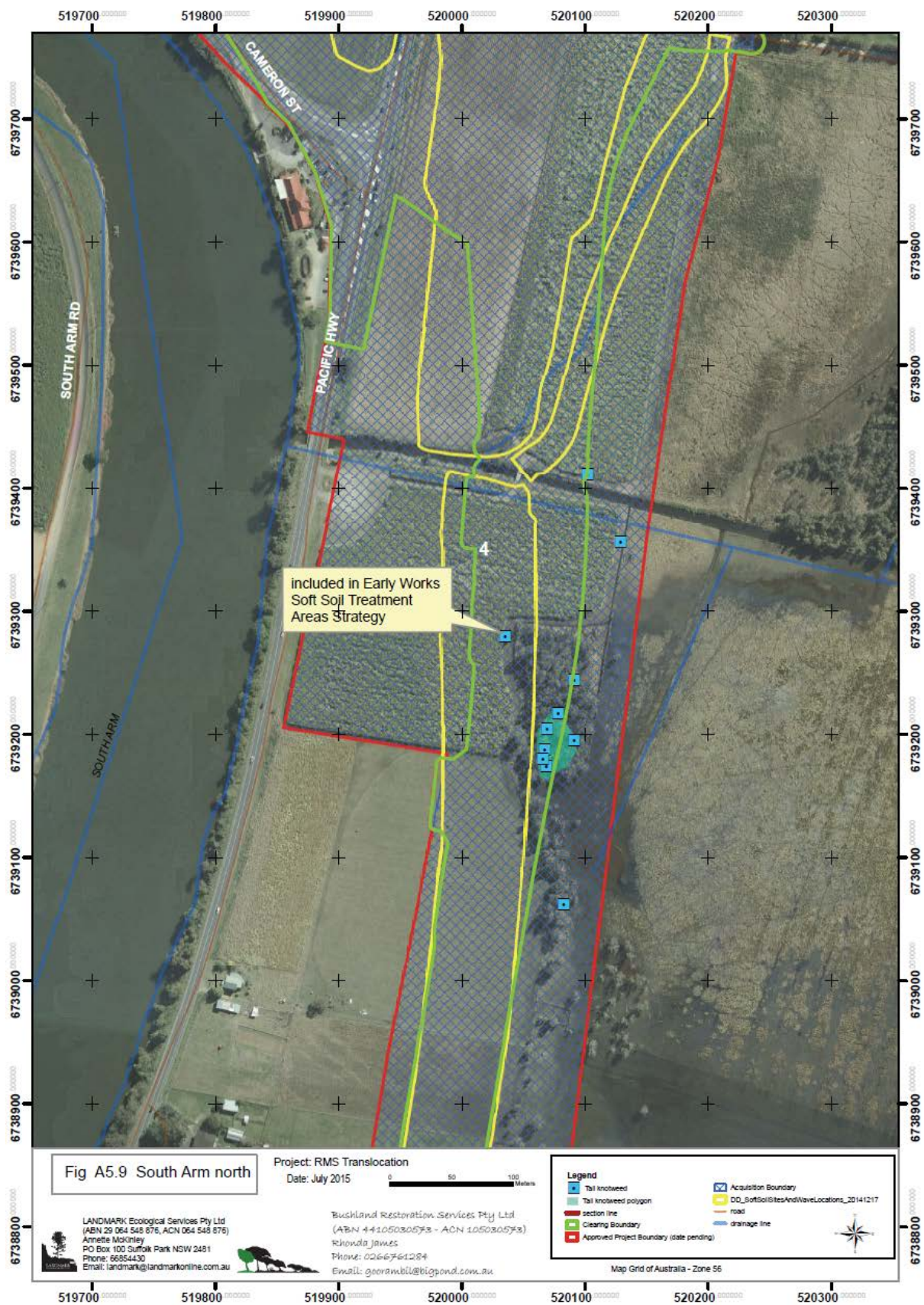


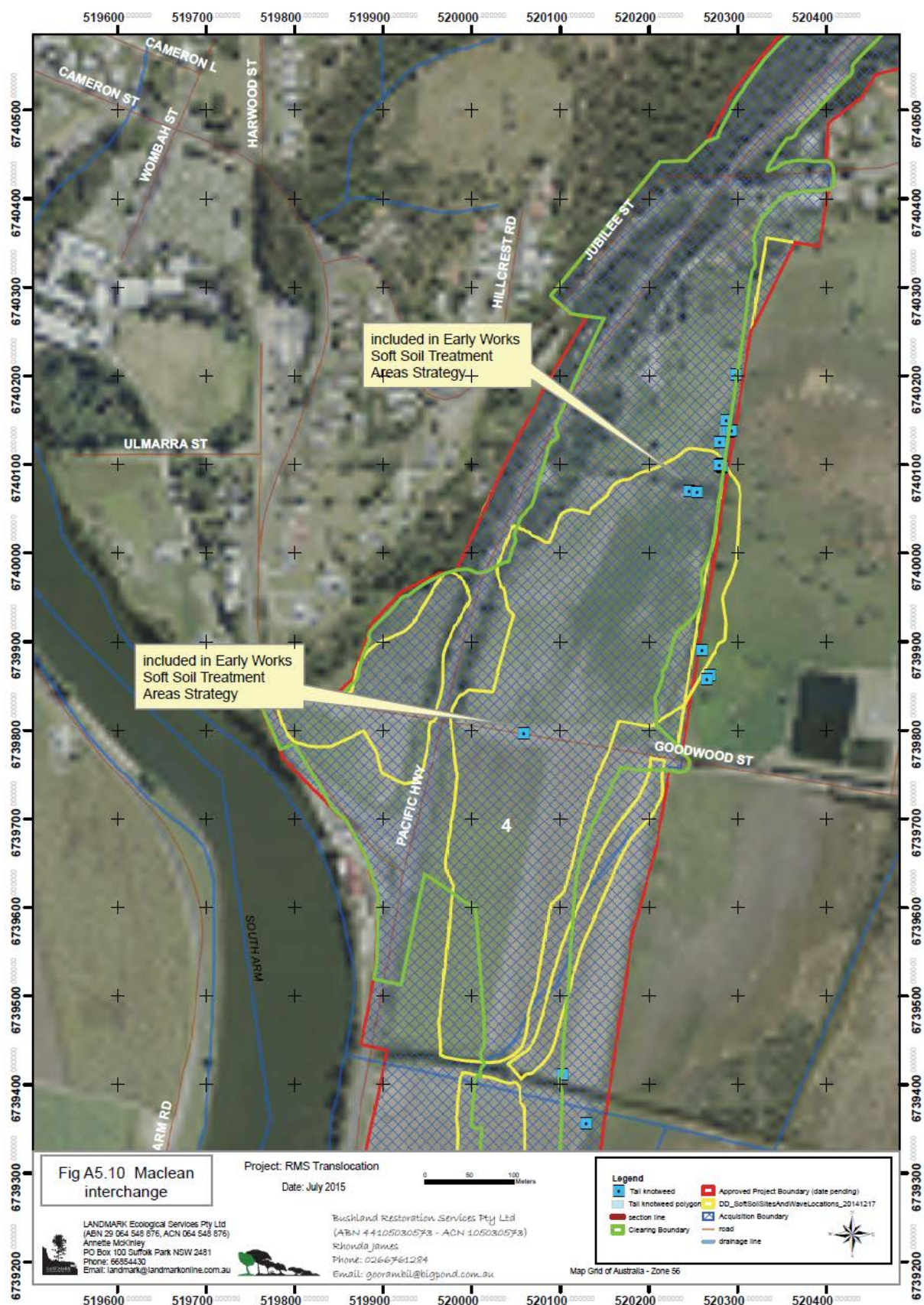


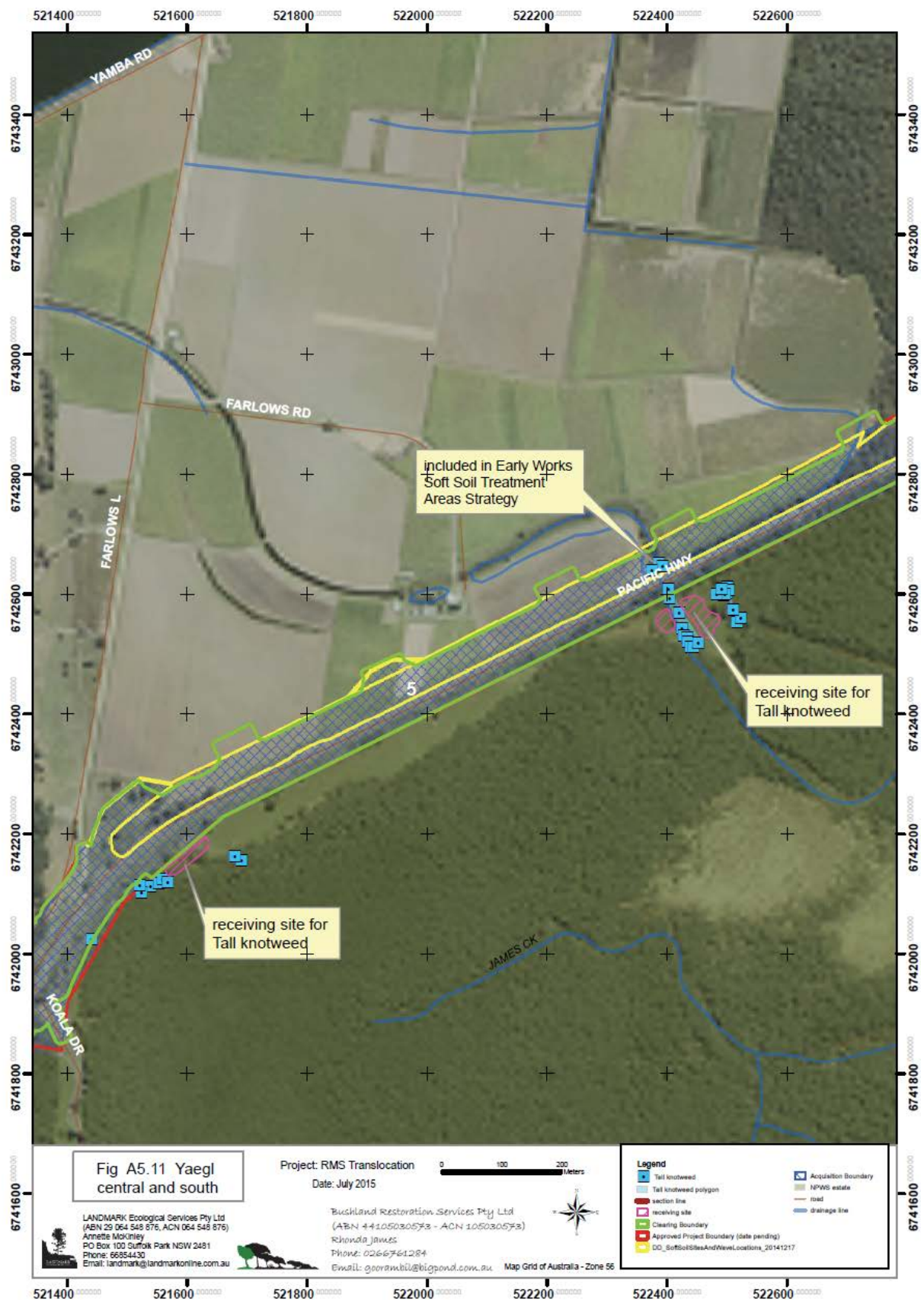


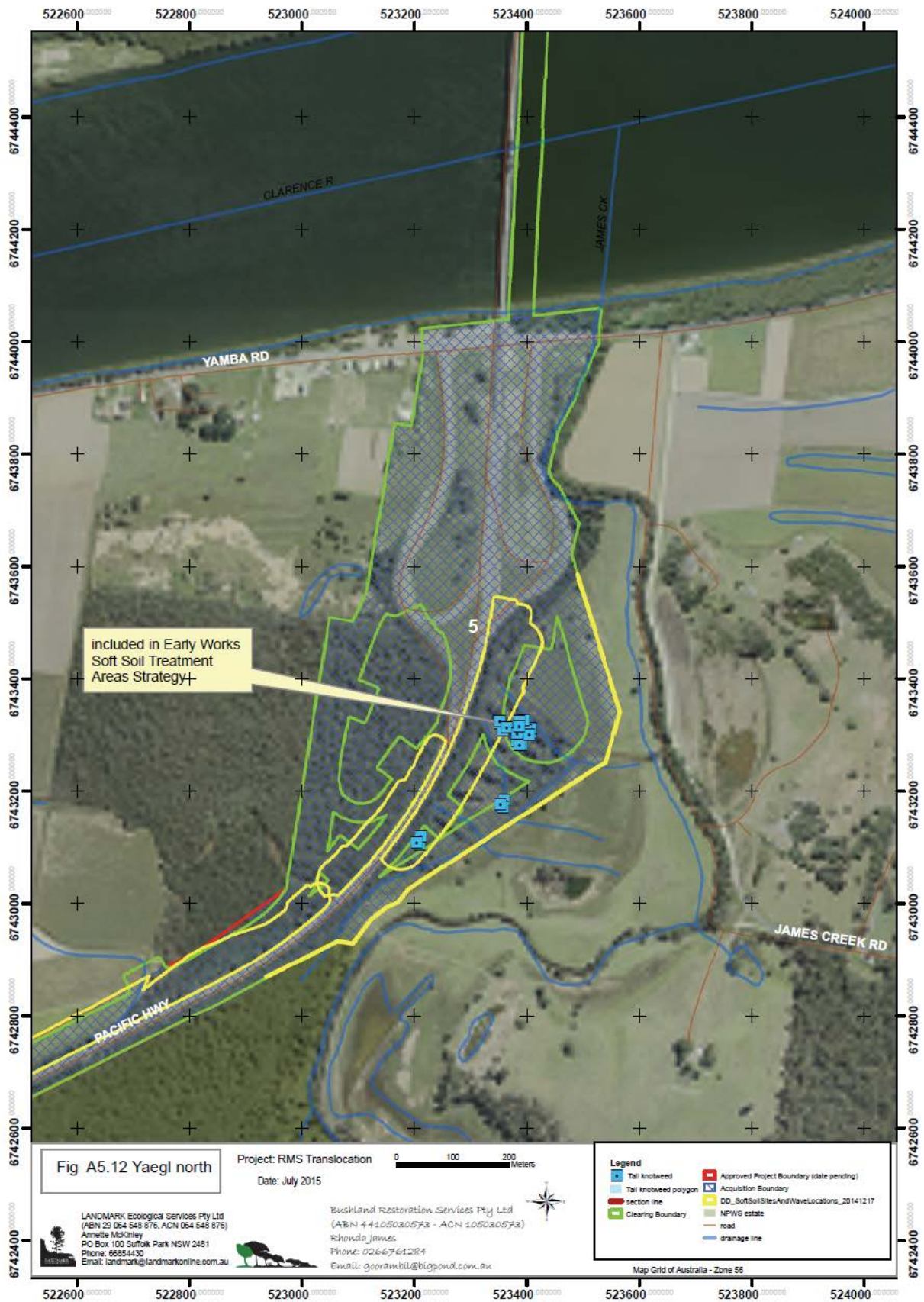


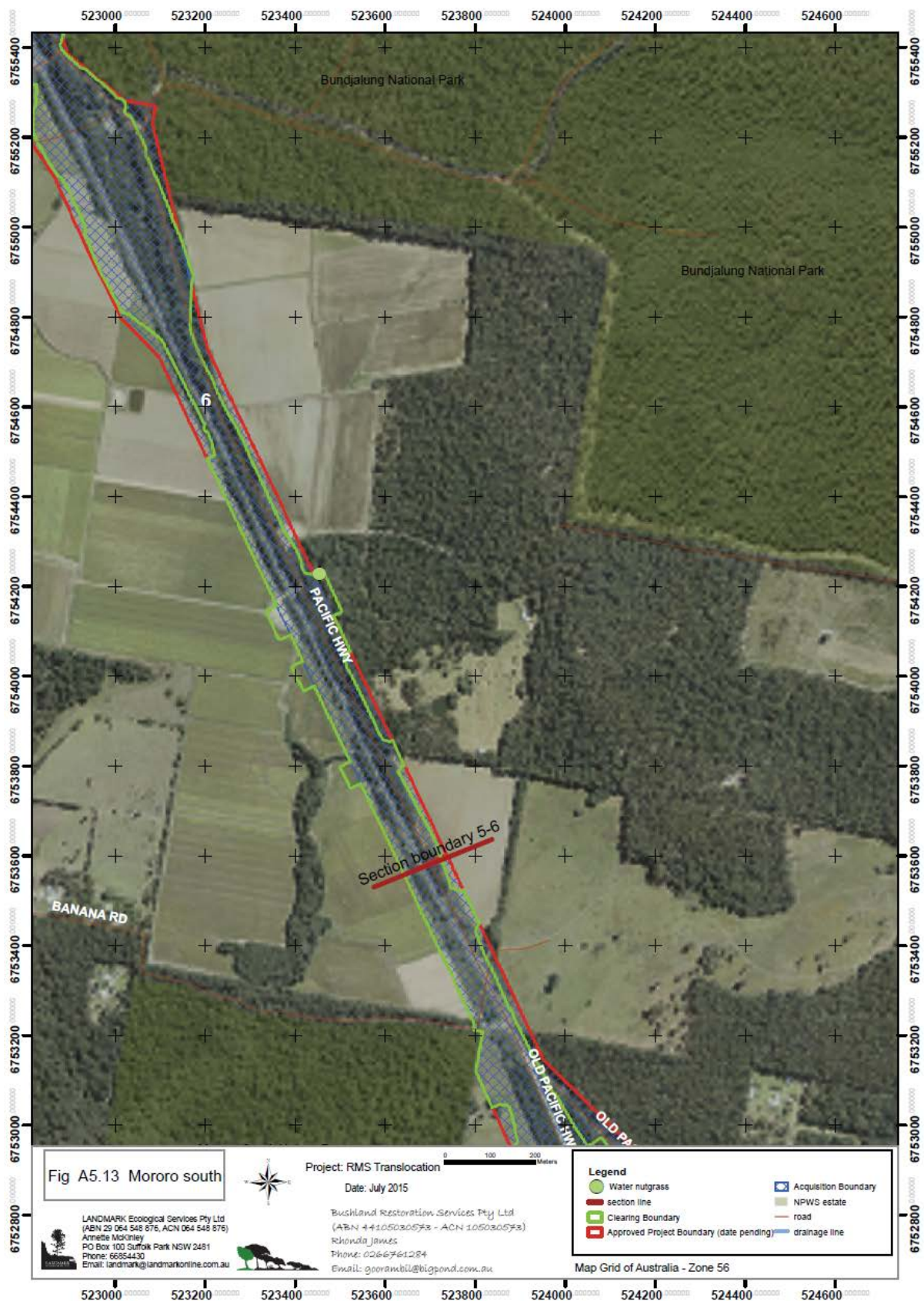


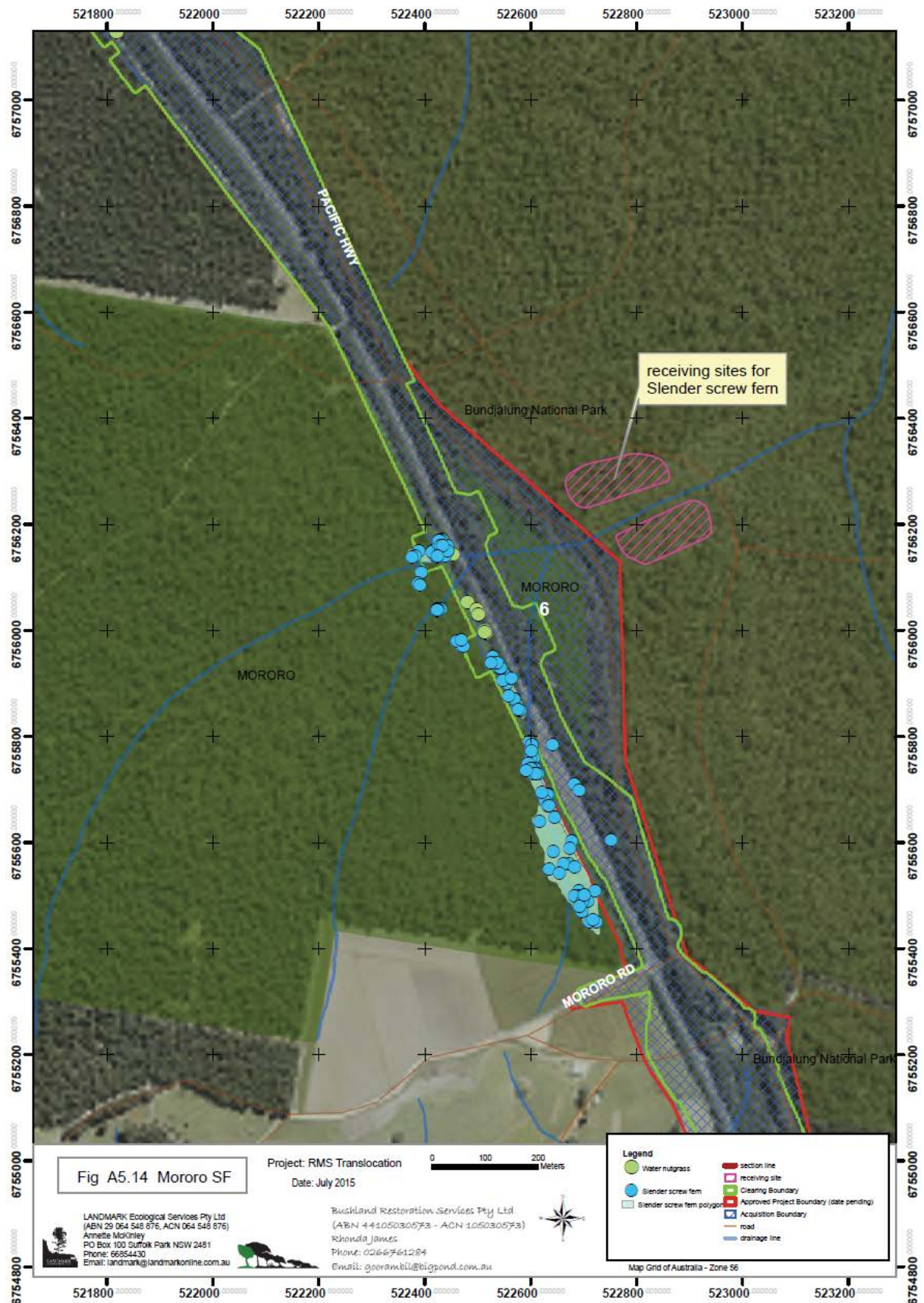


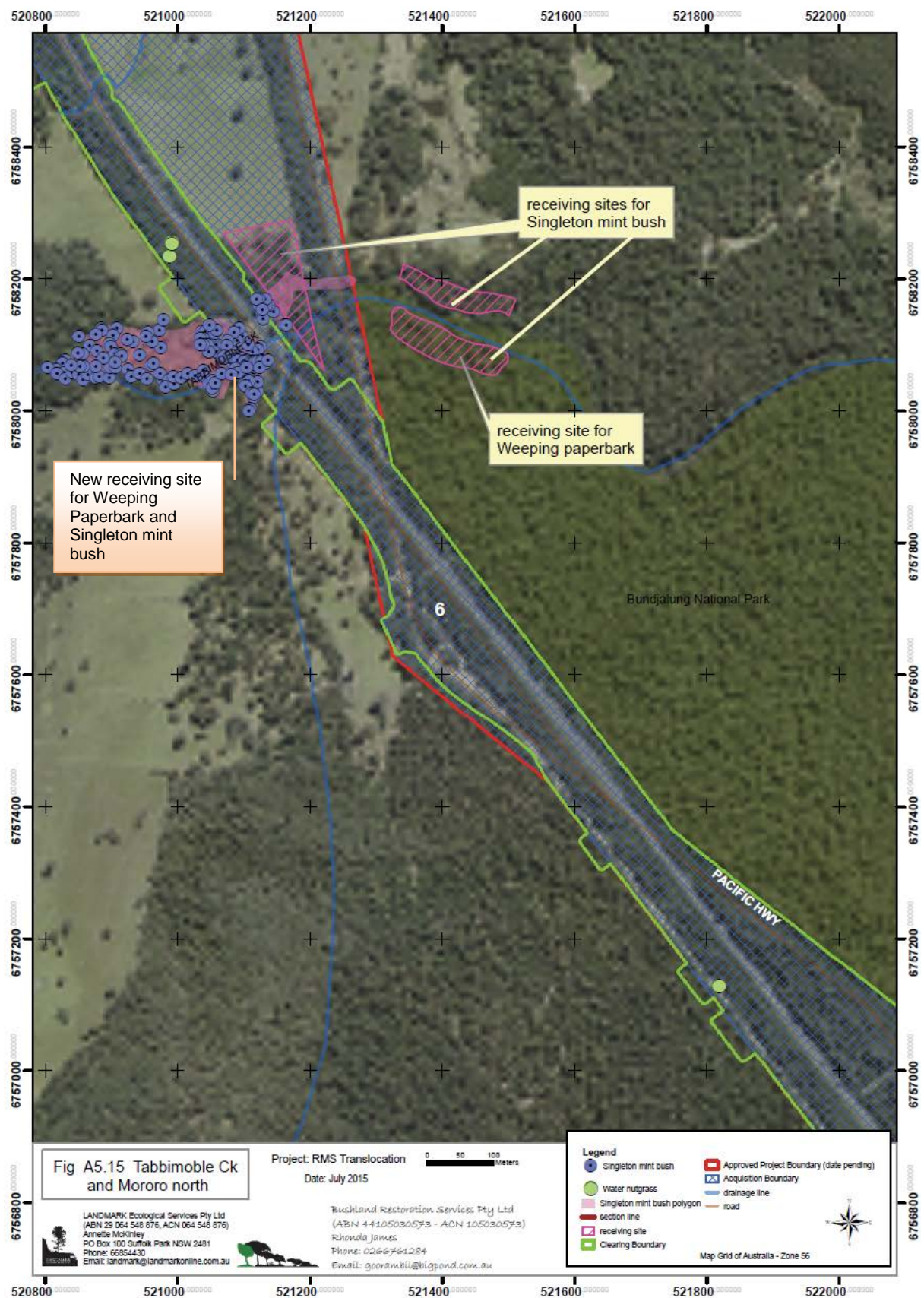


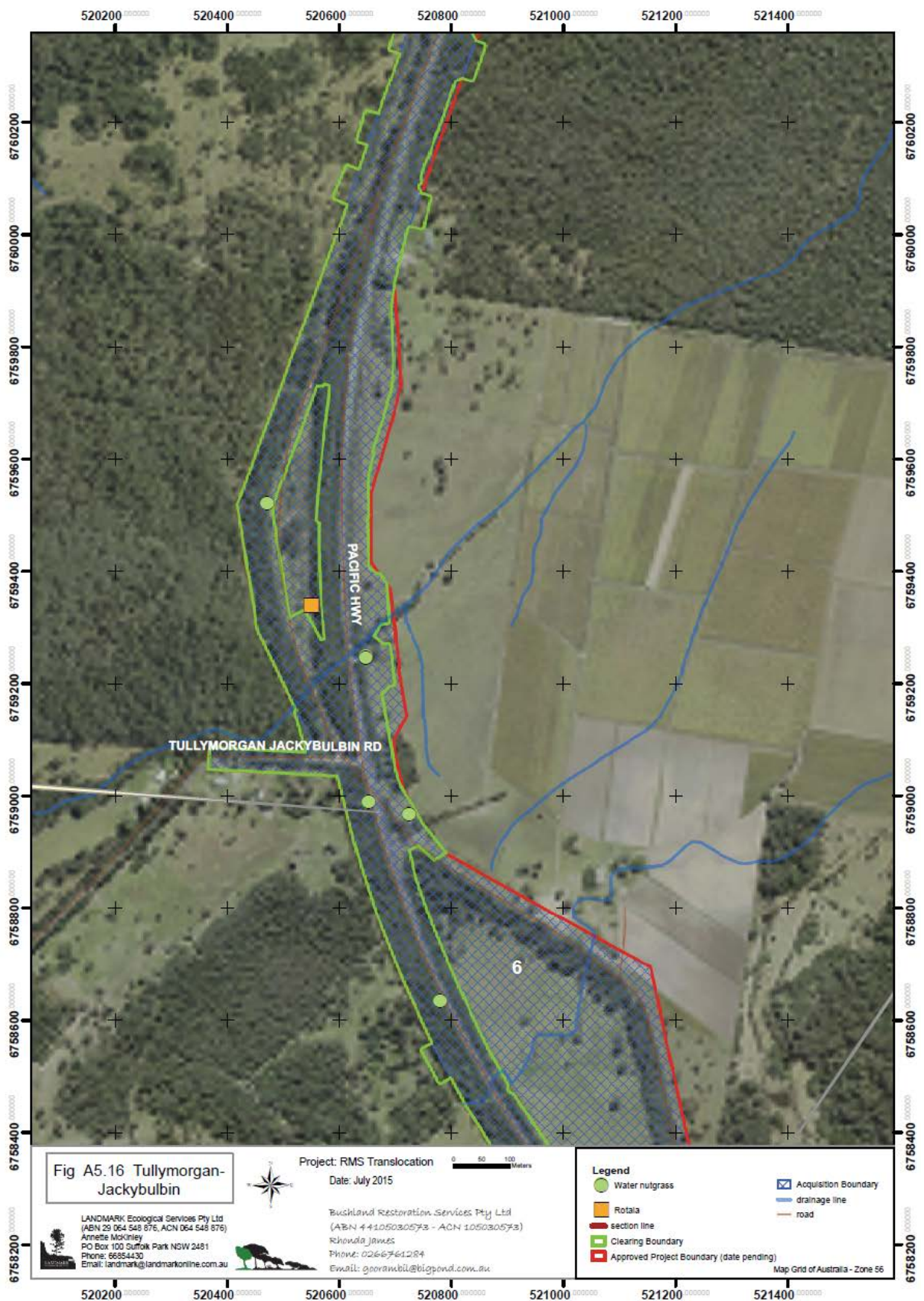


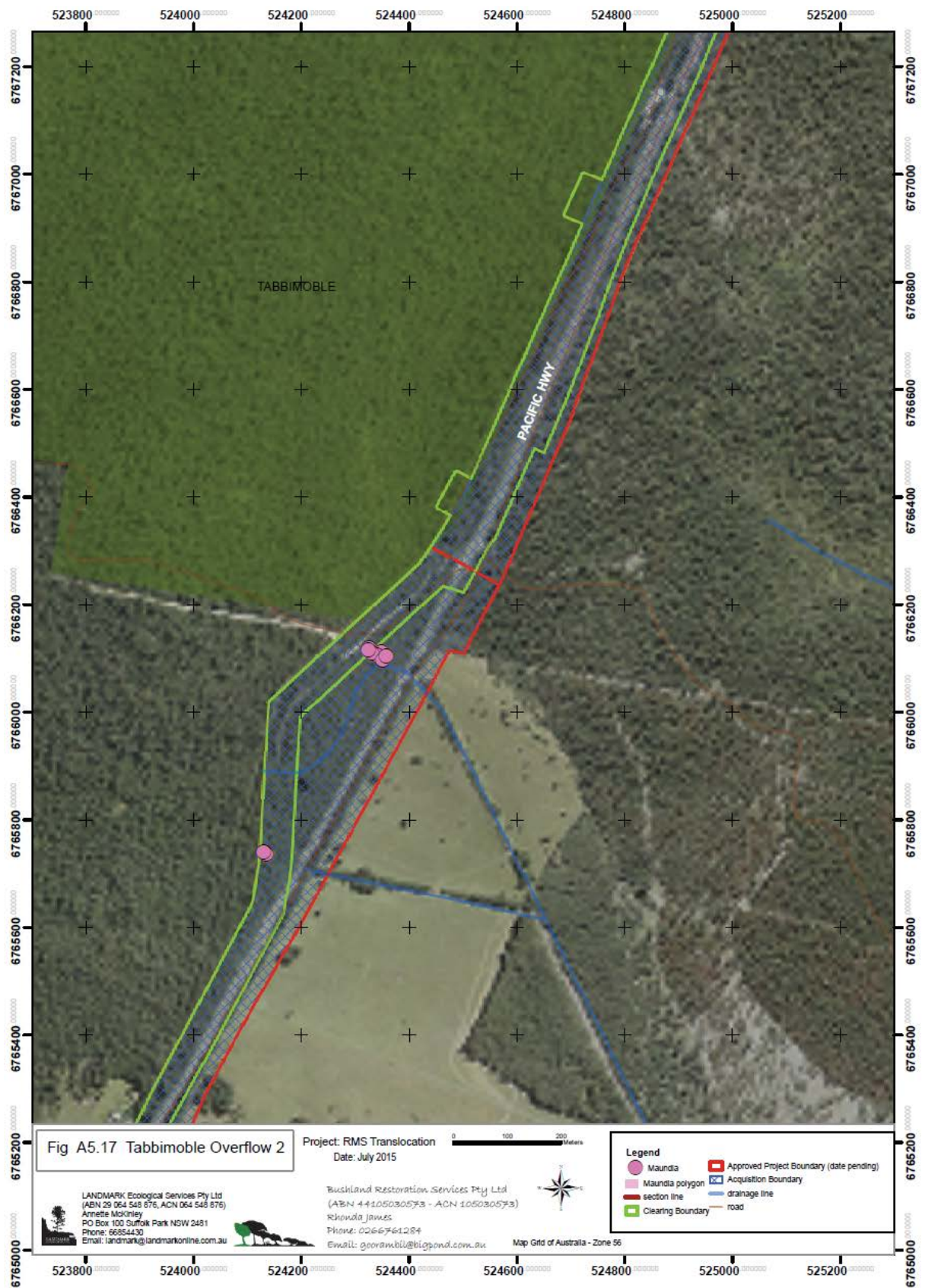


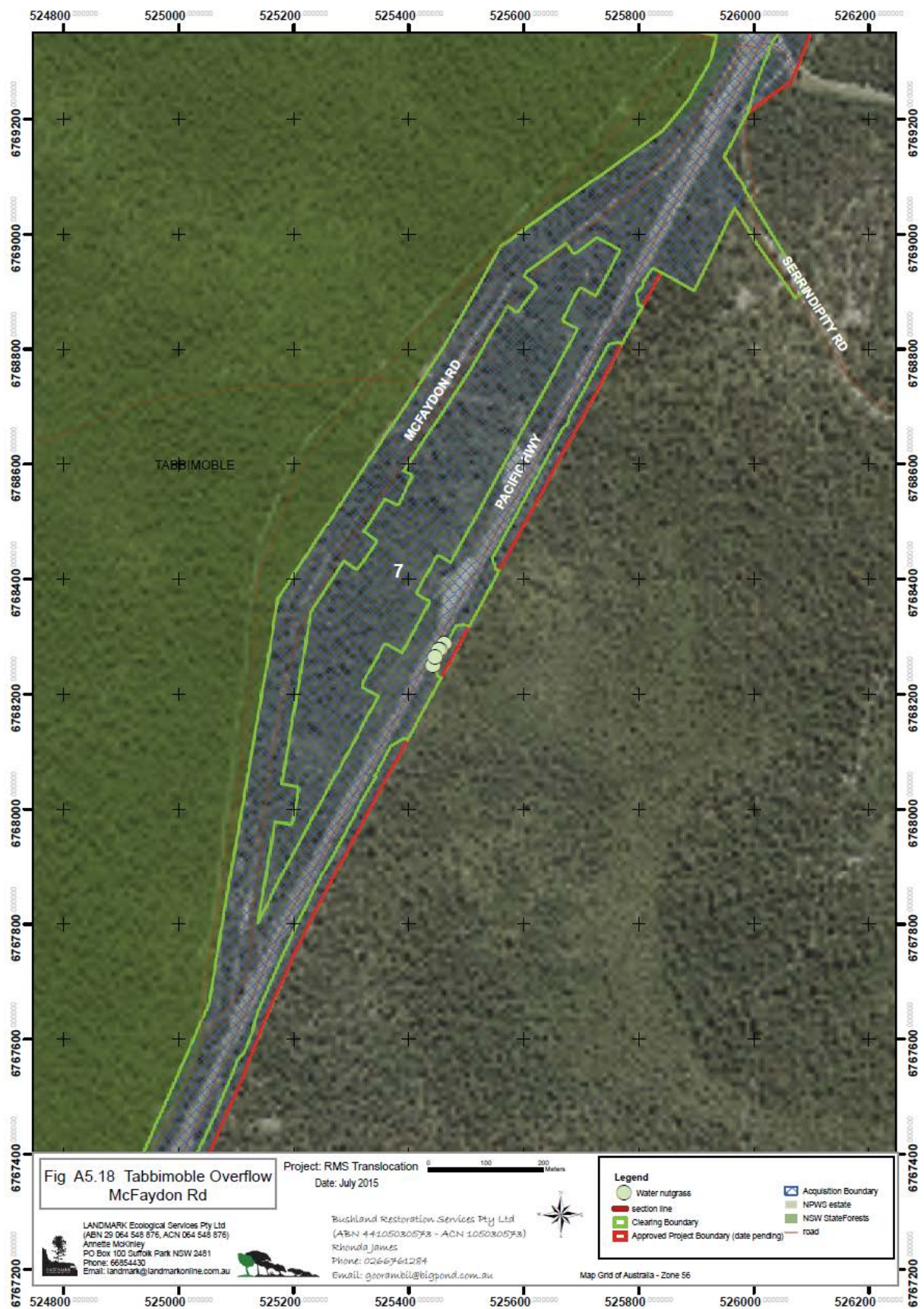


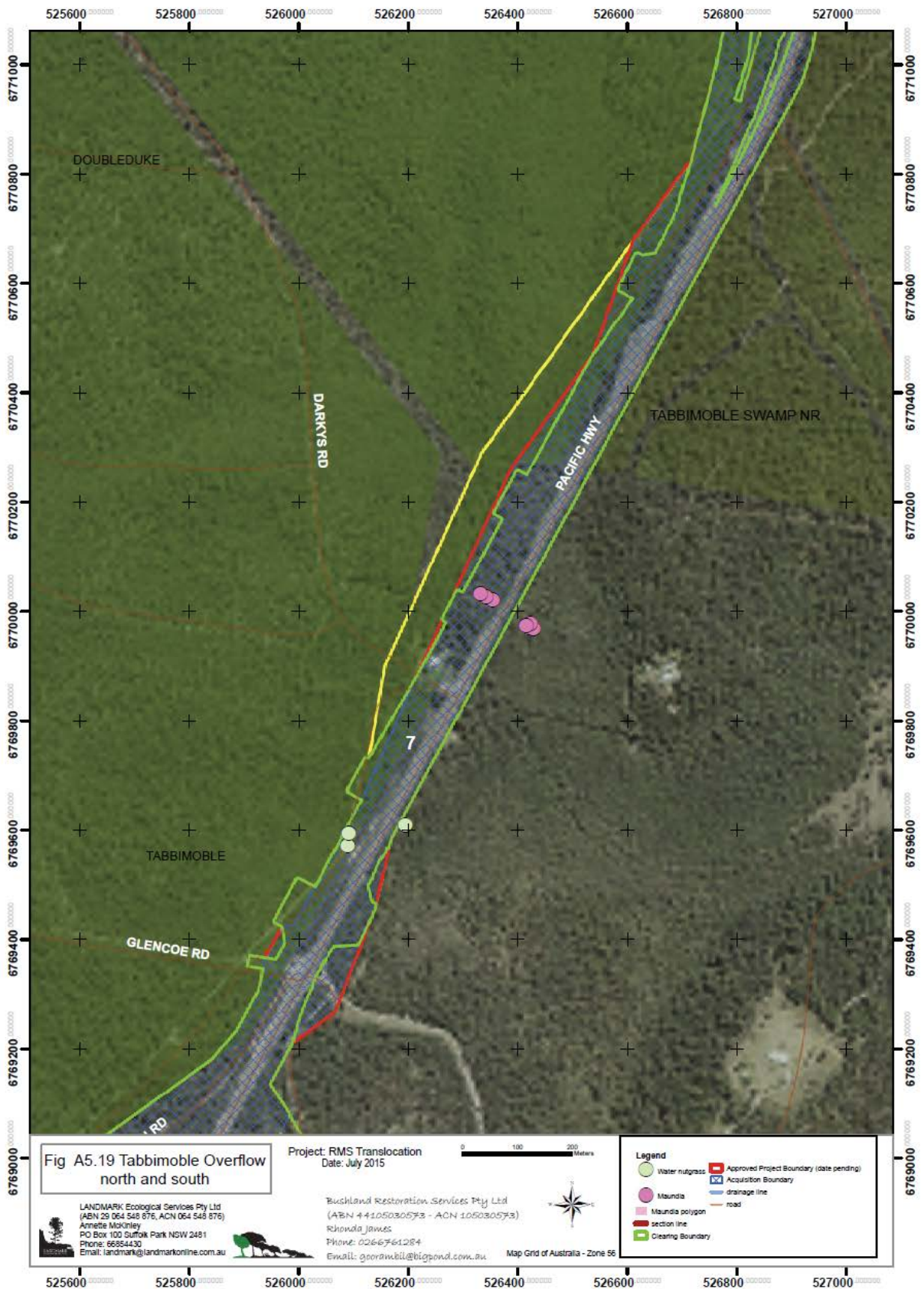


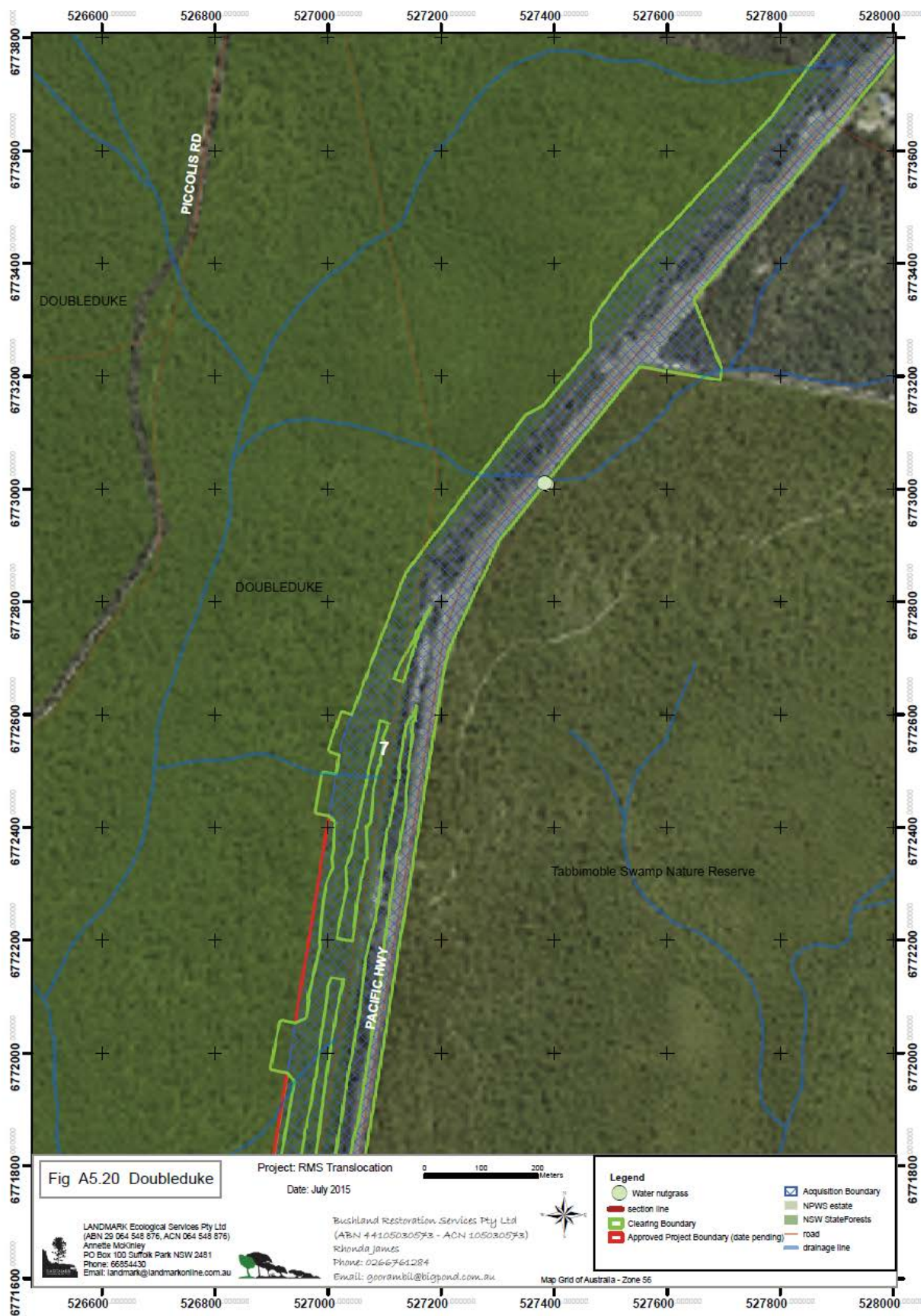


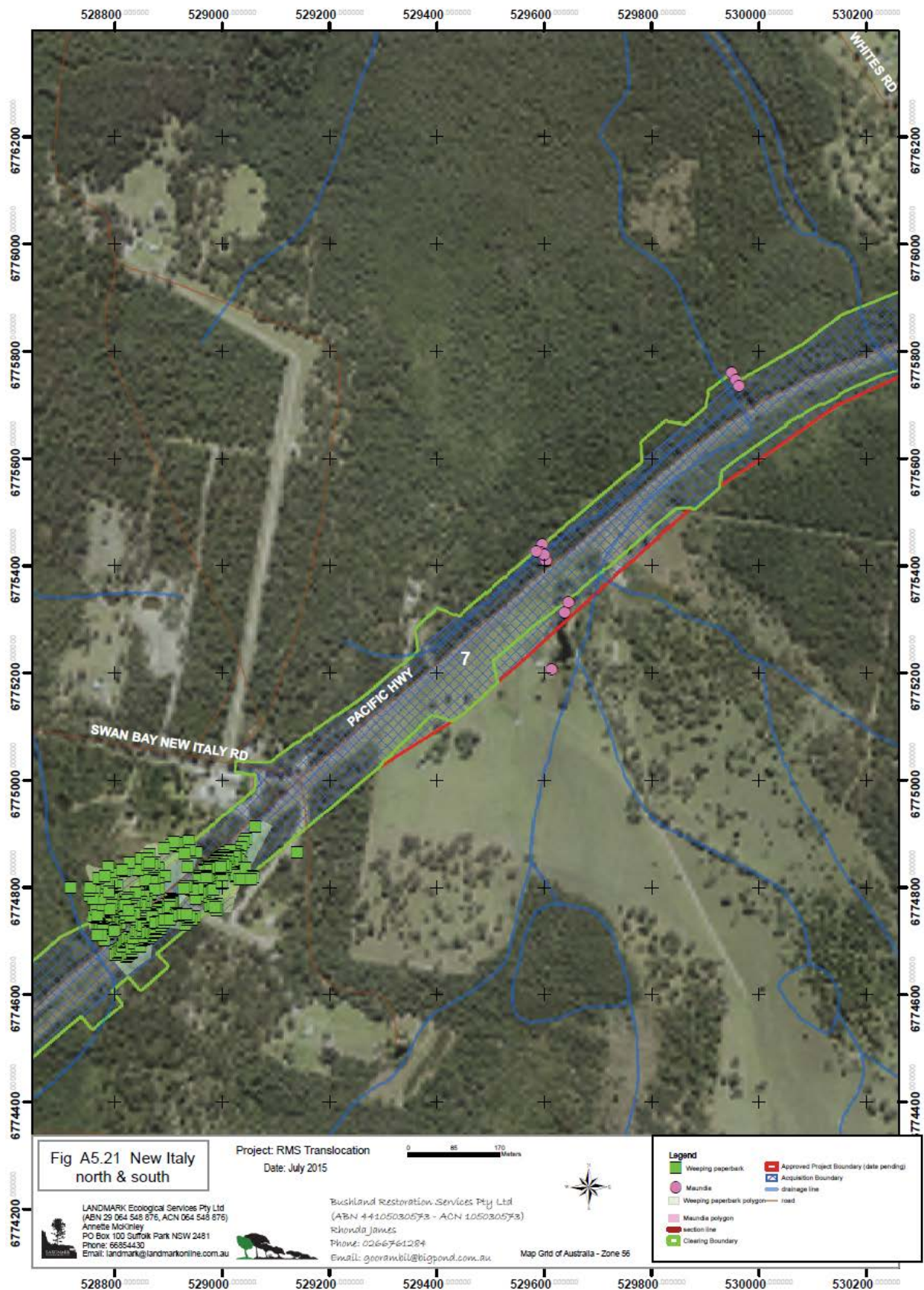


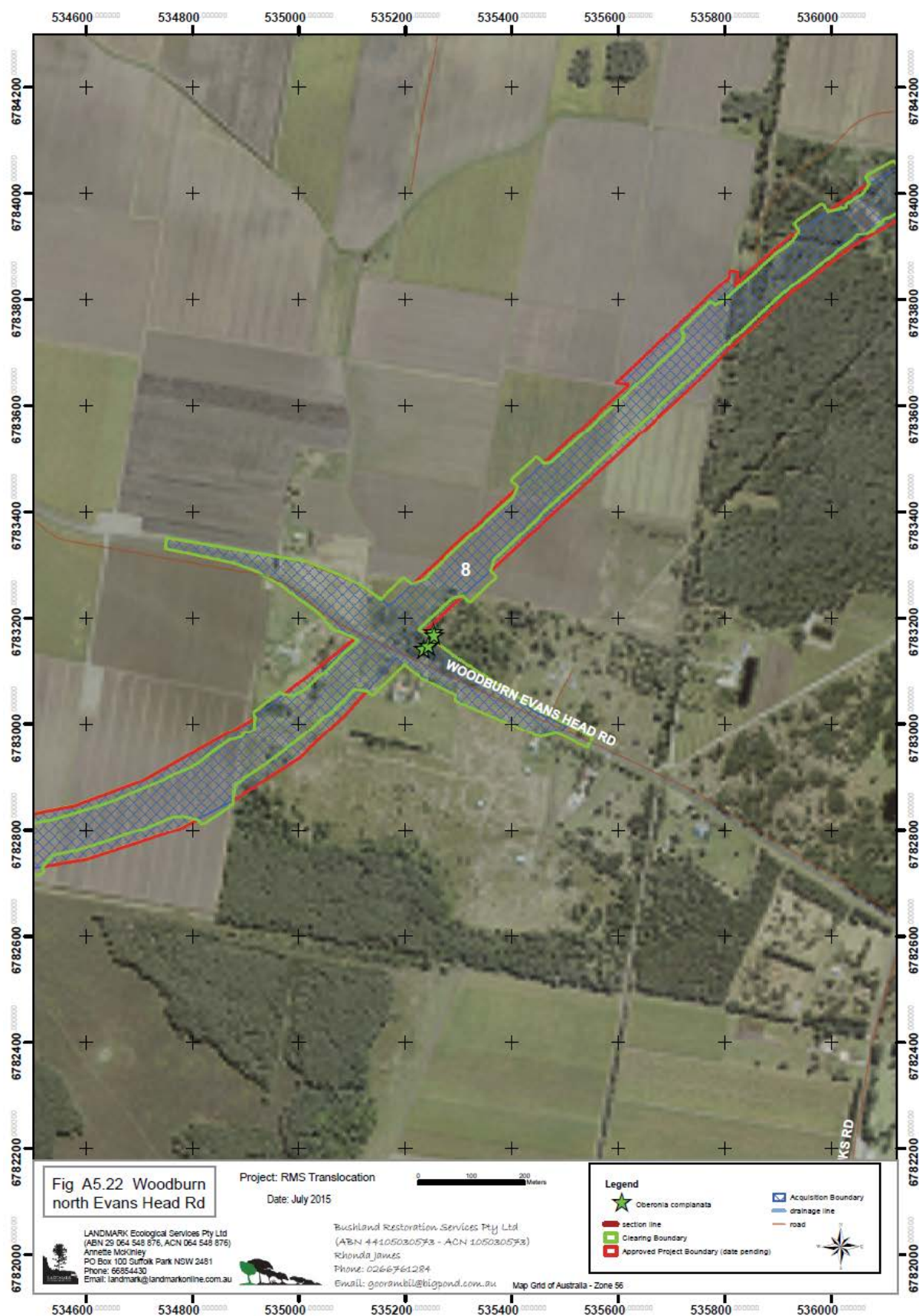


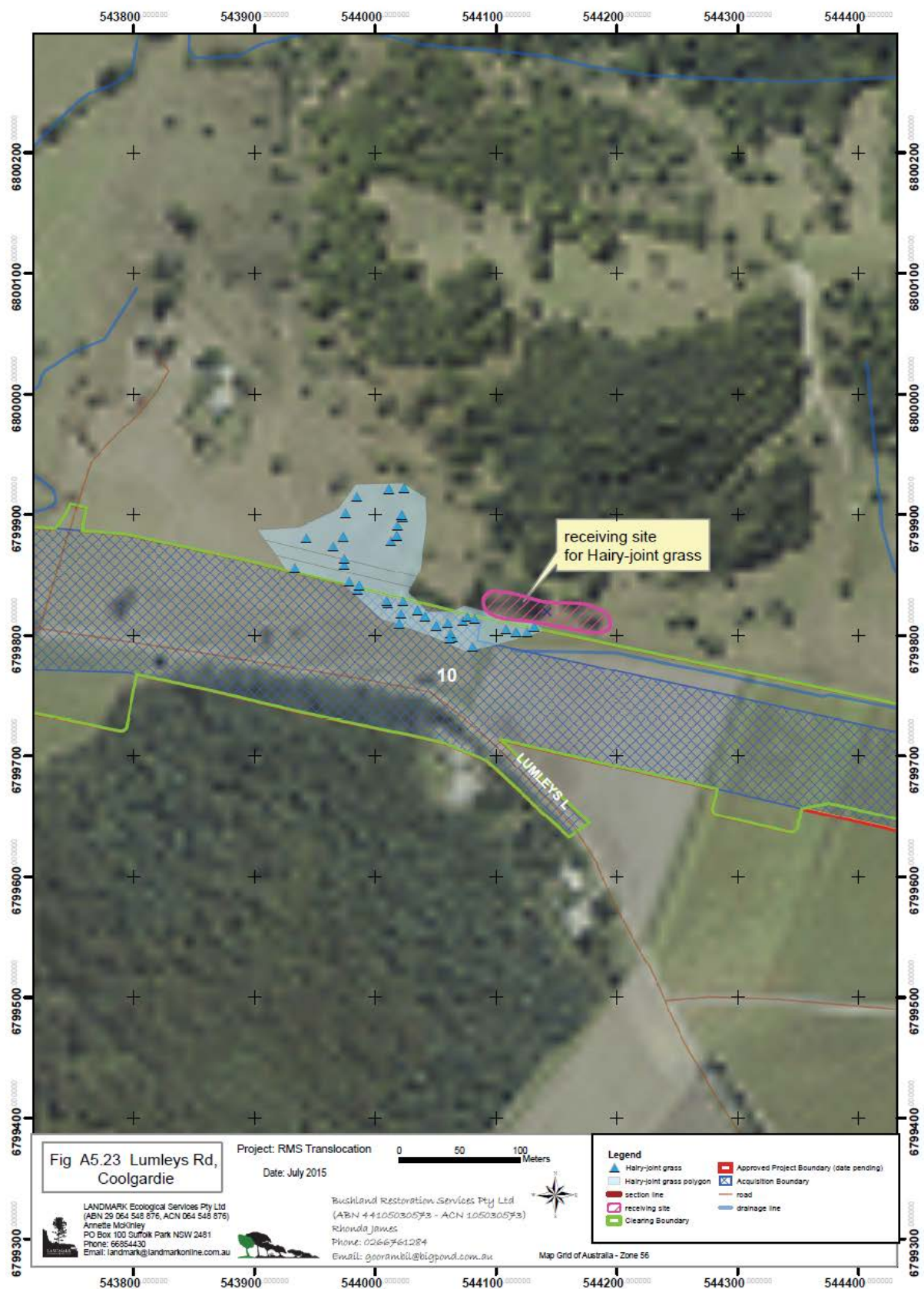


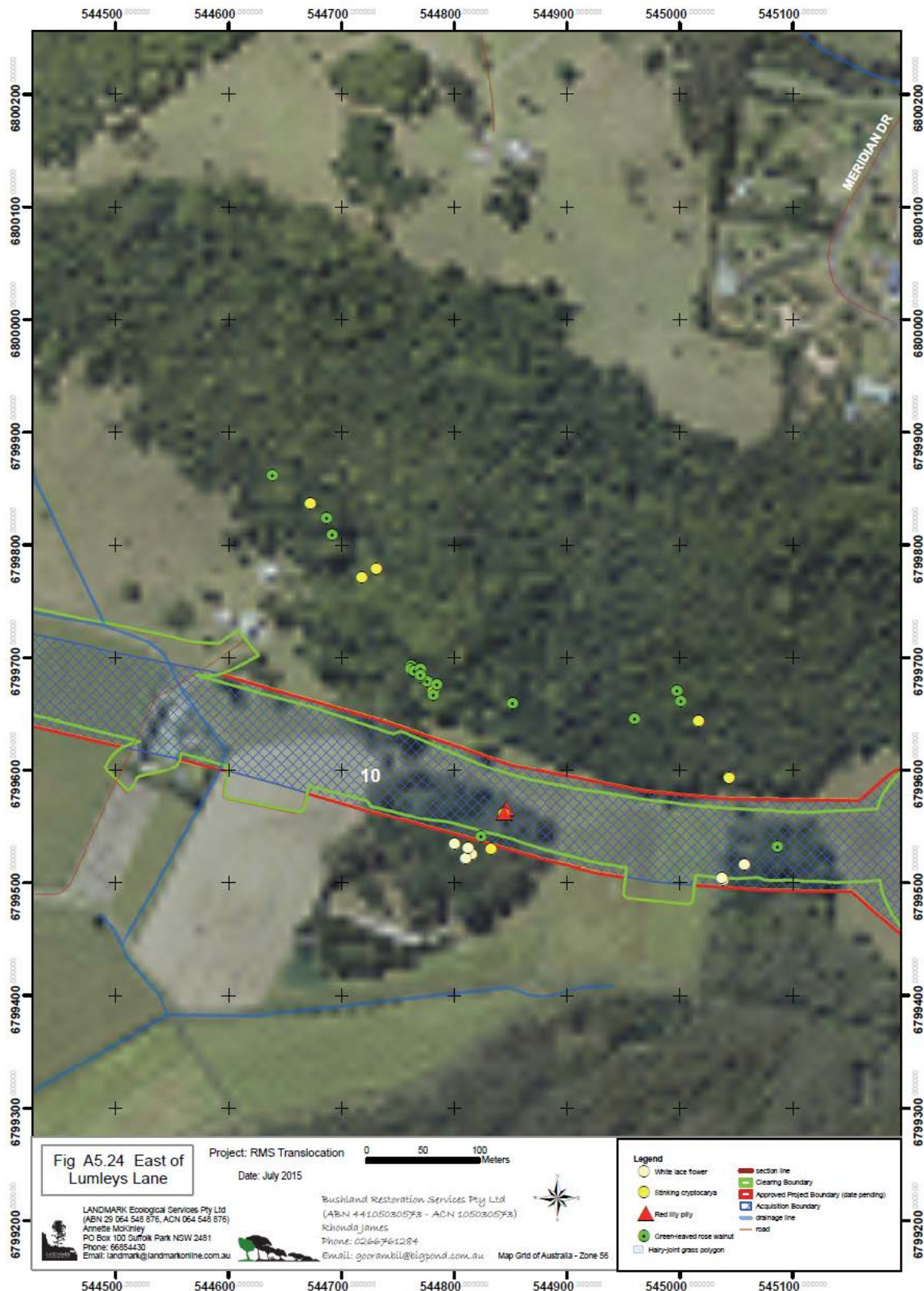












Appendix 6 Receiving sites

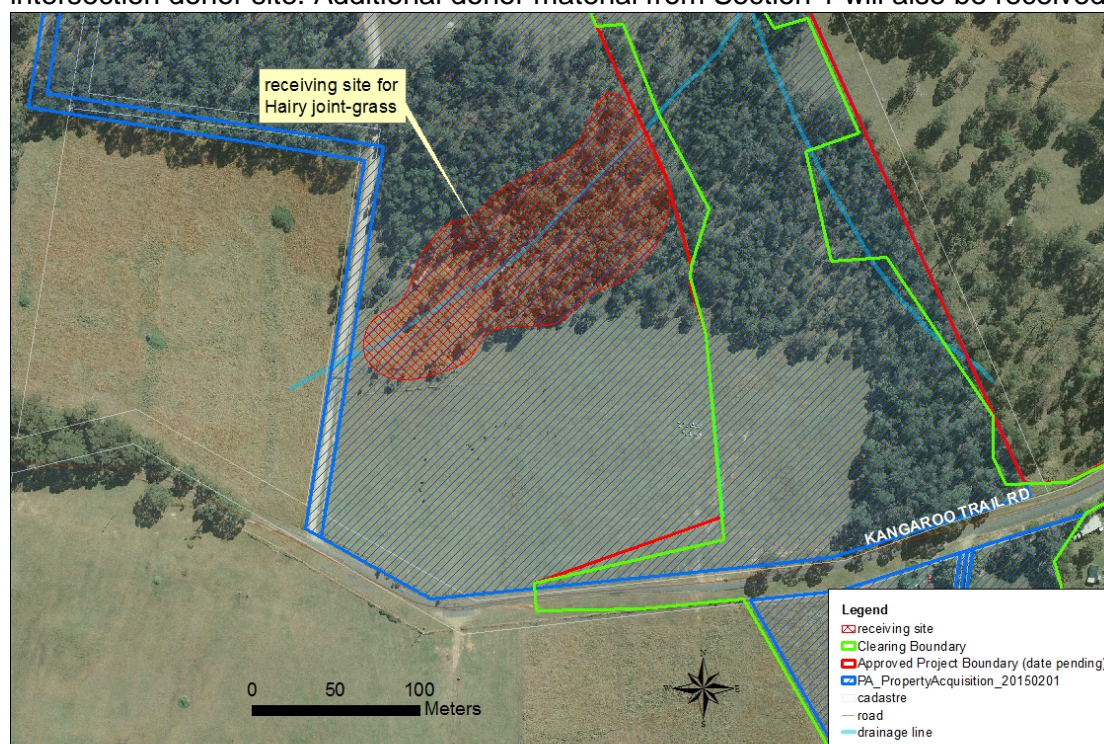
Sites listed south to north.

6.1 Kangaroo Trail Road

Donor species: Hairy joint-grass

Location: Kangaroo Trail Road

The receiving site is located in Section 1, approximately 35km south of Mitchell Road intersection donor site. Additional donor material from Section 1 will also be received.



Tenure: Roads and Maritime

Threats: Weeds and unauthorised access by motor bikes and vehicles. Maintenance of existing hydrology. Appropriate management to maintain biomass at suitable level.

Vegetation type: The site is mapped as Swamp Box - Swamp forest and Blackbutt – Bloodwood dry open forest. Small scale variations in the vegetation depending on drainage lines have produced patches and strips of vegetation with suitable hydrological conditions.

Weed species: Exotic herbs and grasses

Cover: Sparse to common

Site suitability: Hairy joint-grass occurs in a range of native and exotic vegetation types. Suitable hydrological conditions are critical and have been located adjacent to a drainage line.

Reference Site: No local populations of Hairy joint-grass that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at Trustums Hill (Early Works Soft Soil Treatment Area), but the distance between the receiving site and reference site will require consideration when observations are interpreted.

Pre Translocation management

Fence site to restrict vehicle and motorbike access.

The donor population is small and within a drainage line. Ensure that selected receiving location is suitable similar habitat within a drainage line.

Identify and mark with flagging tape the location for Hairy joint-grass within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Spot spray groundcover exotic herbs and grasses. Hand weed if site has ponded water.

Prior to translocation the site is to be weed free and prepared for receipt.

After weed control excavate similar sized slab to the donor slab in preparation for receipt on that day.



Drainage line at Kangaroo Trail May 2015

Translocation Management

The small donor population to be removed as one slab and taken directly to the receiving site.

Propagated seedlings to be planted in well prepared seedbed and bamboo stake placed next to individual plants.

Record and tag the slab and individual plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts. Control weeds on a regular basis.

Regular management to maintain biomass at suitable level by grazing or slashing and raking or spot spray during winter.

6.2 Mahogany Drive, Pillar Valley

(Biodiversity Offset Site no 25)

Donor species: Slender screw fern

Site 25 is also an important offset for Sandstone rough-barked apple, and provides opportunities for additional management actions to enhance a genetically fairly pure population of the species. As translocation of directly impacted trees from hybrid zones within the project corridor has been assessed as not feasible (Section 2.4, Appendix 3) the property provides opportunities for alternative measures of benefit to the species.

Location: 100 Mahogany Drive, Pillar Valley

Receiving site is in the north west corner of the property adjacent to a known occurrence of Slender screw fern (Jacobs 2014d). Distance from donor site at Mororo SF is 51 km.

Two suitable locations with good access were identified. In addition, the creek lines continue away from access tracks and will provide other alternatives.

Site 1 Grid reference 512099, 6705777 (care necessary to avoid damage to Moonee Creek Quassia at this location, see below)

Site 2 Grid reference 512186, 6705790

Tenure: Roads and Maritime

Threats: Close proximity to internal access track along boundary. Install protective fencing to restrict access.

Vegetation type: Edge of Red mahogany – Blackbutt forest and Swamp mahogany – Paperbark forest (structure below refers to Site 1 but is typical of wider area)

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	15-20	10	<i>Eucalyptus pilularis</i>	<i>E. resinifera</i>	
Mid	5-10	10	<i>Melaleuca quinquenervia</i>	<i>Lophostemon suaveolens</i>	<i>Melaleuca alternifolia</i>
Lower	1-3	10	<i>Gahnia clarkei</i>	<i>Lomandra longifolia</i>	
Ground	0-1	80	<i>Pteridium esculentum</i>	<i>Imperata cylindrica</i>	<i>Gahnia clarkei</i>

The north west corner of property is low-lying, with altitude 20-50 m ASL, and is dissected by minor creek lines.

Weeds: Exotic herbs and grasses

Cover: Sparse

Site suitability: The site matches with one example of habitat described for Slender screw fern, as summarised in Appendix 3 i.e. Dry eucalypt forest on sandstone. Small scale variation within the vegetation type results from dissecting drainage lines. Slender screw fern is usually found in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly.

The species is already present, confirming that site characteristics suit the requirements of the taxon.

Reference site

The existing populations of Slender screw fern adjacent to the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Slender screw fern has been observed to die back in dry conditions. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the receiving sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.



Pre translocation management

Identify and mark with flag a single stem of Moonee Creek Quassia at 512099, 6705777, trackside. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with bamboo stakes and pink tape, any existing occurrences of Slender screw fern adjacent to the receiving locations. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with flagging tape suitable receiving locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Due to the distance from donor site this site will be priority 2 for receipt.

The donor population covers an area of 0.0127ha. As much as possible of this population will be translocated. Ensure that receiving area is suitable habitat and after weed control excavate an area in preparation for receipt of slabs up to approximately 30cm x 30cm.

Weeds are sparse and if observed to be removed manually, ensuring that whole plant is removed.

Prior to translocation: the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.



Mahogany Drive July 2015

Translocation Management

The population to be removed in slabs and taken directly to the receiving site. Keep protected and moist in transit.

Record and tag the slabs with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.3 Pine Brush SF road reserve

Donor species: Four-tailed Grevillea

Location: The receiving site is adjacent to the donor site.

Tenure: Roads and Maritime

Threats: Highway edge, likely to require protective barrier

Vegetation type: Swamp forest on sandy soils

Weed species: Exotic herbs and grasses, Lantana

Cover: Sparse to common

Site suitability: The site is in close proximity to the donor site. There is a small site located to the west of donor site and larger site on the eastern side of the clearing boundary. See Figure A5.6 Pine Brush SF.

The species is already present, confirming that site characteristics suit the requirements of the taxon.

Reference sites

Monitoring sites Gq 3.1 and 3.2 at Tucabia north of Tallowood (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Identify and mark with flagging tape a suitable location for planting within the site. The receiving site to include a buffer zone being the whole of the area between the clearing boundary and the project boundary. Within the buffer weeds are to be controlled to reduce invasion into the receiving site.

The donor population is small and located close to the upper bank of the creek. Ensure that selected receiving area is suitable habitat.

Spot spray groundcover weeds and cut, scrape and paint the woody weeds. Lop cut stems into small billets and leave on site.

Prior to translocation: the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.



Receiving site on west of clearing area. July 2015

Translocation Management

Seedlings which have been previously removed and potted on or planted and grown on from seed to be taken to the receiving site. Seedlings and cuttings to be planted in well prepared bed and bamboo stake placed next to individual plants.

Record and tag the plants with identification used in nursery on collection of seed or seedlings.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.4 Tucabia north of Tallowood road reserve

Donor species: Four-tailed Grevillea

Location: The receiving site is adjacent to the donor site.

Tenure: Roads and Maritime

Threats: Highway edge, likely to require protective barrier. Plants impacted by disturbance prior to translocation.

Vegetation type: From Jacobs (2015) Gq3.1 Turpentine forest

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	15-20	9	<i>Syncarpia glomulifera</i>	<i>Eucalyptus psammitica</i>	<i>Corymbia intermedia</i>
Mid	1.5-10	8	<i>Allocasuarina torulosa</i>	<i>Leptospermum trinervium</i>	
Ground	0-1.5	55	<i>Entolasia stricta</i>	<i>Imperata cylindrica</i>	

Weed species: Exotic herbs and grasses, Lantana

Cover: Sparse to common

Site suitability: The site is in close proximity to the donor site. The site is located to the west of donor site adjacent to remaining population.

The species is already present, confirming that site characteristics suit the requirements of the taxon. See Figure A5.5 Tucabia north of Tallowood.

Reference sites

Monitoring sites Gq 3.1 and C3.1 (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Identify and mark with flagging tape a suitable location for planting within the site. The receiving site to include a buffer zone being the whole of the area between the clearing boundary and the project boundary. Within the buffer weeds are to be controlled to reduce invasion into the receiving site.

The donor population is small and an extension of a larger population. Ensure that selected receiving area is suitable habitat.

Spot spray groundcover weeds and cut, scrape and paint the woody weeds. Lop cut stems into small billets and leave on site.

Prior to translocation: the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation management

Seedlings which have been previously removed and potted on or planted from seed to be taken to the receiving site. Seedlings and cuttings to be planted in well prepared bed and bamboo stake placed next to individual plants.

Record and tag the plants with identification used in nursery on collection of seed or seedlings.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.5 Yaegl Nature Reserve south

Donor species: Tall knotweed

Location: Yaegl Nature Reserve south is up to 3km from donor sites in the vicinity of Yaegl NR, also South Arm and Maclean Interchange. Suitable habitat extends along the edge of the vegetation for at least 50m north east and 20m south west of an existing population of Tall knotweed.

All donor sites and *in situ* populations are hydrologically connected to the proposed receiving site during floods. Genetic differentiation between the occurrences is unlikely and there is no impediment to mixing of material from multiple local patches in plantings proposed at the receiving site.

Tenure: Nature Reserve.

Threats: Weeds, maintenance of suitable hydrological conditions required.

Vegetation type: Swamp sclerophyll forest

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	12 -18	10 (edge)	<i>Melaleuca quinquenervia</i>		
Mid					
Lower	0-1	10-50 (patchy)	<i>Eleocharis equisetina</i>	<i>Phragmites australis</i> (edge)	<i>Enydra fluctuans</i>

Weeds Exotic grasses extend along adjacent edge

Cover: Sparse within the receiving site to dense on adjacent edges.

Site suitability: The site matches with the known habitat of Tall knotweed, as summarized in Appendix 3 i.e. damp places, swamp forest or associated with disturbance. Edge of *Melaleuca quinquenervia* communities. See Figure A5.11 Yaegl central and south. Tall knotweed is already present, confirming that site characteristics suit the requirements of the species.

Reference sites: The existing populations of Tall knotweed adjacent to the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Tall knotweed is known to respond to rainfall events, which may be erratic, by developing from freshly dispersed or soil-stored seeds in a timeframe that will vary with seasonal factors. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.



Typical donor site February 2015



Receiving site Yaegl NR south July 2015

Pre-translocation management

Identify the extent of the receiving site and suitable locations within the site for slabs, clumps or nursery-raised plants. Mark out the locations with timber stakes and flagging tape, also metal pegs for location with metal detector if necessary. The receiving site to have a buffer zone of 5m where weeds are controlled to reduce invasion into the receiving site. Remove slabs approximately 30cm x 30cm in preparation for receipt of donor slabs.

Prior to receiving the plant material the receiving sites are to be weed free. Spot spray the tall exotic grasses throughout the receipt areas and extend to include the two existing populations. Do not spray over pooled water or within 5m of any patch of Tall knotweed.

Experienced bush regeneration team to follow hygiene protocols and best practice. Care to be taken in preparation to cause minimum disturbance to the site.

Post translocation management

Record and tag the plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.6 Bundjalung NP adjacent Mororo SF

Donor species: Slender screw fern

Location: Bundjalung NP

Receiving site is to the east of the donor site along the same creek line. Slender screw fern is likely to be present in the receiving site due to similarity of habitat and close proximity to existing population.

Tenure: National Park

Threats: Weed invasion

Vegetation type: Subtropical Coastal Floodplain Forest

Weeds: Exotic herbs and grasses, Lantana

Cover: Sparse

Site suitability: The site is similar habitat and located on the same creekline as donor site. The species is likely to be present in the national park. See Figure A5.14 Mororo SF.

Reference site

The existing populations of Slender screw fern to the west of the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Slender screw fern has been observed to die back in dry conditions. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the receiving sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre translocation management

Identify and mark with bamboo stakes and pink tape, any existing occurrences of Slender screw fern adjacent to the receiving locations. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with flagging tape suitable receiving locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

The donor population covers an area of 0.0127ha. As much as possible of this population will be translocated to this site. Ensure that receiving area is suitable habitat and after weed control excavate an area in preparation for receipt of slabs up to approximately 30cm x 30cm.

Prior to translocation: the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Slabs to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.7 Tabbimobile triangle

Donor species: Singleton mintbush

The receiving site is within and adjacent to a patch of Singleton mintbush, adjoining the donor site.

Tenure: RMS

Threats: Likely to be fire sensitive, weeds, cattle, edge effects from new highway construction.

Vegetation Description: Moist sclerophyll forest

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	25	60	<i>Eucalyptus pilularis</i>	<i>Eucalyptus propinqua</i>	
Mid	5-15	20	<i>Acacia</i>	<i>Melaleuca quinquenervia</i>	
Lower	0-0.5	10	<i>Gahnia melanocarpa</i>	<i>Panicum</i> sp.	<i>Pratia purpurascens</i>

Weeds: Exotic herbs and grasses, Lantana, Cuphea

Cover: Sparse

Site suitability: The site is in close proximity to the donor site, to the west.

Singleton mintbush is already present, confirming that site characteristics suit the requirements of the species. See Figure A5.15 Tabbimobile.

Reference sites:

Monitoring site Pc 6.1C on the east of the highway (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Ensure fencing is installed to restrict cattle access to the site.

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled within the vegetated section of the triangle to provide a buffer to reduce impacts within the receiving site.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees may be able to be transplanted when construction machinery in vicinity of site.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.



Tabbimobile triangle July 2015

Post translocation Management

Plants to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.8 Jackybulbin BO Site 13

Donor species: Singleton mintbush

The receiving site is within and adjacent to a large population of Singleton mintbush located on the banks of Tabbimobile Creek and <0.5km from the donor site. A further population is present further east on the same creek bank. Jacobs (2014b) considers that this south west corner of the property is a revegetation option in which existing natural regeneration could be facilitated to improve condition of potential Sub-tropical Coastal Floodplain Forest.

Tenure: Private, candidate for Biodiversity Offset Package with conservation covenant.

Threats: Likely to be fire sensitive. Weeds. Edge effect from adjacent highway on western boundary of existing population and transplants.

Vegetation Description: Moist sclerophyll forest

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	25	40	<i>Eucalyptus pilularis</i>	<i>Corymbia intermedia</i>	
Mid	3-8	40	<i>Acacia disparrima</i>	<i>Alphitonia excelsa</i>	<i>Glochidion ferdinandii</i>
Lower	0-1	20	<i>Gahnia melanocarpa</i>	<i>Panicum</i> sp.	<i>Pratia purpurescens</i>

Weeds: Exotic herbs and grasses, Lantana

Cover: Sparse

Site suitability: The site matches with the known habitat of Singleton mintbush, as summarized in Appendix 3 i.e. damp places, swamp forest or associated with disturbance. Edge of *Melaleuca quinquenervia* communities.

Singleton mintbush is already present, confirming that site characteristics suit the requirements of the species. See Figure A5.15 Tabbimobile.

Reference sites: The existing populations of Singleton mintbush within and adjacent to the receiving site will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.



Jackybulbin receiving site June 2015

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees may be able to be transplanted when construction machinery in vicinity of site.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Plants to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway if located at the west of the receiving site.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.9 Bundjalung NP, Tabbimobile

Donor species: Singleton mintbush, Weeping paperbark

The receiving site is close to (<0.5km) to the Singleton mintbush donor site and approximately 16 km from the New Italy Weeping paperbark donor site.

Tenure: National Park

Threats: Likely to be fire sensitive

Vegetation Description: Moist sclerophyll forest

Stratum	Height (m)	Crown Cover (%)	Species 1	Species 2	Species 3
Upper	25	40	<i>Eucalyptus pilularis</i>	<i>E. acmenoides</i>	<i>Syncarpia glomulifera</i>
Mid	8	40	<i>Acacia disparrima</i>	<i>Melaleuca quinquenervia</i>	
Lower	0-0.5	10	<i>Gahnia melanocarpa</i>	<i>Entolasia stricta</i>	<i>Pratia purpurascens</i>

Weeds: Exotic herbs and grasses, Lantana

Cover: Sparse

Site suitability: The site matches with the known habitat of Singleton mintbush on sandy banks of Tabbimobile creek in swamp forest and Weeping paperbark on coastal floodplain forest. Singleton mintbush is present on the adjacent property to the north. See Figure A5.15 Tabbimobile.

Reference sites: Singleton mintbush - the existing populations of Singleton mintbush on the adjoining property to the north of the receiving sites will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

Weeping paperbark - the remaining population of Weeping paperbark at New Italy will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site for both species. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site. Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.



Bundjalung NP at Tabbimobile July 2015

Post translocation Management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery to be carried into the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.10 1457 Myall Creek Road (Bungawalbin offset for Devil's Pulpit upgrade)

Donor species: Weeping paperbark

The receiving site is approximately 16km from the New Italy donor site.

Tenure: National Park

Threats: Fire in early development of plants.

Vegetation Description: Floodplain swamp forest

Weeds: Lantana, Groundsel, exotic herbs and grasses

Cover: Sparse to common

Site suitability: Benchmark (2012) describes large areas of floodplain and swamp vegetation types that will be suited to the establishment of Weeping paperbark.

Reference sites: No immediately local populations of Weeping paperbark that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at New Italy. The distance between the receiving site and reference site will require consideration when observations are interpreted.

Pre Translocation management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Identify and mark with flagging tape suitable locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Control woody weeds such as Lantana and Groundsel but cut, scrape and paint and spot spray groundcover weeds.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

Plants to be transported to the site on same day as planting.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.11 Bundjalung NP, Gummigurrah Trail picnic area

Donor species: Yellow-flowered king of the fairies

Location: Between the access road and river.

The receiving site is located approximately 8km from the donor site on Woodburn-Evans Head Road.

Tenure: National Park

Threats: Human visitation and possible illegal collection, fire (this strip of vegetation is protected from frequent fires that characterise vegetation on the south side of the access road).

Vegetation Description:

Forest dominated by Pink bloodwood with moderately dense littoral rainforest species in the mid-storey and mangroves fringing. The targeted host trees, Swamp oak, are scattered throughout, mostly on the river side but some within the adjoining forest. Patches of paperbark swamp interspersed.

Suitable trees or clumps are identified:

Clump no	Easting	Northing	Description	Notes
1	540454	6777085	Patch of ~12 small to medium trees at turning circle	Less shelter than ideal
2	540935	6777740	Single mature tree at edge of picnic area	South-facing location on trunk will be out of sight from picnic area
3	541239	6777879	Group of ~8 medium trees on the bank of a small tributary	Distant from picnic area and tracks
4	541387	6777937	Single mature tree on edge of paperbark stand	South-facing location on trunk will be out of sight from track



Clump 3 Group of Swamp oak July 2015



Clump 4 Swamp Oak trunk July 2015

Weeds: Very few exotic species, not threatening to epiphytes

Site suitability: Host trees of the same species as at the donor site are present, together with littoral rainforest species which are likely to suit the orchids and may be colonised in the future. The site is not subject to the frequent fires which occur in adjacent areas of the park.

Pre Translocation management

(Donor plants are located in clumps or as single plants on three Swamp oak host trees, with height ranging from 1.5 to 8m from the ground).

Identify and mark with flagging tape suitable trees and attachment points.

Translocation Management

Orchids to be placed on the south-facing side of trunks (as observed at donor site), high enough to be beyond unassisted human reach but low enough to be within the shelter of the rainforest mid-storey. Placement should be out of sight from tracks and picnic areas to best possible.

6.12 Yarringully NR

Donor species: Weeping paperbark

The receiving site is approximately 10 km from the New Italy donor site.

Tenure: Nature Reserve

Threats: Straying cattle, pig hunting. Risk of wildfire is low compared with over-burnt vegetation in the general area.

Vegetation Description: Clearing surrounded by Floodplain sclerophyll forest

Receiving site is located in an old house clearing where natural regeneration is now beginning, likely to require management. The site is traversed by the main fire trail, the loop track Quill Trail. Access is thus readily possible depending on soil moisture.

Weeds: Lantana, Groundsel

Cover: Sparse

Site suitability: Floodplain and swamp vegetation types that will be suited to the establishment of Weeping paperbark.

Reference sites: No immediately local populations of Weeping paperbark that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at New Italy. The distance between the receiving site and reference site will require consideration when observations are interpreted.



Pre Translocation management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Identify and mark with flagging tape suitable locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Control woody weeds such as Lantana and Groundsel but cut, scrape and paint and spot spray groundcover weeds.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

Plants to be transported to the site on same day as planting.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.13 Lumleys Lane BOS 22 Pasture

Donor species: Hairy joint-grass

The receiving sites are adjacent to the donor sites.

Tenure: RMS

Threats: Exposure to highway, weeds, grazing regime

Vegetation Description: Exotic grassland / edge of freshwater wetland

Weeds: Lantana, exotic herbs and grasses

Cover: Common

Site suitability The site is in close proximity to the donor sites. The sites are located adjacent to the donor sites.

Hairy joint-grass already present, confirm that site characteristics suit the requirements of the species. Figure A5.23

Reference sites: The existing populations of Hairy joint-grass within and adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site as close as possible to location of existing records. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Spot spray exotic herbs and grasses during winter when Hairy joint-grass is dormant.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

See receiving site 1 Kangaroo Trail for Hairy joint-grass.

6.14 Coolgardie Road BOS 24 Pasture

Donor species: Hairy joint-grass

The receiving site is adjacent to and within 1km from several Hairy joint-grass donor sites in the Coolgardie-Wardell area (Figure A5.26).

Tenure: RMS

Threats: Proximity to highway, may require protective barrier

Vegetation Description: (Jacobs 2014h) Pasture/wetland surrounded by Floodplain sclerophyll forest

Weeds: Exotic herbs and grasses

Cover: Sparse to common

Site suitability: The site is in close proximity to the donor sites. The site is located to the north and south west of donor sites. Hairy joint-grass already present, confirming that site characteristics suit the requirements of the species.

Reference sites: The existing populations of Hairy joint-grass within and adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants. Observations of the

reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site as close as possible to location of existing records. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Spot spray exotic herbs and grasses during winter when Hairy joint-grass is dormant.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.



West of Kays Lane July 2015

Translocation Management

See receiving site 1 Kangaroo Trail for Hairy joint-grass.

6.15 Lumleys Lane BOS 22 Buckombil BOS 17 Meridian Drive BOS 23

Rainforest donor and receiving sites

Three properties provide opportunities for translocation operations for a group of rainforest tree species. The species are Green-leaved rose walnut, Red lilly pilly, Rough-shelled bush-nut, Stinking Cryptocarya and White laceflower.

General methods to be used include propagation from seed and cuttings, digging and potting of seedlings and excavation and transplant of saplings and mature trees.

All three properties include large areas of rainforest and regrowth rainforest, usually dominated by exotic species, with diverse rainforest understoreys. In combination with the weed management programs that are proposed for these areas of regrowth, planting of seed and cutting propagated plants into regenerating rainforest habitat is a recommended approach.

Cleared areas, forest or edges with machinery access will be required for transplants of mature trees. Such areas are present on the lower slopes of the escarpment, where soils are of intermediate to high fertility, as a result of basalt substrate or the influence of basalt from the ridge tops, and are well suited to the rainforest species.

Reference sites: Rainforest species - the existing populations of rainforest species on the properties adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants.

6.16 Lumleys Lane BOS 22 Rainforest

Donor species: Rainforest trees

The receiving site is up to 1km from a number of donor sites for all species in the Coolgardie-Wardell area.

Tenure: RMS

Threats: Exposure to highway, weeds

Vegetation Description:

Jacobs (2014e) classify the rainforest as Biometric type White Booyong – Fig subtropical rainforest of the North Coast.

Dominant canopy species: *Aphananthe philippinensis*, *Livistona australis*, *Cryptocarya obovata*, *Guioa semiglauca*, *Endiandra pubens*, *Diploglottis cunninghamii*

Dominant mid storey species: *Wilkiea huegeliana*, *Streblus pendulinus*, *Breynia oblongifolia*, *Maclura cochinchinensis*, *Pittosporum multiflorum*

Dominant lower storey species: *Cissus antarctica*, *Alpinia caerulea*, *Doodia aspera*, *Trophis scandens*, *Calamus muelleri*, *Cordyline petiolaris*

Weeds: Camphor Laurel, Large-leaved Privet, Lantana, exotic herbs and grasses

Cover: Sparse to common

Site suitability The site is in close proximity to the donor sites. The site is located to the north and south west of donor sites.

Rainforest species already present, confirm that site characteristics suit the requirements of the species. Figure A5.23



Lumleys Lane July 2015

6.17 Buckombil BOS 17 Rainforest

Donor species: Rainforest species

The receiving site is up to 4km from several donor sites in the Coolgardie-Wardell area to the north.

Tenure: Private, candidate for Biodiversity Offset Package with conservation covenant.

Threats: Weeds

Vegetation Description: Subtropical rainforest White Booyong -Fig subtropical rainforest of the North Coast (Jacobs 2014f).

Canopy dominants:

Argyrodendron trifoliolatum, *Ficus macrophylla*, *Flindersia schottiana*, *Ficus obliqua*, *Araucaria cunninghamii*, *Dendrocnide excelsa*

Mid storey dominants:

Sloanea australis, *Archontophoenix cunninghamiana*, *Cryptocarya obovata*, *Endiandra pubens*, *Dysoxylum fraserianum*

Lower storey dominants:

Trophis scandens, *Cissus hypoglauca*, *Calamus muelleri*, *Alpinia caerulea*, *Alocasia brisbanensis*, *Maclura cochinchinensis*.

Weeds: Lantana, Mistflower, Large and small-leaved Privet, exotic herbs and grasses.

Cover: Sparse to dense

Site suitability: Areas of subtropical rainforest present on the site.

6.18 Meridian Drive BOS 23 rainforest

Donor species: Rainforest species

The receiving site is up to 2km from several donor sites in the Coolgardie-Wardell area.

Tenure: Private, candidate for Biodiversity Offset Package with conservation covenant.

Threats: Weeds

Vegetation Description: Subtropical rainforest

Weeds: Lantana, Large-leaved privet

Cover: Sparse to dense

Site suitability: Areas of subtropical rainforest present on the site.

Pre Translocation management

Install protective barrier if translocated species to be placed in close proximity to the edge of clearing zone.

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site. Select sites within gaps or on the edge of existing rainforest.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees to be transplanted on forest edges or easily accessible gaps in the forest.

Spot spray throughout the site to control groundcover weeds. Woody weeds such as Lantana and Privet to be cut, scrape and painted and lopped into billets and left on site. Larger woody weeds and Camphor Laurel to be drill and injected and left in situ.

Prior to translocation the site is to be weed free and prepared for receipt.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Plants to be transported to the sites. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

6.19 Tabbimoble Creek west

Receival sites identified for Weeping paperbark were determined as not suitable for receival of this species due to access difficulties and inundation of floodwaters, as noted in the Year 1 (2016/2017) Translocation Monitoring Report. For further information see Appendix 7.

Donor species: Singleton mintbush, Weeping paperbark

The receiving site is close to (<0.5km) to the Singleton mintbush donor site and approximately 16 km from the New Italy Weeping paperbark donor site, see figure 5.15.

Tenure: Roads and Maritime Biodiversity Offset

Threats: Likely to be fire sensitive

Vegetation Description: Moist sclerophyll forest

Weeds: Exotic herbs and grasses, Lantana

Cover: Sparse

Site suitability: The site matches with the known habitat of Singleton mintbush on sandy banks of Tabbimoble creek in swamp forest and Weeping paperbark on coastal floodplain forest. Singleton mintbush is present on the adjacent property to the north. See Figure A5.15 Tabbimoble.

Reference sites: Singleton mintbush - the existing populations of Singleton mintbush on the to the north east of the receiving sites will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

Weeping paperbark - the remaining population of Weeping paperbark at New Italy will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

6.20 Coolgardie Road/ Randles Creek (Site 12)

Receival site identified for a number of rainforest species Stinking Cryptocarya, Rusty Rose Green Walnut, Red Lilly Pilly, White Laceflower and Rough-shelled Bush Nut following poor performance at Lumleys lane (BOS 22), as noted in the Year 1 (2016/2017) and Year 2 (2017/2018) Translocation Monitoring Report.

Donor species: Rainforest species

The receiving site is up to 1km from several donor sites in the Coolgardie area to the north , see figure A5.26.

Tenure: Site will remain in Roads and Maritime road reserve.

Threats: Weeds

Vegetation Description: Subtropical rainforest White Booyong -Fig subtropical rainforest of the North Coast (Jacobs 2014f).

Weeds: Lantana, Mistflower, Large and small-leaved Privet, exotic herbs and grasses.

Cover: Sparse to dense

Site suitability: Areas of subtropical rainforest present on the site.

Appendix 7 Change of Translocation Receival Sites for *Melaleuca irbyana* (Weeping Paperbark) for Portion C

To:	Peter Higgs (EPA), Murray Curtis (ERM), Scott Lawrence (RMS), Woods, Mark (Pacific Complete), Jason Sheehan (RMS), Brian Tolhurst (EPA), Matthew Stephens (RMS)	Date:	18/04/17
From:	Tom St Vincent Welch (Pacific Complete)		
cc:	Mathew Neeson (Pacific Complete), Jasmine Walden (PC)		
Subject:	Change of translocation receival sites for <i>Melaleuca irbyana</i> (Weeping Paperbark) on Portion C.		

As part of the approved Woolgoolga to Ballina (W2B) Pacific Highway Upgrade Translocation Strategy, the translocation of *Melaleuca irbyana* (Weeping Paperbark) is required.

Dr Andrew Benwell, who is contracted to undertake translocation works on W2B, has identified the receival sites listed within the Translocation Strategy as not suitable for receival of this species due to access difficulties and inundation of floodwaters. Below is a statement from Andrew Benwell regarding the proposed changes:

"I inspected prospective Melaleuca irbyana (Weeping Paperbark) receival sites on 8/4/17 and found a suitable area in the Biobanking property at Tabbimoble Creek on the western side of the highway. Access to the other two sites at Bungalwalbin is still blocked by floodwater so they are probably much too wet for planting.

The larger paddock areas on the Tabbimoble Creek land are all still waterlogged but the sites shown on the attached plan have drained sufficiently to be able to plant. Floodwater has been over the sites but they drain a bit faster. The sites are on the western side of a small creek which has a good crossing underlain with stones so there should be no problems with access. The sites are large open clearings surrounded by floodplain forest of Swamp Box, Forest Red Gum, Broad-leaved Paperbark, Casuarina glauca and White Stringybark, which will make the site more sheltered. I inspected cleared areas at the northern end of the land but they were too waterlogged.

Melaleuca irbyana grows in floodplain situations as well as on relatively dry rises such as at New Italy. The site identified is on a slight dome so in between wet and dry. Two areas have been selected with slightly different drainage, soil texture and exposure."

The proposed translocation sites within the above Roads and Maritime owned property are located within areas that will be protected by an in-perpetuity BioBanking agreement.

To increase the likelihood of a successful translocation of the species and the provision of safe and reliable access for monitoring and maintenance at the site, the proposal from Andrew Benwell as above is recommended to be implemented. If agreed, the W2B Translocation Strategy would be updated to reflect the changed location.

From: Peter Higgs [<mailto:Peter.Higgs@epa.nsw.gov.au>]

Sent: Monday, 24 April 2017 10:18 AM

To: St Vincent Welch, Tom; Murray Curtis; Woods, Mark (Pacific Complete); Jason.L.SHEEHAN@rms.nsw.gov.au; LAWRENCE Scott B (Scott.LAWRENCE@rms.nsw.gov.au); Brian Tolhurst; matthew.stephens@p2t.net.au

Cc: Neeson, Mathew; Walden, Jasmine (PB); Playne, Adam (PB)

Subject: RE: Translocation Strategy Change Memo - Portion C

Hi Tom,

The EPA are comfortable with the proposed changes to the translocation strategy for W2B, regarding the Weeping Paperbark (*Melaleuca irbyana*), and as detailed by Dr Andrew Benwell in the attached document.

Regards

Peter

Peter Higgs

Senior Threatened Species Officer-North Coast Region

North Branch, NSW Environment Protection Authority

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Appendix 8 Green-leaved Rose Walnut Remediation Action Plan

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10 December 2019
Ref No: 2938-1145

BGC Contracting
Level 3/143 Coronation Drive
MILTON QLD 4064

Attention: Mr Jason Haslett

Dear Jason

Green-leaved Rose Walnut Rehabilitation Plan – W2B Section 4 Major Civil Works

Background

Introduction


This *Green-leaved Rose Walnut Rehabilitation Plan* has been prepared to address *Action 3: Rehabilitation of the Green-leaved Rose Walnut Remediation Advice – W2B Section 4 Major Civil Works* (GeoLINK 2019; Ref. No. 2938-1088).

The aim of this plan is to ameliorate the impacts of removal of the Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *errulate*) located on the western side of the Woolgoolga to Ballina (W2B) alignment at the Maclean interchange (chainage 80700). The Green-leaved Rose Walnut is listed as Endangered under the *NSW Biodiversity Conservation Act 2016* (BC Act). This plan aims to maintain consistency with the objectives of the following W2B documents:

- *Flora Translocation Strategy: Early Works Soft Soil Treatment Areas, Woolgoolga to Ballina Pacific Highway Upgrade, Version 2* (RMS 2015a).
- *Flora Translocation Strategy Flora Translocation Strategy Pacific Highway Upgrade Sections 3-11 excluding Early Works Soft Soil Treatment Areas Woolgoolga to Ballina Version 2* (RMS 2015b).

The specific objectives of this plan are to:

- Identify additional occurrences of Green-leaved Rose Walnut in the Maclean area.
- Collect and propagate at least 20 cuttings/seeds.
- Establish at least ten Green-leaved Rose Walnut at the Maclean interchange (Management Zone 1).
- Manage weeds at the Green-leaved Rose Walnut tree on the eastern side of the Pacific Highway at approximate chainage 81700 (Management Zone 2).



This plan will form an addendum to the *Flora Translocation Strategy Pacific Highway Upgrade Sections 3-11 excluding Early Works Soft Soil Treatment Areas Woolgoolga to Ballina Version 2 (RMS 2015b)*.

Site Inspection

To assist with developing this plan, a site inspection was undertaken on 28 March 2019 attended by BGC (Laura Andersen), ECOS Environmental Pty Ltd (Dr Andrew Benwell) and GeoLINK (David Andrighetto and Adrian Leader). Key outcomes from the site inspection influencing the actions of this plan include:

- No emergent shoots or living roots of cleared Green-leaved Rose Walnut tree were present. The main rootball has been removed. Translocation of subject tree's root material is therefore not a remediation option.
- There is negligible room for plantings in the remaining forest area within the W2B Project Boundary adjacent to where the plant was removed. It is unlikely that planting within established forest would grow well due to competition with existing established vegetation.
- The Green-leaved Rose Walnut tree on the eastern side of the Pacific Highway in the road reserve at approximate chainage 81700 is not suitable for seed or cutting collection.
- Preliminary searches for a known Green-leaved Rose Walnut tree near the Maclean Essential Energy substation failed to detect any Green-leaved Rose Walnut trees. It is unlikely that any Green-leaved Rose Walnut trees in this area would be suitable for seed/ cutting collection due to current state of this vegetation from vine, weed and flying-fox damage.
- Searches for Green-leaved Rose Walnut trees potentially suitable for seed/ cutting collection in Maclean Nature Reserve were suspended. There are historic records of Green-leaved Rose Walnut within the reserve however due to vegetation damage from flying-foxes, it is unlikely that any trees present would be in a suitable condition for seed/cutting collection.

Consideration For Sourcing Materials

Opportunities to source Green-leaved Rose Walnut trees from a nursery were investigated. Liaisons with Firewheel Nursery (a recognised nursery that specialise in subtropical rainforest species) found that they did not propagate Green-leaved Rose Walnut or know of any local suppliers that do.

Nurseries generally do not stock threatened flora species due to the licencing provisions associated with collecting and propagating threatened species. Being a rare and slow growing species, Green-leaved Rose Walnut also does not have the plant growth traits typically targeted by nurseries.

Collection and propagation of seeds/ cuttings from Green-leaved Rose Walnut trees growing naturally has been determined as the appropriate course of action for the project and is consistent with the project Flora Translocation Strategy (RMS 2015b).

Action 1: Targeted Green-leaved Rose Walnut Surveys

Objective:

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

Actions:

Action	Requirement	Timing	Responsibility
Database searches	Undertake database searches for local Green-leaved Rose Walnut records including: <ul style="list-style-type: none"> ■ Office of Environment and Heritage: BioNet Database. ■ Atlas of Living Australia. ■ Australasian Virtual Herbarium. 	April 2019	Ecologist
Identify target Green-leaved Rose Walnut survey areas	Identify locations for target Green-leaved Rose Walnut surveys on public land based on the database search results, aerial photograph interpretation and vegetation mapping review.	April 2019	Ecologist
Target field surveys	Two ecologists/ botanists would undertake targeted Green-leaved Rose Walnut field surveys for one to two days. The following information would be collected for each Green-leaved Rose Walnut detected: <ul style="list-style-type: none"> ■ Location (GPS co-ordinate) ■ Tree height. ■ DBH. ■ Plant condition/health. ■ Presence/absence of reproductive material (flowers or fruit). ■ Presence/absence of new leaf growth (suitable for cuttings). ■ Suitable for seed/cuttings collection. ■ Site condition. ■ Plant community type. ■ Canopy cover. ■ Mid-storey cover. ■ Ground cover. 	April 2019	Ecologist
Reporting	Report findings of the above actions to Pacific Complete (PC)/ NSW Roads and Maritime Service (via BGC).	April 2019	Prepare report: Ecologist Distribute report: BGC

Outcome:

Target Green-leaved Rose Walnut surveys addressing **Action 1** were undertaken in the Maclean area in April 2019 by GeoLINK (refer to **Attachment A**). No Green-leaved Rose Walnut trees were detected. **Action 2 Collect and Propagate Seeds/ Cuttings** will most likely need to be sourced from Green-leaved Rose Walnut trees associated with Section 10 of W2B.



Action 2: Collect and Propagate Seeds/ Cuttings

Objective:

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

Actions:

Seed/ cutting collection and propagation would be undertaken in accordance with Section 3: *Translocation Procedure* of RMS (2015b), including the following sections:

- Section 3.1 Guidelines: This section details guidelines relevant to collection and propagation of plant material and pathogen hygiene.
- Section 3.2 General methods: Translocation methods relevant to the subject plan for Green-leaved Rose Walnut include seed collection and cuttings.
- Section 3.3 Seed collection and propagation: November to May (also other times) is identified as the likely period that seeds of Green-leaved Rose Walnut may be available. Seed collection, labelling, storage and nursery propagation considerations are also detailed.
- Section 3.5 Cuttings: Stem and cuttings will be rooted with hormone treatment in specialist misting facilities. All cutting material should be labelled to indicate plant of origin.
- Section 3.6 Potting and growing on: Provisions relevant to the subject Green-leaved Rose Walnut translocation are provided for both seedlings and cuttings.

Seed/ cuttings material would be collected from either Green-leaved Rose Walnut populations in the Maclean area or W2B Section 10. The Section 10 population is the most likely source and includes:

- One Green-leaved Rose Walnut tree within the project area outside the clearing limits east of Lumleys Lane.
- Fifteen Green-leaved Rose Walnut trees within the project area outside the clearing limits west of Pimlico Road (RMS 2015b).

The location of the Section 10 donor sites are detailed in RMS (2015b).

The status of collection and propagation activities will be detailed in the annual report.

Timing:

Commence: April 2019.

Note: Flexibility with the timing of this component is required. The time between seed/cutting collection and stock being ready for planting may be up to 2-3 years.

Responsibility:

Suitably experienced botanist/ horticulturalist and associated nursery.

Action 3: Vegetation Regeneration and Green-leaved Rose Walnut Plantings (Management Zone 1)

Objective:

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

Site Description:

Management Zone 1 is located at approximate chainage 80660 on the western side of the Maclean interchange, within the W2B Project Boundary (refer to **Plate 1** and **Plate 2**). It is approximately 20 m wide and 40 m long (*note: the final dimensions would be determined on site to take advantage of the foothill terrace while avoiding the steeper slopes and floodplain where possible*). A chainmesh fence borders the site to the north/ west, while the road formation and drain occurs to the south/ east. The site is located at the bottom of a forested foothill at the interface with the floodplain and has a south-east aspect. It is situation approximately 40 m south-west of where the cleared Green-leaved Rose Walnut tree was located.

The site has been previously cleared, however native saplings are regenerating (Flooded Gum *Eucalyptus grandis*, Cheese Tree *Glochidion ferdinandi*, Foambark Tree *Jagera pseudorhus* and Tuckeroo *Cupaniopsis anacardioides*).



Plate 1 Aerial photo of Management Zone 1

Base image source: Pacific Complete SiteMap Portal (29/03/2019).



Plate 2 Management Zone 1 viewed from south-east

Actions: Management Zone 1

Action	Requirement	Timing	Responsibility
Site Preparation	<p>In accordance with Section 3.4 <i>Pre-translocation receiving site preparation</i> of RMS (2015b), actions required include:</p> <ul style="list-style-type: none"> ■ Fence off site and install no-go signage. ■ Weed control using best practice weed management methods to create opportunities for natural regeneration. 	<p>Six monthly monitoring/ weed control* until propagated Green-leaved Rose Walnut stock are ready to plant.</p> <p>*Weed monitoring and treatment has been undertaken in April 2019 and May 2019. The next planned monitoring and treatment (if required) is November 2019.</p> <p>Fencing and no-go signage was completed mid-2019.</p>	Appointed botanist/ horticulturalist/ bush regenerator

Action	Requirement	Timing	Responsibility
Planting	<p>Plant of at least 10 Green-leaved Rose Walnut trees amongst a planting of other rainforest species (such as Red Kamala <i>Mallotus philippensis</i>, Cheese Tree, Foambark Tree and Guioa (<i>Guioa semiglauc</i>a)) The planting would be established at 2 m spacing. Include acacias (e.g. <i>Acacia disparrima</i> and/or <i>A. melanoxylon</i>) around the perimeter of the site to provide protection.</p> <p>Planting would be undertaken in accordance with Section 3.11 <i>Transport to field and planting</i> of RMS (2015b) and include:</p> <ul style="list-style-type: none"> ■ Preliminary: Sun-harden all nursery stock – seedlings and established cuttings of trees. ■ Transport to receiving site: Nursery stock to be protected from wind and desiccation during transport (well-watered at starting point and in covered tubs or under secure tarpaulin). ■ Planting: Place in excavated hole or depression and back fill with local soil as necessary. Weed free mulch may be required for the planted tree species to assist in retaining moisture and suppress weed. Watering will be necessary on planting and may be ongoing depending on the season. Consider use of wetting agent. <p>After transplanting, individuals will be tagged with their ID code. A map of the receiving site showing the transplanted individuals identified by ID code will be prepared.</p> <p>Best practice planting methods would be adopted including weed management, mulching and slow release fertilisers.</p>	Once Green-leaved Rose Walnut stock are ready (as determined by appointed botanist/horticulturalist).	Appointed botanist/horticulturalist/bush regenerator
Follow-up monitoring and maintenance	<p>Monitoring and maintenance would be undertaken in accordance with Section 5 of RMS (2015b). This would include mulching, watering and weed management when required; and collection of monitoring data.</p>	<p>Year 1 post planting: every 3 months.</p> <p>Year 2 post planting: every 6 months;</p> <p>Once a year thereafter (minimum 3 years; up to 5).</p>	Appointed botanist/horticulturalist/bush regenerator
Monitoring Reporting	An annual monitoring report would be prepared in accordance with Section 5 of RMS (2015b).	Annually	<p>Prepare report: Appointed botanist/horticulturalist/bush regenerator</p> <p>Distribute report: BGC</p>

Action 4: Vegetation Regeneration (Management Zone 2)

Objective:

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

Site Description:

Management Zone 2 comprises *Flooded Gum – Brush Box moist forest of the coastal ranges of the North Coast* vegetation with a single Green-leaved Rose Walnut tree. It is located on the eastern side of the Pacific Highway in the road reserve at approximate chainage 81700 (refer to **Plate 3** and **Plate 4**).

The subject Green-leaved Rose Walnut is currently smothered with the vine weed Dutchman's Pipe (*Aristolochia elegans*). Weed management in the vicinity of this plant (minimum 30 m radius) would increase the opportunity for natural regeneration, reduced competition and strengthen its resilience to edge effects and exposure created by the highway clearing.



Plate 3 Aerial photo of Management Zone 2


Base image source: Pacific Complete SiteMap Portal (29/03/2019).



Plate 4 Green-leaved Rose Walnut at Management Zone 2

Actions: Management Zone 2

Action	Requirement	Timing	Responsibility
Weed Management	Implement best practice weed management to suppress weeds at the site and encourage natural regeneration. Target weed species include (but are not limited to) Dutchman's Pipe, Tobacco Bush (<i>Solanum mauritianum</i>), Climbing Asparagus Fern (<i>Asparagus plumosus</i>), Lantana (<i>Lantana camara</i>), Ochna (<i>Ochna serrulata</i>), Camphor Laurel (<i>Cinnamomum camphora</i>) and Cocos Palm (<i>Syragrus romanzoffiana</i>).	Commence: April 2019* Follow up weed management works would be undertaken simultaneously with any monitoring/maintenance works at Management Zone 1. *Weed monitoring and treatment has been undertaken in April 2019 and May 2019. The next planned monitoring and treatment (if required) is November 2019	Appointed bush regenerator
Monitoring Reporting	Annual reporting for Management Zone 1 would include the monitoring and	Annually (including with	Prepare report: Appointed



Action	Requirement	Timing	Responsibility
	management actions and outcomes for Management Zone 2. The report would be prepared in accordance with Section 5 of RMS (2015b).	Management Zone 1 reporting).	botanist/ horticulturalist/ bush regenerator Distribute report: BGC

Monitoring evaluation and reporting

Monitoring evaluation and reporting for **Actions 2, 3 and 4** would be in accordance with Section 5 of RMS (2015b), as summarised below. **Action 1** has been completed (refer to **Attachment 1**).


Monitoring

Monitoring of the Green-leaved Rose Walnut plantings would be evaluated by measuring vital rates (survival growth fecundity) of propagules. The following data would be collected for the Green-leaved Rose Walnut plants at Management Zone 1 and Management Zone 2 as a minimum:

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

Timeframe:

Monitoring of the Green-leaved Rose Walnut plants at Management Zone 1 and Management Zone 2 would be conducted during and after construction for a minimum of 3 years a total of approximately 5



years. The monitoring timing would be syncretised with the translocation monitoring being undertaken on the W2B project.

Record of Rehabilitation Plan Actions and Results:

- Record of collection of propagules.
- Germination time and % cutting strike rate and time required.
- Nursery conditions.
- Growing on period.
- Planting out.
- Post-planting care.
- Baseline measurements of translocated plants as below.
- Vegetation regeneration (including weed management works).

Monitoring Frequency:

The monitoring frequency associated with **Action 3: Vegetation Regeneration and Green-leaved Rose Walnut Plantings (Management Zone 1)** would be in accordance with RMS (2015b), as follows:

- Pre planting (Site Preparation): Six monthly monitoring/ weed control at Management Zone 1 until propagated Green-leaved Rose Walnut stock are ready to plant. The status of collection of propagules and stages
- Post planting:
 - Year 1: every 3 months.
 - Year 2: every 6 months.
 - Once a year thereafter (minimum 3 years; up to 5).

The monitoring frequency associated with **Action 4: Vegetation Regeneration (Management Zone 2)** would be undertaken simultaneously with any monitoring/ maintenance works associated with **Action 3**.

Performance criteria and adaptive management

Relevant performance criteria from Section 5.2 of RMS (2015b) apply for the **Actions 2, 3 and 4** and are summarised below. **Action 1** has been completed (refer to **Attachment 1**).

Propagation and Record keeping:

Criteria for successful propagation would include:

- The required number of transplants was available for the translocation.
- Correct labelling and documentation was maintained through cultivation.
- Techniques for successful propagation are determined.
- A genetically representative collection was maintained.

Short Term Criteria (to 5 years):

For the planted Green-leaved Rose Walnut plants:

- At least 70% of the planted trees are surviving after the first year and 60% after five years (and arrangements for replacement from backup stock are underway in case of failure to meet this target).
- Flowering and seed production occurs in planted individuals (if appropriate to species timeframe and maturity of planted material).
- The plantings display similar growth development and vigour to naturally occurring populations.

Habitat and threat management:

- Good quality habitat restored in and surrounding the receival site.
- Maintenance carried out at suitable intervals.
- Threatening processes including weed invasion controlled or eradicated.

Monitoring Reporting

Monitoring reporting for this rehabilitation plan would be included as part of the annual reporting provisions for RMS (2015b). The report will include:

- Background and description of the rehabilitation works (initial report)
- The status of collection and propagation activities.
- Adopted propagation methods (initial report).
- Monitoring methods.
- Monitoring results.
- Evaluation of translocation success to date.
- Identify any corrective actions required.
- Recommendations for immediate and ongoing management.
- General recommendations for future translocation projects.

Please contact the undersigned should you require any further information.

Yours sincerely

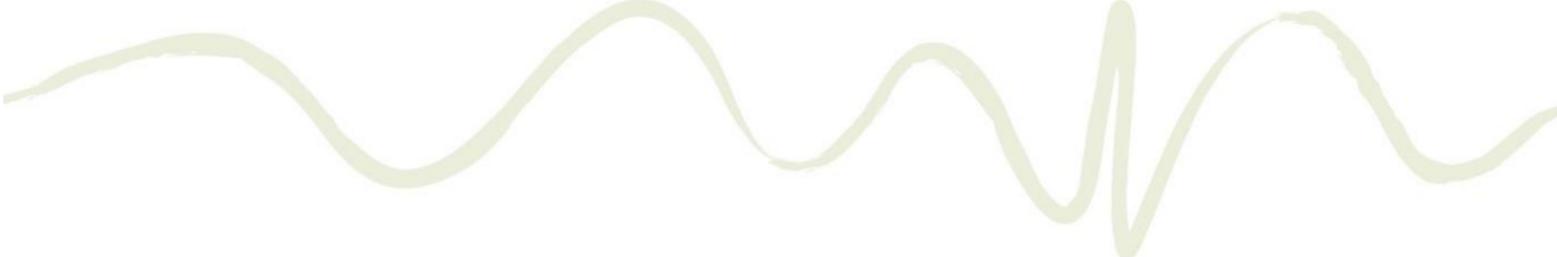
GeoLINK



David Andrighetto

Ecologist

UPR	Description	Date issued	Issued By
2938-1097	First issue (draft)	29/03/2019	David Andrighetto
2938-1099	Second issue	1/04/2019	David Andrighetto
2938-1137	Third issue	01/11/2019	David Andrighetto
2938-1140	Fourth issue	19/11/2019	Grant McLean
2938-1145	Fifth issue	10/12/2019	David Andrighetto



**Attachment 1 Green-leaved Rose Walnut Surveys - April 2019:
W2B Section 4 Major Civil Works**

29 April 2019
Ref No: 2938-1104

BGC Contracting
Level 3/143 Coronation Drive
MILTON QLD 4064

Attention: Mr Taurai Masvingise

Dear Taurai

Green-leaved Rose Walnut Surveys -April 2019 – W2B Section 4 Major Civil Works

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1.1 Introduction


GeoLINK was engaged to address *Action 1: Targeted Green-leaved Rose Walnut Surveys* of the *Green-leaved Rose Walnut Rehabilitation Plan – W2B Section 4 Major Civil Works* (GeoLINK 2019; Ref. No. 2938-1099). The objective of the survey was to identify additional occurrences of Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*) in the Maclean area, that form part of the Maclean Green-leaved Rose Walnut population. The trees within Woolgoolga to Ballina Pacific Highway upgrade (W2B) Section 4 form part of this population. The suitability of detected trees for seed/cutting collection and propagation as part of the rehabilitation plan would be considered (refer to GeoLINK 2019 for details).

1.1 Database Searches

Database searches for local Green-leaved Rose Walnut records were undertaken on 1 April 2019 and included the following databases:

- Australasian Virtual Herbarium.
- Office of Environment and Heritage (OEH): BioNet Database.
- Atlas of Living Australia.

The Australian Virtual Herbarium search found five Green-leaved Rose Walnut records in the Maclean area, located within 5 km of the Green-leaved Rose Walnut trees in W2B Section 4 (refer to **Attachment 1**). These records date between 1980 and 2016. A single outlying record occurs 36 km south of Maclean in the Pillar Valley.



The OEH Bionet database search found four Green-leaved Rose Walnut records in the Maclean area (excluding the W2B Section 4 trees), located within 1 km of the Green-leaved Rose Walnut trees in W2B Section 4 (refer to **Attachment 1**). An additional record occurs approximately 6 km to the north-northeast of Maclean in the Ashby locality.

The Atlas of Living Australia database search found nine Green-leaved Rose Walnut records in the Maclean area (excluding the W2B Section 4 trees), although these all duplicated the records from the other databases (refer to **Attachment 1**).

Overall the data searches suggest the presence of a low density Green-leaved Rose Walnut population at Maclean, occupying pockets of rainforest and wet sclerophyll forest in an area extending between Maclean Nature Reserve and Ashby; including Ulgundahi Island, Maclean High School/ Cemetery and private land associated with Maclean Pinnacle.

1.2 Green-leaved Rose Walnut Surveys

Target Green-leaved Rose Walnut surveys were undertaken by GeoLINK ecologists David Havilah and Grant Maclean on 9 and 11 April 2019. The surveys involved meander surveys in rainforest and wet sclerophyll forest on public land in the Maclean locality in the following locations:

- All public land associated with the Maclean High School, Showground and Cemetery (including the locations of two Green-leaved Rose Walnut records).
- Habitat associated with a Green-leaved Rose Walnut record on the western bank of the South Arm of the Clarence River (opposite Maclean Nature Reserve).
- Vegetation associated with the existing flying fox camp either side of Cameron Street including appropriate habitat extending north east along a small creek occurring on a property easement.
- Appropriate habitat within public land on Woodford Island.
- Areas of appropriate habitat on public land in and around Townsend (east of the highway) including vegetation associated with Pacific Valley Christian School.
- Areas of appropriate habitat, downslope of Lookout Rd on public land including land.
- Areas of the Clarence River riparian zone to the east of the new Harwood Bridge (south bank).

A total of 24 hours of target meander surveys were undertaken.

Key survey limitations include:

- Limited land access; the surveys were restricted to accessible public land only.
- Flying-fox damage and vine weed invasion in the rainforest and wet sclerophyll forest associated with the Maclean flying-fox camp at Maclean Nature Reserve, Maclean High School/ Cemetery, Maclean Essential Energy substation and gully north of Cameron Street. It is unlikely that any Green-leaved Rose Walnut trees in this area would be suitable for seed/cutting collection due to current state of this vegetation.

1.3 Results and Discussion

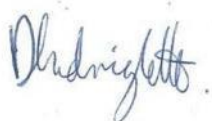
No Green-leaved Rose Walnut trees were detected. The above listed survey limitations are a key factor contributing to this outcome. Many of the Green-leaved Rose Walnut locations identified by the database searches were unable to be accessed or were impacted by flying-fox roosting.

Action 2: Collect and Propagate Seeds/Cuttings of the Green-leaved Rose Walnut Rehabilitation Plan – W2B Section 4 Major Civil Works (GeoLINK 2019) will need to be sourced from Green-leaved Rose Walnut trees associated with the Ballina/ Richmond River catchment.

Please contact the undersigned should you require any further information.

Yours sincerely

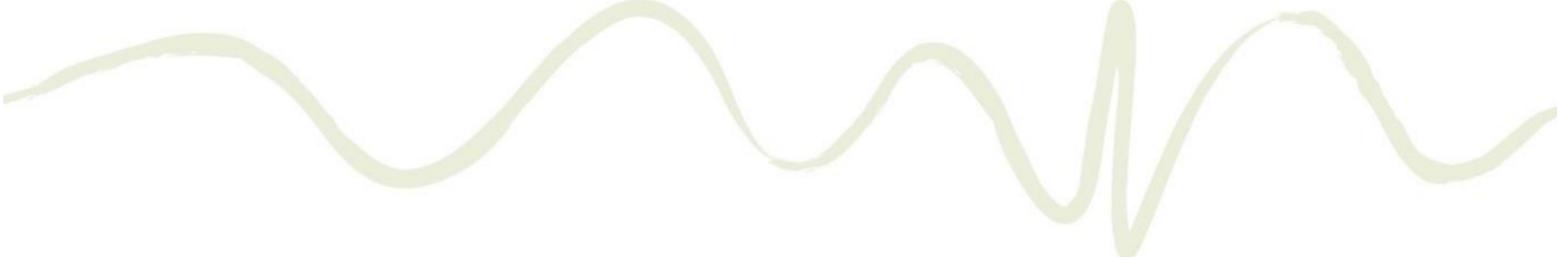
GeoLINK



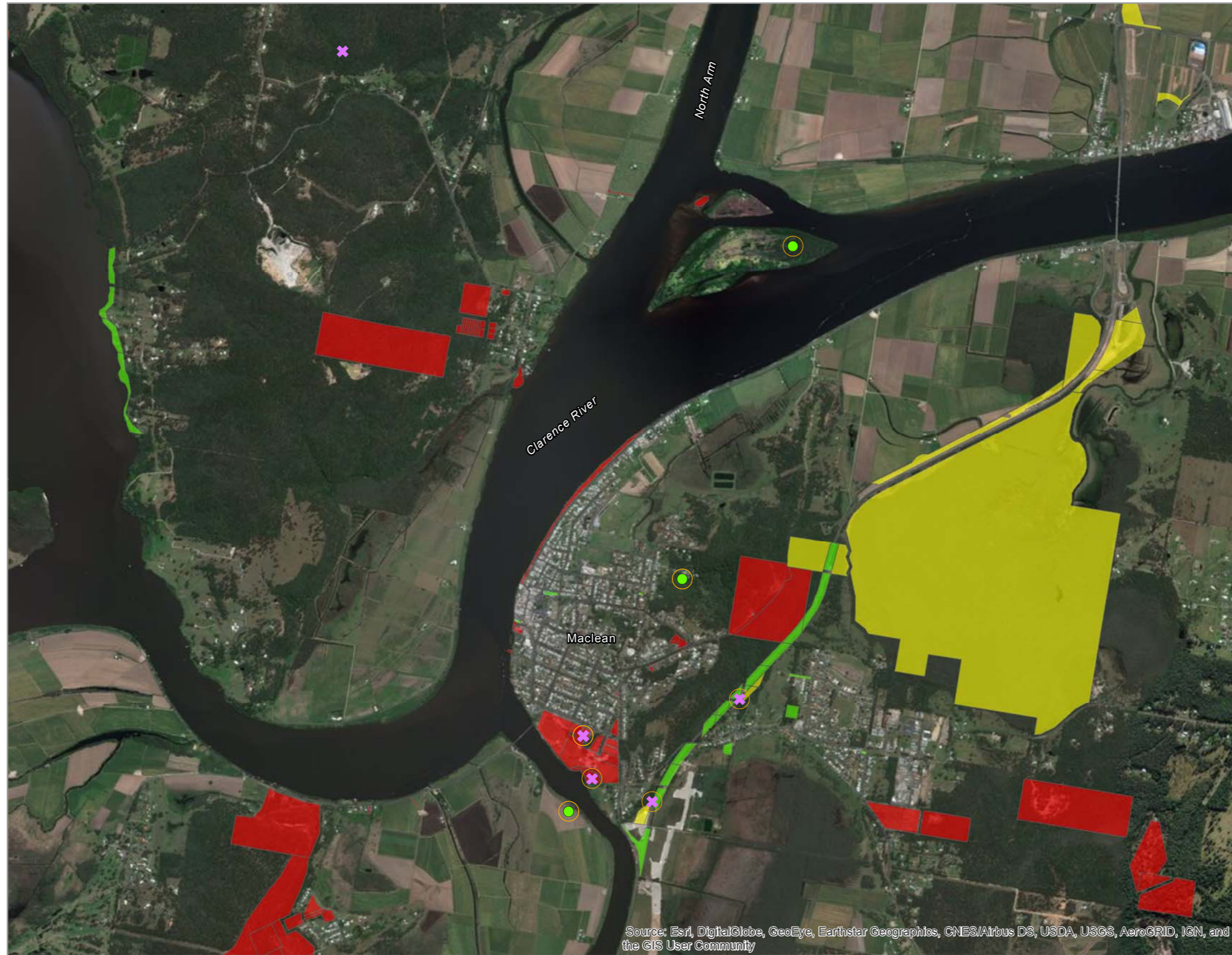
David Andrighetto

Ecologist

UPR	Description	Date issued	Issued By
2938-1104	First issue	29/04/2019	David Andrighetto



Attachment 1 Green-leaved Rose Walnut Database



LEGEND

- Crown land
- Land under LGA authority
- NSW Government land
- Green-leaved Rose Walnut (Australian Virtual Herbarium))
- Green-leaved Rose Walnut (bionet)
- Green-leaved Rose Walnut (Atlas of Living Australia)

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GeoLINK
environmental management and design

Green-leaved Rose Walnut Surveys -April 2019 - W2B Section 4 Major Civil Works
2938-1105

Attachment 1 - Green-leaved Rose Walnut Database