Fraser Ecological

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Vegetation Management Plan

49- 51 Annam Drive

Bayview

16th December 2021

SUMMARY

Fraser Ecological Consulting has been contracted to prepare a Vegetation Management Plan (VMP) for the proposed development at 49 - 51 and drive Bayview in the Northern beaches Council local government area.

The vegetation community occurring on site is PCT 1565 'Central Coast escarpment moist forest' also known as 'Coastal Sandstone Ridgetop Woodland'. It is a locally common vegetation type, however, the microclimates available on site (southern aspects on a sheltered gully slope) provide a more 'mesic' rainforest influenced species composition.

Figure A breaks up the site into 2 management zones for weed management, bush regeneration and native replanting as follows:

- Management Zone 1: Bushfire asset protection zone. Further to Appendix A for Planning for Bushfire Protection 2019 requirements. This area shall be managed as a bushfire inner protection area and shall require selective canopy tree removal retention of all groundcovers and shrubs in islands with selected. Retained native trees have been identified. Shall remain in a fuel reduced state. Maintenance weed removal is required particularly plants that dominate the mid-story in some areas. Total area equates to 800 sqm.

- Management Zone 2: is the core bushland to be retained for the northern portion of the property. It is topographically differentiated from the asset protection zone by the presence of large sandstone rock outcrops which are inaccessible for standard bushfire APZ maintenance purposes. Total area equates to 1500 sqm.

This VMP is to be achieved by weed management, supplementary native plantings and regeneration of native vegetation via best practice techniques. In recognition of the site's sensitive nature, the actions are also consistent with the "Checklist for Bush Regeneration Activities in the Habitat of Threatened Species, Endangered Populations and Endangered Ecological Communities" issued by the NSW National Parks and Wildlife Service. The plan is also in accordance with "Bush Regeneration-Recovering Australian Landscapes" (Buchanan 1989) and "Bringing the Bush Back to Western Sydney" (DIPNR and AABR 2003).

Weed control from areas of high resilience to low resilience, upper slope to lower slope in accordance with the '*Bradley Method*' (Buchanan 1989) shall be undertaken in 3 stages described as primary, secondary and maintenance weeding. Weed control techniques including hand removal and herbicide application have been described in detail and have been recommend for particular species of concern including woody weeds, small hand pull-able plants and those with underground reproductive structures.

Three (3) hollow bearing trees were observed and confirmed to be on site. Fraser Ecological recently tagged these trees so that the surveyor could update the overall site survey plan to show exactly where these trees occur what tree numbers corresponded with the arborist impact assessment report prepared by Trevor Hawkeswood (refer to Figure B on following pages). The recently updated survey identified these trees to be numbered 52, 57 and 59 in relation to the tree location plan prepared by Trevor Hawkeswood.

The most significant hollow bearing tree is numbered 52. It provides potential habitat for threatened Powerful Owl (*Ninox strenua*). Unfortunately, it is located very close to the proposed dwelling and has

been marked for removal. if Council agrees to its removal, pre-clearing surveys would be required under the supervision of a fauna ecologist, and genuine efforts shall be made to relocate and salvage the hollows from Tree 52 and 59 (one spout only) and re-attached to trees at the rear of the property.

This VMP shall be implemented for a monitoring period of five (5) years. The protection of native vegetation shall remain in perpetuity unless consent is provided by Council for additional tree removal.

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Fraser Ecological Consulting accepts no liability or responsibility in respect of any use or reliance upon this report by any third party.

Unauthorised use of this report in any form is prohibited.

Licensing

When conducting flora and fauna surveys, consultants are required to possess licences to ensure that works are completed in an appropriate manner. Fraser Ecological Consulting is licensed under s.132c and s.91 of the NSW National Parks and Wildlife Act (1974) from the NSW Office of Environment & Heritage. This allows Alex Fraser to undertake scientific investigations, collect specimens of protected flora and fauna across NSW in service and non-service areas and undertake bushland restoration works in EECs. This licence requires that all survey results are reported to the NSW NPWS for inclusion into the Atlas of NSW Wildlife.

Alex Fraser also holds an Animal Research Authority under the Animal Research Act (1995), as administered by NSW Agriculture. Surveys are approved and supervised by an Animal Care and Ethics Committee, applying the standards as detailed in the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (NHMRC 1997).

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1.0 Introduction

1.1. Introduction

Fraser Ecological Consulting has been contracted to prepare a Vegetation Management Plan (VMP) for the proposed dwelling house construction at 49-51 Annam Road Bayview in the Northern Beaches Council local government area.

This plan has been prepared in response to *Council's RFI dated 15th October 2021 as follows (italics):*

Council's Biodiversity referrals team have calculated the slope for the property to be >18 degrees. As such, Section 3.2.2 of Planning for Bushfire Protection (2019) applies to the development. Pursuant to this clause, "a management plan must be submitted with the DA to provide details on how the APZ will be implemented and maintained. The management plan should include:

- *The mechanical means necessary to complete the management required;*
- *A schedule for maintenance to occur to ensure the APZ is regularly managed; and*
- *The relevant body responsible for maintaining the APZ".*

This information must be included in the Vegetation Management Plan (VMP). A VMP is required in accordance with P21DCP cl. B4.4(d) and is to be prepared by a suitably qualified person with the aim of identifying and requiring the retention and management of vegetation for conservation purposes for all areas of the site outside the approved APZ.

The VMP must outline the management of the site according to Management Zones, that are chosen based on management objectives and activities.

The following details must be included in the VMP at a minimum:

- *Replanting of vegetation*
- *Removal of priority weeds*
- *Retention and protection of important habitat features (including hollow-bearing trees and large sandstone outcrops)*
- *Erosion and sediment control and fencing*
- *Adherence to asset protection zones*

The VMP is required to consider the Landscape Plan and requirements of the IPA in accordance with Planning for Bushfire Protection (2019).

As such, the consultant preparing the VMP must consult with the Bushfire Consultant, Landscape Architect and Ecologist to ensure achievable outcomes for the site. Details of such consultation must be included within the report.

"In response to the Ecologist's comments in the email chain below, and in the interest of time I think it best that I provide some written comments as guidance for the Ecologist rather than a site visit.

My colleague and I attended the site a few weeks ago and identified at least 3 hollow-bearing trees, including hollows in two large Eucalypts and one Allocasuarina. One large hollow bearing trees is located below the sandstone escarpment on the east of the site near the boundary with No. 53-55 Annam Road – potentially Tree 28 or 29? (could not be confirmed as the trees were not tagged). See attached one photo to assist the Ecologist in identifying the hollow bearing trees. Please note that cavities within the trees, regardless of being caused by termites, are still classified as habitat for threatened species and should thus be prioritised for retention within the site. All trees will need to be checked thoroughly and photographic evidence and corresponding tree number is to be provided in the report.

With regards to the VMP, it is the responsibility of the Ecologist to determine the management zones based on activities performed within the zone (weed management, APZ, landscaping etc). As the site is small, we would recommend that there be as few zones as possible to avoid overcomplicating the VMP. Maps are to be included in the VMP, particularly a description and map of each proposed management zone, including existing bushland condition and significant environmental features.

As a minimum the VMP should have two zones. Suggested zones include:

- *Asset Protection Zone (APZ)*
- *Conservation Areas (outside the APZ)*

Performance criteria for this particular site (due to small size) may be just include photo-point monitoring undertaken by the owner. If this option is used, photo points must capture all management obligations. Copies of annual monitoring reports are to be provided to Northern Beaches Council's Bushland & Biodiversity Team.

The VMP must contain sufficient information to allow a bush regenerator to prepare a quote to implement all or any part of the plan.

Please note that all comments within the Biodiversity Referral (15th October 2022) are to be addressed in addition to the information provided in this email."

Therefore, in response to Council's requests (above), on the 28th November 2021 ecologist Alex Fraser (Fraser Ecological) undertook field surveys and identified the 3 hollow-bearing trees occurring within the APZ and tagged them so that the surveyor could update the proposed plans accordingly to show their location.

It was envisaged that this exercise would correlate with the location of tree ID numbers used by in the Arborist Impact Assessment (prepared by Trevor Hawkeswood dated 20/11/20).

We concur with Council's observations that it was very difficult on the ground to determine which tree ID numbers are the significant hollow-bearing trees.

The arborist consultant (Trevor Hawkeswood) updated the Arborist Impact Assessment Report (dated 26/11/21) identify which tree require removal (including those for the APZ) as follows: *Trees 27, 28, 29, 37, 38, 39, 40, 49, 50, 51, 80, 81, 86, 87, 88, 109, 117, 130, 131,*

134, 135, 141, 142, 144, 145, 148,151, 158 are to be removed because of bushfire concerns, i.e. they are within the APZ (Asset Protection Zone) or allowing access to construction etc.

The updated survey plan prepared by HR Ramsay and Co (dated 9/12/21) shows the exact location of the identified hollow bearing trees (provided on the following pages).

The updated survey provided on the following pages note that the hollow bearing trees are numbered 5257 and 59. Note that the arborist consultant has not recommend that these trees, be approved for removal, however, in reality these trees will be located very close all within the proposed building envelope. We raise concerns about the removal of Tree 52 which is a significant hollow bearing tree. Ideally it would be good if you could be retained. If it cannot be retained we can recommend a specialist consultant that has expertise in relocating hollows and trying to attach them to existing trees outside the bushfire asset protection zone. However, the logistics in doing this may not be practical. Refer to Section 4.8 for more detailed in this regard.

We have used the Landscape Plans prepared by Space Landscape Designs (REV C dated 8/3/21) as a baseline reference plan as best depicts the proposal in relation to trees identified for removal (Figure A – VMP Management Zones).

1.2 VMP aims and objectives

This VMP is to be achieved by weed management, supplementary native plantings and regeneration of native vegetation. In recognition of the site's sensitive nature, the actions are also consistent with the "Checklist for Bush Regeneration Activities in the Habitat of Threatened Species, Endangered Populations and Endangered Ecological Communities" issued by the NSW National Parks and Wildlife Service. The plan is also in accordance with "Bush Regeneration- Recovering Australian Landscapes" (Buchanan 1989) and "Bringing the Bush Back to Western Sydney" (DIPNR and AABR 2003).

This VMP shall be implemented for an initial period of five (5) year monitoring period in order to allow establishment of rehabilitation works and shall be managed in perpetuity.

The objectives of the VMP are to:

1) Conserve, rehabilitate, enhance and protect the remnant vegetation and to maintain and improve the faunal habitat of the site

2) Implement measures directed at minimising development impacts on the environment and do not contradict the requirements for future construction of the dwelling (i.e. APZ requirements).

3) Monitor and maintain all works until the 5 year monitoring period of the VMP, where it is considered that after this period the ecological processes on the site will be stabilised in perpetuity (with post 5 year VMP period obligations – Section 5)

4) Provide a working document to deliver successful weed management and revegetation outcome in the long term.

5) Provide a document that allows a bush regenerator to quote to implement the works

1.3 Site characteristics

The study site is located in the suburb of Bayview (49-51 Annam Drive) in the Northern Beaches Council LGA as depicted in Figure 1. The site contains remnant bushland and is topographically constrained. It is on a south-east facing slope of dense vegetation and rocky outcrops.

The total area of the site is 0.4 ha of which less than 2500 m² is proposed for development (hence avoiding the need to provide a biodiversity assessment report and triggering the New South Wales Biodiversity Offsets Scheme).

The dwelling will be built to a BAL flame zone with a 10 m asset protection zone extending to the north-west of the proposed building envelope.

Figure A shows the two management zones that are subject to this Vegetation Management Plan.

This report relies upon in the following documents previously submitted with a development application (or recently amended accordingly):

- Arborist Impact Assessment Report (prepared by Trevor Hawkeswood updated November 2021)
- Landscape Plan dated 8th March 2021 by Space Landscape Designs
- Dwelling house construction plans
- Council comments dated 15th Oct 2021
- Survey plan prepared by HR Ramsay and Co Surveyors dated 9th December 2021

Figure 1: The site in context of the wider locality

Figure 2: Aerial map of the locality (Source: six maps.com)

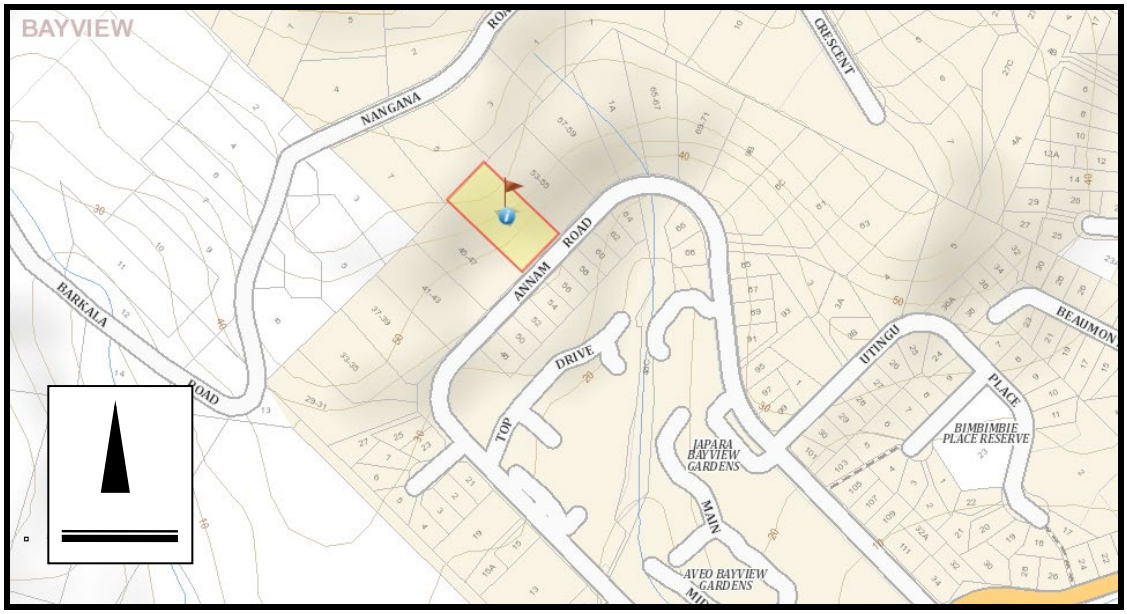


Figure 3: Map of the site showing the local water catchment and general topography (Source: SIX Maps)

Figure 4: Aerial map of the site showing property boundaries in red

(Source: Nearmap.com)

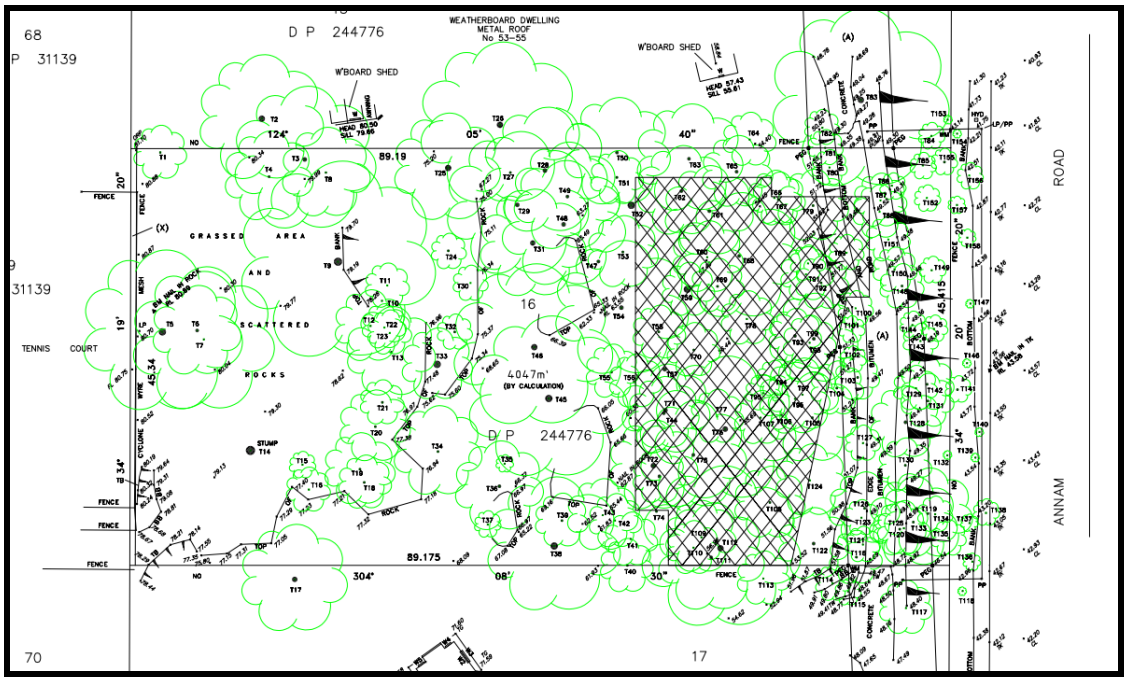


Figure 5: Tree location plan in relation to the building envelope

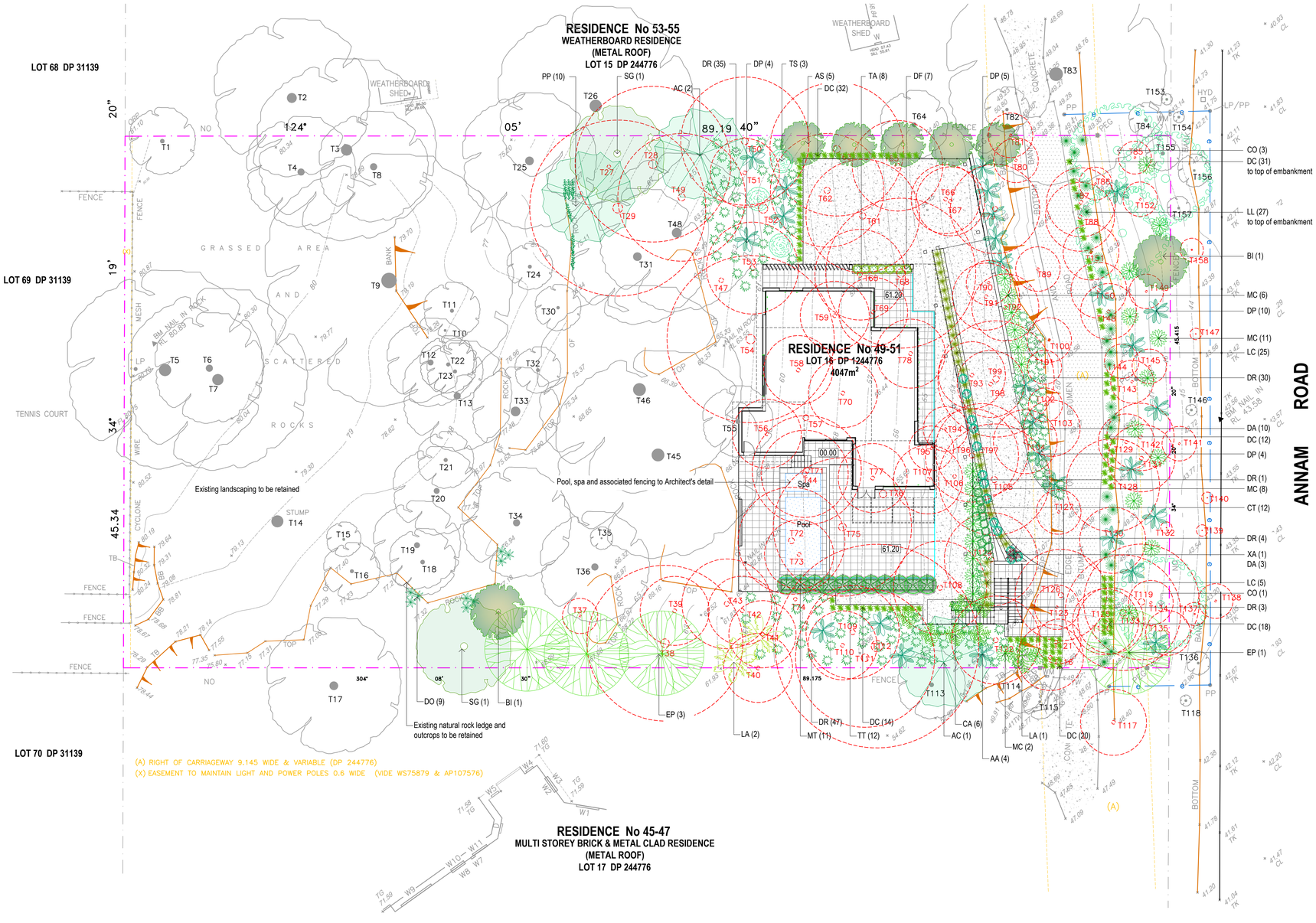
LEGEND

- BOUNDARY
- EXISTING FENCE
- 85.50 EXISTING CONTOURS
- EXISTING BITUMEN
- PROPOSED CONCRETE (TO ARCHITECT'S DETAIL)
- PROPOSE PAVEMENT (TO ARCHITECT'S DETAIL)
- PROPOSED WALL (TO ARCHITECT'S DETAIL)
- T28 EXISTING TREE TO BE RETAINED (REFER ARBORIST REPORT)
- T78 EXISTING TREE TO BE REMOVED (REFER ARBORIST REPORT)

PROPOSED PLANT SCHEDULE

KEY		BOTANICAL NAME	COMMON NAME	QTY	MATURE HGT	POT SIZE
		TREES				
^ **	AC	ANGOPHORA COSTATA	SMOOTH-BARKED APPLE	3	10m	45Ltr
**	AS	ACMENA SMITHII	LILLY PILLY	5	12m	45Ltr
**	BI	BANKSIA INTEGRIFOLIA	COAST BANKSIA	2	8m	45Ltr
^	CO	CORYMBIA GUMMIFERA	RED BLOODWOOD	4	30m	45Ltr
	CA	CYATHEA AUSTRALIS	ROUGH TREE FERN	6	4m	250mm
^	EP	EUCALYPTUS PUNCTATA	GREY GUM	4	35m	45Ltr
^ **	LA	LIVISTONA AUSTRALIS	CABBAGE TREE PALM	3	10m	250mm
*	MT	MAGNOLIA GRANDIFLORA 'TEDDY BEAR'	TEDDY BEAR MAGNOLIA	11	3m	250mm
^	SG	SYNCARPIA GLOMULIFERA	TURPENTINE	2	60m	45Ltr
		SHRUBS				
**	AA	ASPLENIUM AUSTRALASICUM	BIRDS NEST FERN	4	1m	200mm
	DP	DORYANTHES PALMERI	SPEAR LILY	23	2m	250mm
*	DF	DREPANOSTACHYUM FALCATUM	HIMALAYAN BAMBOO	7	3.5m	200mm
^	MC	MACROZAMIA COMMUNIS	MACROZAMIA	27	1.0m	200mm
**	TS	TELOPEA SPECIOSISSIMA	WARATAH	3	3.0m	200mm
^	XA	XANTHORRHOEA ARBOREA	GRASS TREE	1	2m	25Ltr
		GRASSES / GROUND COVERS				
	CT	CERASTIUM TOMENTOSUM	SNOW-IN-SUMMER	12	0.2m	200mm
^ **	DO	DOODIA ASPERA	PRICKLY RASP FERN	9	0.8m	140mm
	DC	DIANELLA CAERULEA	BLUE FLAX LILY	115	0.6m	140mm
	DA	DICHONDRA ARGENTEA	SILVER FALLS	13	0.1m	140mm
	DR	DICHONDRA REPENS	KIDNEY WEED	120	0.1m	140mm
	LC	LOMANDRA CONFERTIFOLIA 'SEASCAPE'	SEASCAPE	30	0.5m	140mm
**	LL	LOMANDRA LONGIFOLIA	SPINY-HEADED MAT-RUSH	27	1m	140mm
^	PP	PANDOREA PANDORANA	WONGA WONGA VINE	10	-	140mm
*	TA	TRACHELOSPERMUM ASIATICUM 'FLAT MAT'	FLAT MAT	8	0.2m	200mm
*	TT	TRACHELOSPERMUM JASMINOIDES 'TRICOLOUR'	VARIEGATED JASMINE	12	0.2m	200mm

** Littoral Rainforest EEC species
^ Native species found onsite
* Podium planting



LANDSCAPE SPECIFICATION NOTES

SITE PREPARATION
Locate any underground and overground services & ensure no damage occurs. Levels on plan are nominal only & all dimensions to be checked on site prior to commencement. Final structural integrity of all items shall be the sole responsibility of landscape contractor.

WORKMANSHIP AND MATERIAL QUALITY
Materials and workmanship are to conform to the current applicable Australian Standard Specifications and Codes.Any work or materials, which, in the opinion of the Site Manager do not meet appropriate industry standards should be rejected.

PROTECTION OF EXISTING TREES:
Prior to construction, the builder shall erect tree protection fencing to the drip line of existing trees to be retained. The fence shall be constructed of star pickets at 2.4m spacings and connected by three strands of 2mm wire at 300mm spacings to a minimum height of 1500mm. Protect all trees affected by demolition & construction. Take necessary precautions to protect the Structural Root Zone(SRZ) as per AS 4970-2009 Australian Standard for Protection of Trees on Development Sites.Tree protection measures shall remain intact until the completion of all construction works.
Prohibited Works or material storage within the TPZ as per AS 4970-2009 except with approval of council:
- entry of machinery or storage of building materials, parking of any kind of vehicle
- erection or placement of site facilities, removal or stockpiling of soil or site debris
- disposal of liquid waste including paint & concrete wash
- excavation or trenching of any kind (including irrigation or electrical connections).
- attaching any signs or any other objects to the tree, placement of waste disposal or skip bins
- pruning and removal of branches, other than those by a qualified Arborist

Compacted Ground/Coring: Avoid compaction of the ground under trees. If compaction nevertheless occurs loosen the soil by Coring. Coring to be carried out by a qualified Arborist.

REMOVAL OF EXISTING TREES
All trees to be removed shall be carried out by a qualified arborist and work shall conform to the provisions of AS4373-2007 Australian Standards for The Pruning of AmenityTrees.

ELIMINATE WEEDS
Remove all existing weeds by hand, wiping or spraying with a glyphosate based herbicide. Weed control shall never be performed by mechanical cultivation or by scraping. Herbicide spraying is to be used to eliminate all existing weeds 30 days prior to planting.

EXCAVATION & SUB SOIL PREPARATION
Excavate garden beds to the depth required and rip or scarify base & sides of pit to a minimum depth of 150mm.

SUB SOIL DRAINAGE
Install drainage layer where there is surface water runoff draining into garden bed areas & where the existing sub-soil has more than 50% clay composition & there is a risk of subsurface water ponding.
Install perforated corrugated ag. line 75-100mm Dia. with geotextile filter sock & backfill to a minimum 200mm using free draining material, reclaimed/recycled where available. Direct flows at a minimum 0.5% fall to SW system. In areas isolated from stormwater system excavate & backfill an appropriate water dispersion pit.

REUSE EXISTING TOPSOIL
Existing site topsoil should be salvaged & appropriately stockpiled where possible.

IMPORTED TOPSOIL
All construction must comply with AS 4419-2003 Soils for Landscaping and Garden Use. Turf Areas: 'Turf Underlay', Tree Pit and Shrub Planting: 'Premium Garden Mix' as supplied by, ANL p: 02 9450 1444 or approved alternative.
Planting in Planter Boxes: Soilmix A - 'Planter Box Mix', Soilmix B - Washed River Sand as supplied by, ANL p: 02 9450 1444 or approved alternative.

TREE STOCK
Tree stock to be supplied by production nurseries in accordance with AS 2303:2018 Tree Stock for Landscape Use.
Health & Vigour: Supply plants with foilage size, texture & colour consistent with that shown in healthy specimens of the species. Balance of Crown: Supply plants with max. variation in crown bulk on opposite sides of stem axis, +/- 20%. Stock selection should also be based on NATSPEC Guide *Specifying Trees: a Guide to Assessment of Tree Quality.*

STAKING
Install 2 x 2400mm x 50mm x 50mm hardwood timber stakes with hessian ties to all trees. Provide appropriate support considering exposure to prevailing winds. Stakes and hessian ties to be removed as soon as the tree is self supporting.

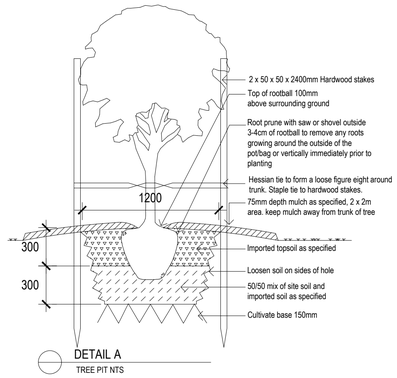
ALUMINIUM GARDEN EDGING
Supply and install Link Edge 75mm as per Landscape Plan. Compact and level the base in the required area as indicated on Landscape Plan. Half hammer spikes into prepunched holes (approx 4 spikes every 3m length) starting from the first hole in the end of the Link Edge. Use spike washers supplied by manufacturer.Half hammer subsequent spikes in pivotal areas along the length. (Especially at points where a curve is required). Connect lengths together by using fish-plate connectors supplied by manufacturer. Check position of Link Edge is correct before hammering spikes firmly into ground.

IRRIGATION SYSTEM
New inground dripline irrigation system to be installed with backflow preventer and with timers. Irrigation system to be designed and installed to local codes.
The entire irrigation system shall be fully automated and provide drip irrigation to all tree, shrub and ground cover zones. It is the Contractor's responsibility to verify water pressure available and determine all design-built parameters prior to any installation and sizing of irrigation components. Irrigation system to be connected to water tank to supplement water from mains.

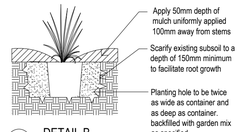
MULCHING
All construction must comply with AS 4454-2003 Compost, soil conditioners and mulches. All planting area impacted by building works to receive 50-75mm of garden Mulch, Droughtmaster, ANL p: 02 9450 1444 or approved alternative. Keep mulch 100mm away from plant stem & form a well to stop excessive water runoff. Finish flush with adjacent surfaces.

WATERING
Water in immediately after plant installation & allow for soil settlement. For the first 2 to 4 weeks after planting, the root zone & immediate surrounds must be kept moist. Continue watering until plants have established.

RETAINING WALLS & PLANTER BOXES
All retaining walls & planter boxes to be constructed to Engineer's details. Ensure all internal surfaces are waterproofed. Geotextile wrapped ag. drainage line backfilled with aggregate is to be installed behind all retaining walls & connected to stormwater in accordance with Sydney Water regulations. All planter boxes are to have Atlantis drainage cell (or approved alternative) installed & connected to stormwater in accordance with Sydney Water regulations.



DETAIL A
TREE PIT NTS



DETAIL B
SHRUB PLANTING DETAIL N.T.S

NOTES:
- Contractors to check and verify all dimensions and all levels on site prior to any works.
- Any discrepancies should be immediately referred to Space Landscape Designs.
- All work to comply with B.C.A. Statutory Authorities and relevant Australian Standards.
- Dimensions recognised over scaling. All measurements are in millimetres.

Rev.	Date	Issue	Checked
A	24/02/21	Preliminary Issue	AE
B	03/03/21	Preliminary Issue	AE
C	08/03/21	DA Issue	AE

SPACE LANDSCAPE DESIGNS
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Suite 138, 117 Old Pittwater Rd, Brookvale NSW 2100

PROJECT: Farbod Danesh
SITE ADDRESS: 49-51 Annam Road, BAYVIEW

CLIENT: Farbod Danesh
DRN: C.Wallace (B.LArch)
SCALE: 1:200@A1
PROJECT NO: 211843

DRAWING TITLE: LANDSCAPE PLAN
DRAWING No: L-100
Rev: C

1.3 Geology

Vegetation within the catchment is a result of the interaction of many environmental factors including the underlying geology, soil, rainfall, temperature, aspect and fire regime.

The site occurs within the "Watagan" Soil landscape. The features of this landscape are provided below:

Landscape—rolling to very steep hills on fine-grained Narrabeen Group sediments. Local relief 60–120 m, slopes >25%. Narrow, convex crests and ridges, steep colluvial sideslopes, occasional sandstone boulders and benches. Tall eucalypt open-forest with closed-forest (rainforest) in sheltered positions.

Soils—shallow to deep (30–200 cm) *Lithosols/Siliceous Sands (Uc1.24)* and *Yellow Podzolic Soils (Dy3.21, Dy3.41, Dy4.11)* on sandstones; moderately deep (100–200 cm) *Brown Podzolic Soils (Db1.11), Red {Podzolic Soils (Dr2.21)* and *Gleyed Podzolic Soils (Dg2.21)* on shales.

Limitations—mass movement hazard, steep slopes, severe soil erosion hazard, occasional rock outcrop.

This soil landscape is underlain by Wianamatta Group Ashfield Shale and Bringelly Shale formations. The Ashfield Shale consists of laminite and dark grey shale. Bringelly Shale consists of shale, calcareous claystone, and laminite. Between these two shale members is the Minchinbury Sandstone consisting of fine to medium-grained lithic quartz sandstone The topography of this landscape is drainage lines in Mittagong Formation. Broad sandstone benches with narrow shale lenses and minimal rock outcrop. Relief up to 20 m. Slope gradients 3–7%.

Characteristics of the soil landscape report are provided on the following pages. The geology and soils of the site influence the locally occurring vegetation types.

Figure 6: Soil landscape of the site and surrounds (Source: Espade.com)

wn	WATAGAN	Colluvial

Source: Soil and Land Resources of the Hawkesbury-Nepean Catchment *interactive DVD*

Landscape—rolling to very steep hills on fine-grained Narrabeen Group sediments. Local relief 60–120 m, slopes >25%. Narrow, convex crests and ridges, steep colluvial sideslopes, occasional sandstone boulders and benches. Tall eucalypt open-forest with closed-forest (rainforest) in sheltered positions.

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Limitations—mass movement hazard, steep slopes, severe soil erosion hazard, occasional rock outcrop.

LOCATION

Occurs north of Collaroy, on steep sideslopes of the Erina Hills. It is associated with coastal headlands and bluffs along the Hawkesbury River and its lower tributaries. Also occurs along deep valleys in Bouddi National Park and along the escarpment west of Umina.

LANDSCAPE

Geology

Narrabeen Group of sediments. Mostly interbedded laminite and shale with quartz to lithic quartz sandstone. Minor red claystones occur north of the Hawkesbury River. Clay pellet sandstone occurs south of the Hawkesbury River (Herbert, 1983).

Topography

Rolling to very steep low hills. Local relief is 60–120 m. Slope gradients are steeper than 25%. Crests and ridges are convex and narrow. Hillslopes are steep with talus slopes containing sandstone boulders. Occasional sandstone benches and colluvial benches are present. Slopes with gradients >70% often have cliffs and scarps >10 m high

Vegetation

Mostly uncleared, tall eucalypt open-forest (wet sclerophyll) and closed-forest (rainforest). Much of the native vegetation on the Northern Beaches peninsula has been cleared.

Tall eucalypt open-forests occur on drier and more exposed slopes and crests. Tree species include spotted gum *Eucalyptus maculata*, grey ironbark *E. paniculata*, Sydney blue gum *E. saligna*, turpentine *Syncarpia glomulifera*, bangalay *E. botryoides*, rough-barked apple *Angophora floribunda* and forest oak *Allocasuarina torulosa*.

Rainforest occurs on sheltered slopes. Characteristic tree species include lilly pilly *Acmena smithii*, cheese tree *Glochidion ferdinandi*, coachwood *Ceratopetalum apetalum* and cabbage tree *Livistona australis*.

Land use

Most land has been gazetted as national park or nature reserve. Examples include Brisbane Water, Ku-ring-gai Chase and Bouddi National Parks and Muogamarra Nature Reserve. Some locations such as Taylors Point and Bayview are urban residential.

Existing Erosion

Minor gully erosion occurs along unpaved roads. Moderate sheet erosion occurs on the steep hillslopes. Landslip and rockfall have occurred on steep slopes with wet, unstable and disturbed soils. This has resulted in serious damage to roads and buildings at Newport.

SOILS

Dominant Soil Materials

wn1—Loose, stony, brownish-black sandy loam. This is stony, brownish-black, loamy sand to loam-fine-sandy with loose apedal single-grained structure and sandy porous fabric. It usually occurs as topsoil (A1 horizon). Texture is commonly a fine sandy loam. Surface condition is generally loose but may also be friable when sufficient organic matter is present. Colour is usually brownish-black (10YR 2/2) or black (10YR 1.7/1). The pH ranges from moderately acid (pH 5.0) to slightly acid (pH 6.0). Strongly weathered, subrounded, small sandstone fragments, charcoal fragments and roots are common.

wn2—Hardsetting, brown sandy clay loam. This is a brown loam to fine sandy clay loam which is hardsetting when dry. It has apedal massive structure and slowly porous, earthy fabric. It usually occurs as an A2 horizon. Colour varies considerably and ranges from brownish-black (10YR 2/2) to yellowish-brown (10YR 5/6). The pH ranges from moderately acid (pH 5.5) to slightly acid (pH 6.0). Sandstone fragments may be common, and often occur as a stone line in the base of this material. Charcoal fragments and roots are often present.

wn3—Strongly pedal, yellowish-brown fine sandy clay. This is yellowish-brown sandy clay to medium clay, with moderately or strongly pedal structure and porous, rough-faced, ped fabric. This material occurs as subsoil on sandstone bedrock (B horizon). Fine sand is commonly present throughout this material. Peds are sub-angular blocky and range in size between 20–50 mm. Colour is commonly yellowish-brown (10YR 5/8) or orange yellowish-brown (7.5YR 6/8). Brown,

red, yellow or grey mottles are common. The pH ranges from extremely acid (pH 3.5) to moderately acid (pH 5.0). Some sandstone rock fragments and roots are present, but charcoal fragments are absent.

wn4—Strongly pedal clay. This is light to medium clay with strongly pedal structure and dense, smooth-faced ped fabric. It generally occurs as subsoil on shale or siltstone bedrock (B horizon). Peds are crumb, polyhedral or sub-angular blocky in shape. They range in size from 2–10 mm and are smooth-faced and dense. Colour varies considerably depending on site drainage characteristics. Colours range from dark brown (10YR 3/4) and dark reddish-brown (2.5 YR 3/4) in freely drained areas to light grey (10YR 7/2) in poorly drained areas. Red, yellow or grey mottles also are present in poorly drained areas and/or at depth. The pH is usually strongly acid (pH 5.5). Siltstone and shale fragments are rare, as are roots. Charcoal fragments are absent.

Associated Soil Materials

Litter and decomposing organic debris. This can be identified readily as decomposing plant remains. The litter layer is particularly well developed to depths of up to 30 cm in forested areas.

Occurrence and Relationships

Sandstone crests. Up to 15 cm of hardsetting, brown sandy clay loam (**wn2**) overlies up to 50 cm of strongly pedal, yellowish-brown sandy clay (**wn3**). Total soil depth is 50–100 cm. Boundaries between soil materials are clear [Yellow Podzolic Soils (Dy 3.21)].

Siltstone and shale crests. Up to 10 cm of **wn2** overlies up to 100 cm of highly pedal, brown clay (**wn4**). Total soil depth is 100–150 cm and the boundary between the soil materials is sharp [Brown Podzolic Soil (Db 1.11)].

Very steep sideslopes. Where slope gradients generally exceed 40%, up to 20 cm of **wn1** overlies either bedrock (Siliceous Sands and Lithosols (Uc1.24)) or up to 50 cm of **wn3** [Yellow Podzolic Soils (Dy 4.11)].

Moderately steep sideslopes with sandstone bedrock. Up to 30 cm of **wn1** overlies 10–30 cm of **wn2** and up to 100 cm of **wn3**. Boundaries between soil materials are sharp. Total soil depth is 30–120 cm (Yellow Podzolic Soils (Dy 3.41)). Occasionally **wn1** is absent and **wn2** overlies **wn3** (Yellow Podzolic Soils (Dy3.21)).

Moderately steep sideslopes with siltstone or mudstone (shale) bedrock. Up to 15 cm of **wn1** overlies 20–30 cm of **wn2** and >60 cm of **wn4**. Total soil depth is >100 cm. Boundaries between soil materials are usually clear to sharp. Red and Brown Podzolic Soils (Dr2.11, Db1.11) occur on well-drained slopes with Gleyed Podzolic Soils (Dg2.21) on poorer drained footslopes.

Drainage lines. Generally, 100 cm of stony dark brown sandy loam (**wn1**) overlies bedrock [Siliceous sands (Uc1.22)].

LIMITATIONS TO DEVELOPMENT

Urban Capability

Generally not capable of urban development.

Rural Capability

Generally not capable of regular cultivation or being grazed.

Landscape Limitations

Mass movement hazard
Rockfall hazard
Steep slopes
Extreme erosion hazard
Shallow depth (localised)
Surface movement potential (localised)

Soil Limitations

wn1 Stoniness
Low available water capacity
Low fertility
Very strongly acid
High aluminium toxicity

wn2 Stoniness (localised)
Hardsetting surface
Low fertility
High aluminium toxicity
Very strongly acid

wn3 Low wet strength
Low permeability
Low fertility
Strongly acid
Very high aluminium toxicity

wn4 Low wet strength
Low permeability
Low fertility
Strongly acid
Very high aluminium toxicity

Fertility

The general fertility is low to moderate. The soil materials are strongly acid and have low or moderate available water capacities, very low nutrient status, with low nitrogen and very low phosphorus levels and low to moderate CEC. The subsoils may have low permeability and pronounced aluminium toxicity.

Erodibility

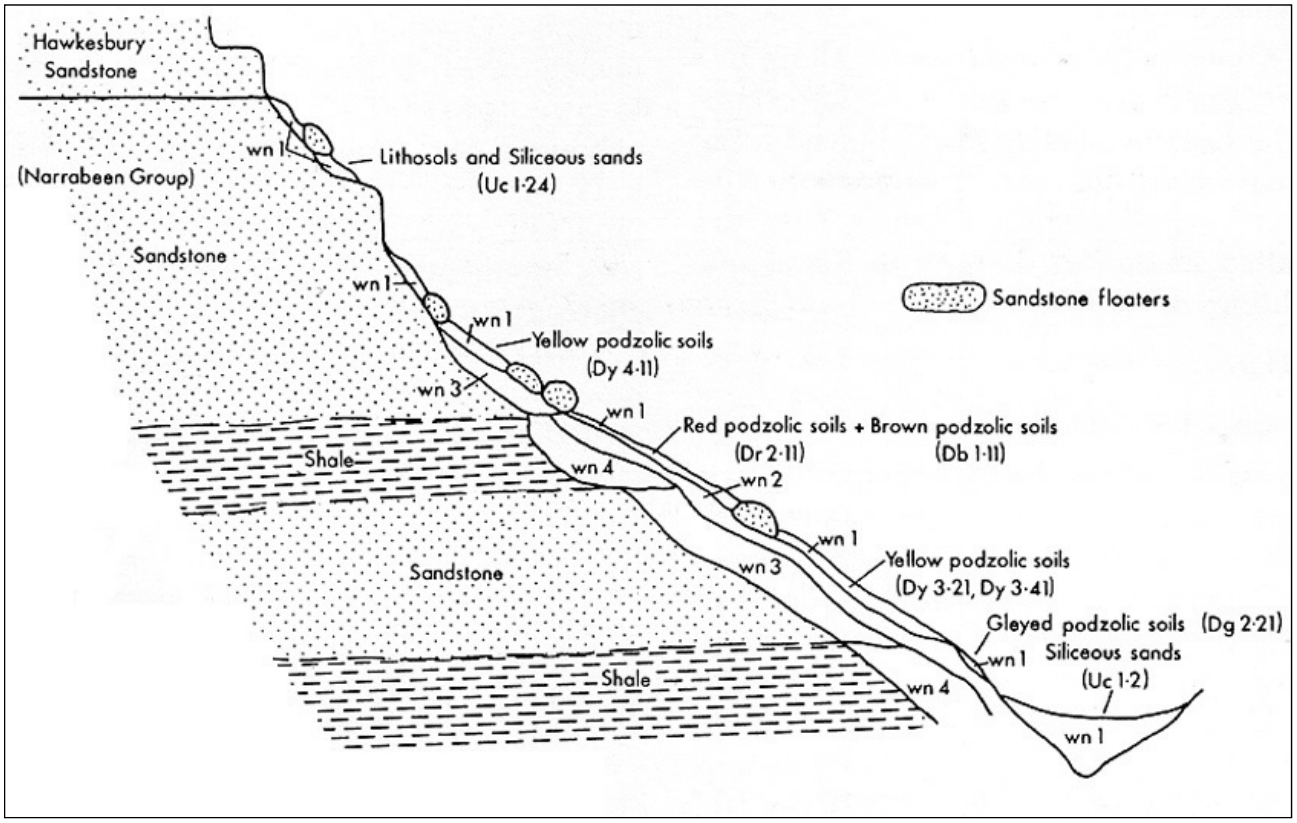
The wn1 soil material has low erodibility, consisting dominantly of highly permeable coarse sand grains. The other soil materials have moderate erodibility as they are well graded with porous and coherent fabric. Where **wn4** is dispersible it is highly erodible; otherwise it has low erodibility.

Erosion Hazard

Despite the low to moderate erodibility of the soil materials steep slopes produce an erosion hazard for non-concentrated flows which is extreme. Calculated soil losses for the first twelve months of urban development range up to 372 t/ha for topsoil and 547 t/ha for subsoil. Soil erosion hazard for concentrated flows is also extreme.

Surface Movement Potential

Soils are generally shallow and therefore slightly reactive. Where profiles contain >50 cm of **wn3** or **wn4** they are moderately reactive. Large variations in soil properties occur over short distances.



Schematic cross-section of Watagan soil landscape illustrating the occurrence and relationship of the dominant soil materials.

2.0 Methods

2.1 Desktop survey

A desktop survey is performed to ensure all relevant documentation is considered when preparing the plan. Documents and other sources of information used in this VMP include:

- Aerial photographs and topographic maps
- Sydney Soil Landscape Series Sheet 9130 (Chapman and Murphy 1998)
- Tree Removal Plan
- Arborist Impact Assessment Report Prepared by Trevor Hawkeswood (dated November 2021)
- Landscape Plan prepared by Space Landscape Designs dated 8th March 2021
- Council comments dated 15th October 2021
- Survey plan prepared by H Ramsay & Co Surveyors dated 6th December 2021

2.2 Field Surveys

A visual inspection was undertaken on the 28th November 2021 to identify and evaluate vegetation assessment including floristics, structure, extent, type and projective foliage cover, presence of weed species and other significant features were noted and recorded). All flora recorded were predominantly identified to family, genus and species level with confirmation according to *Field Guide to the Native Plants of Sydney* (Robinson, 2003), *Weeds of the south-east: an identification guide for Australia* (Richardson, 2006) and the Botanic Gardens Trust (2009) *PlantNET* flora database.

3.0 Vegetation occurring on site

The site contains the following native vegetation community:

BioNet Vegetation Classification - Community Profile Report

Plant Community Type ID (PCT ID): 1565

PCT Name: Central Coast Escarpment moist forest
Classification Confidence Level: 2-High
Vegetation Description: Moist open forests with a canopy dominated by Syncarpia glomulifera. The mid-storey includes a sparse small tree layer and a dense shrub layer with various climbers. The ground layer is typically dominated by ferns along with scattered grasses.| Ranges of the Sydney Basin mainly on sandstones and conglomerates elevations below 650m.
Variation and Natural Disturbance:
Vegetation Formation: Wet Sclerophyll Forests (Grassy sub-formation);
Vegetation Class: Northern Hinterland Wet Sclerophyll Forests;
IBRA Bioregion(s): Sydney Basin;
IBRA Sub-region(s): Hunter; Wollemi; Yengo; Wyong; Pittwater;
LGA: Not Assessed
Lithology: Sandstone
Landform Pattern: Not Assessed
Landform Element: Not Assessed
Emergent species: None
Upper Stratum Species: Syncarpia glomulifera; Angophora floribunda; Eucalyptus acmenoides;
Mid Stratum Species: Allocasuarina torulosa; Persoonia linearis; Hibbertia scandens; Maytenus silvestris; Hibbertia dentata; Myrsine variabilis; Polyscias sambucifolia; Smilax australis; Cissus hypoglauca; Pandorea pandorana;
Ground Stratum Species: Doodia aspera; Calochlaena dubia; Adiantum aethiopicum; Imperata cylindrica; Oplismenus imbecillis; Entolasia marginata; Pseuderanthemum variabile;

It is also known as 'Coastal Sandstone Ridgetop Woodland'. It is a locally common vegetation type, however, the microclimates available on site (southern aspects on a sheltered gully slope) provide a more 'mesic' rainforest influenced species composition as noted in the species list provided below.

Canopy species

- *Eucalyptus punctata* (Grey Gum)
- *Syncarpia glomulifera* (Sydney Turpentine)
- *Eucalyptus crebra* (Narrow-leaved Ironbark)
- *Angophora costata* (Smooth-barked Apple)
- *Eucalyptus resinifera* (Red Mahogany)
- *Eucalyptus robusta* (Swamp Mahogany)
- *Corymbia gummifera* (Red Bloodwood)
- *Allocasuarina torulosa* (Forest Oak)
- *Allocasuarina littoralis* (Black She Oak)
- *Ficus superba* var. *henneana* (Deciduous/ Strangler Fig)
- *Guioa semiglauca* (Wild Quince)
- *Pittosporum undulatum* (Sweet Pittosporum)
- *Glochidion ferdinandi* (Cheese Tree)

Understorey species

- *Livistona australis* (Cabbage Palm)
- *Calochlaena dubia* (Soft Bracken Fern)

- *Smilax glyciphylla* (Sweet Sarsparilla)
- *Eustrephus latifolius* (Wombat Berry)
- *Cissus antarctica* (Water Vine)
- *Geitonoplesium formosum* (Scrambling Lilly)
- *Senecio vagus ssp. eglandulosus (native)*
- *Synoum glandulosum* (Scentless Rosewood)

Introduced weed species

- *Lantana camara* (Lantana)
- *Asparagus aethiopicus* (Asparagus Fern)
- *Erythrina × sykesii* (Coral Tree)
- *Senna pendula* (Cassia)
- *Lonicera japonica* (Japanese Honeysuckle)

The vegetation is considered to be in good condition despite the presence of introduced exotic weeds.

No threatened plant species were recorded on site.

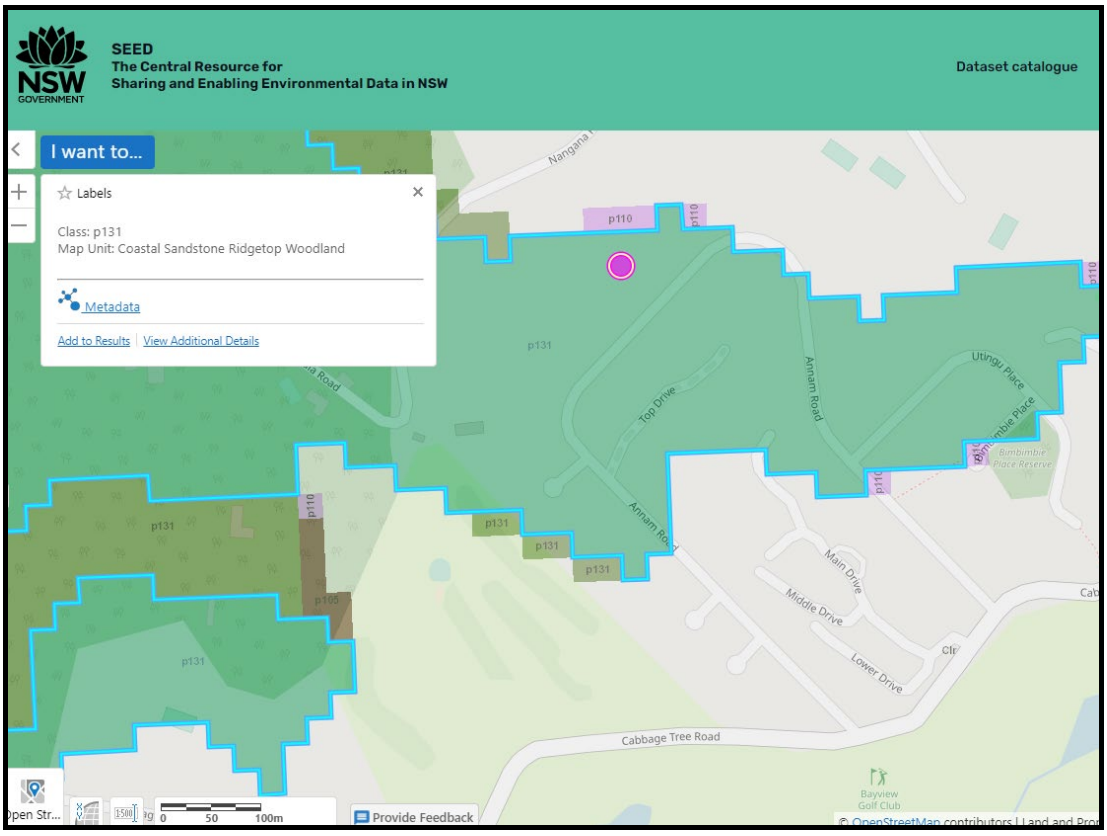


Figure 7: SCIVI vegetation mapping project undertaken by New South Wales DPIE (Source: SEED.nsw.gov.au)

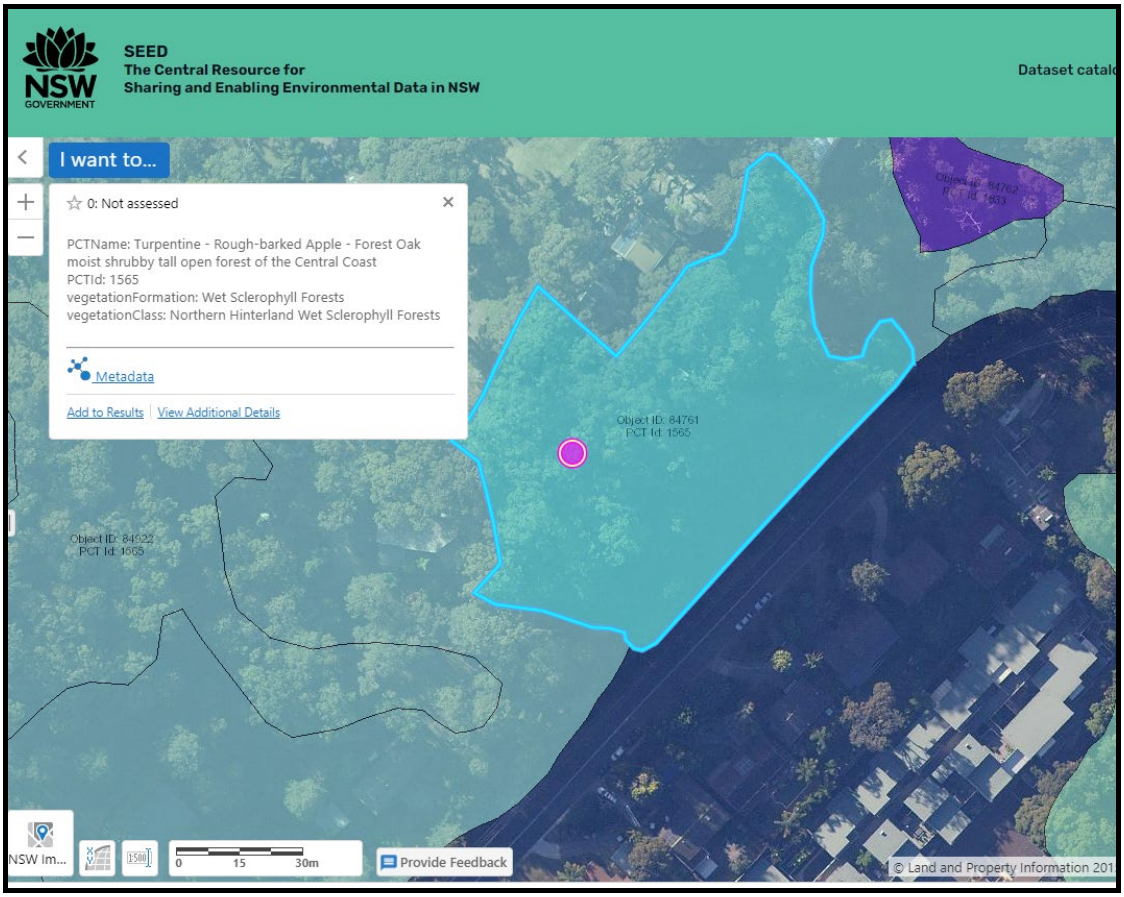


Figure 8: Sydney Metro Veg Mapping (Source: SEED.nsw.gov.au)


NE
E
SE
S
SW
60
90
120
150
180
210
135°SE (T)
33°39'51"S, 151°17'34"E ±16ft
241ft
Fraser Ecological
22 Nov 2021, 13:36:30


SE
S
SW
W
120
150
180
210
240
270
209°SW (T)
33°39'51"S, 151°17'35"E ±22ft
235ft
Fraser Ecological
22 Nov 2021, 13:37:40


W
NW
N
NE
E
270
300
330
0
30
60
90
2°N (T)
33°39'51"S, 151°17'34"E ±42ft
199ft
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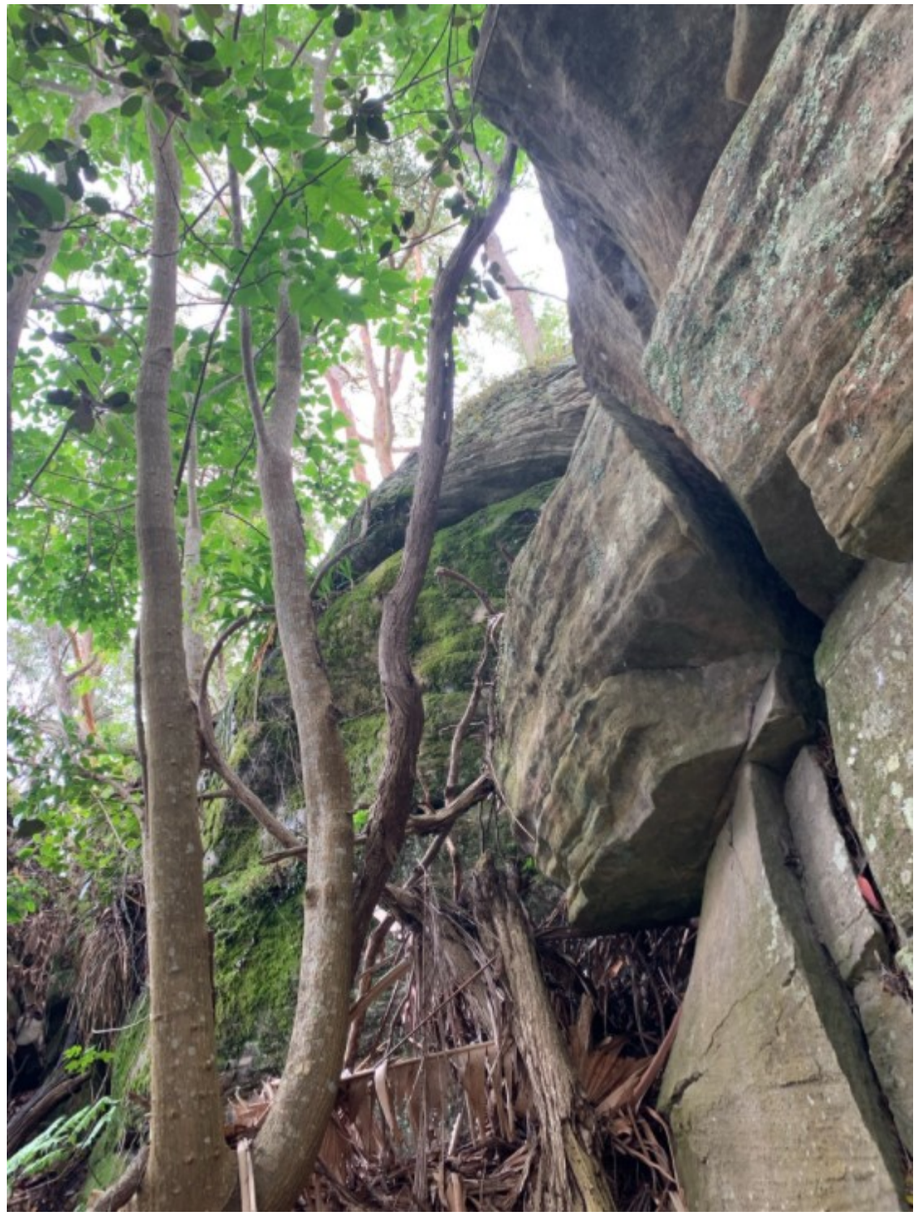
22 Nov 2021, 13:38:53

Lantana

Asparagus Fern



Coral Tree

4.0 Management actions

All works are to be carried out in accordance with this plan. Actions are listed in the Works Schedule in Section 5 and are detailed below.

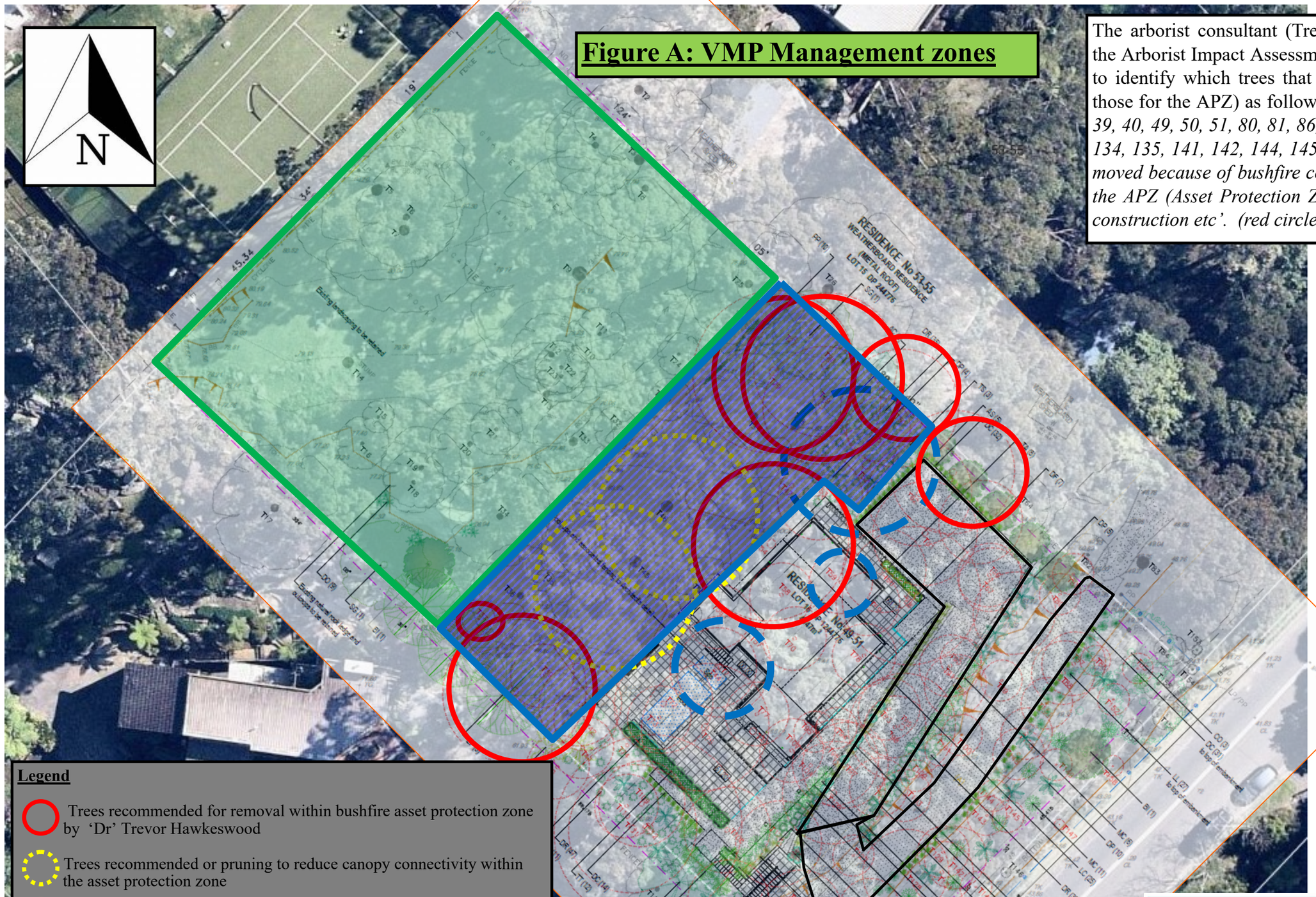
Figure A breaks up the site into 2 management zones for weed management, bush regeneration and native replanting as follows:

- **Management Zone 1:** Bushfire asset protection zone. Further to Appendix A for *Planning for Bushfire Protection 2019* requirements. This area shall be managed as a bushfire inner protection area and shall require selective canopy tree removal retention of all groundcovers and shrubs in islands with selected. Retained native trees have been identified. Shall remain in a fuel reduced state. Maintenance weed removal is required particularly plants that dominate the mid-story in some areas. Total area equates to 800 sqm.

- **Management Zone 2:** is the core bushland to be retained for the northern portion of the property. It is topographically differentiated from the asset protection zone by the presence of large sandstone rock outcrops which are inaccessible for standard bushfire APZ maintenance purposes. Total area equates to 1500 sqm.

Figure A: VMP Management zones

The arborist consultant (Trevor Hawkeswood) updated the Arborist Impact Assessment Report (dated 26/11/21) to identify which trees that require removal (including those for the APZ) as follows: '*Trees 27, 28, 29, 37, 38, 39, 40, 49, 50, 51, 80, 81, 86, 87, 88, 109, 117, 130, 131, 134, 135, 141, 142, 144, 145, 148,151, 158 are to be removed because of bushfire concerns, i.e. they are within the APZ (Asset Protection Zone) or allowing access to construction etc'. (red circles)*



Legend

- Trees recommended for removal within bushfire asset protection zone by 'Dr' Trevor Hawkeswood
- Trees recommended or pruning to reduce canopy connectivity within the asset protection zone
- Hollow bearing trees (Requires sensitive removal and possible relocation into Management Zone 2)
- Management Zone 1: Bushfire Asset Protection Zone (APZ)
- Management Zone 2: Remnant bushland to be retained and regenerated

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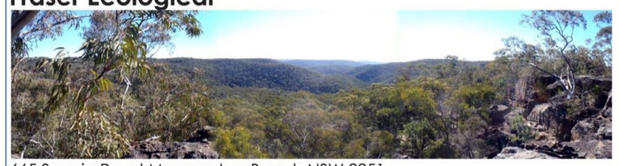

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4.1 Weed Control

This is required for all management zones.

The predominant weeds occurring on site were:

- *Lantana camara* (Lantana) - significant amounts recorded - **priority weed**
- *Asparagus aethiopicus* (Asparagus Fern) - significant amounts recorded - **priority weed**
- *Erythrina × sykesii* (Coral Tree) - **priority weed**
- *Senna pendula* (Cassia)
- *Lonicera japonica* (Japanese Honeysuckle) - **priority weed**

Weed control involves a combination of physical and chemical techniques, and prevention techniques after initial removal.

Whilst hand removal is preferred technique for weed removal, any use of herbicide chemicals needs to be done by qualified and experienced individuals only (Chem Cert 3 minimum qualification) under the supervision of a qualified and experienced bush regeneration consultant.

Hand removed weeds shall be placed in piles for burns (subject to an RFS / Council approved permit) or taken to a dedicate green waste facility. On-site mulching of weeds is only permitted if no seeds are present. The seed free mulch shall not be re-applied to the same area – it shall be re-used for native revegetation works elsewhere on site (refer to section 4.3).

4.1.1 Physical Weed Control

Physical weed controls include methods that remove weeds, or parts thereof, by physical means including hand weeding, mowing / slashing or mechanical clearing.

Hand weeding is the most sensitive control method for most weeds in environmentally sensitive areas and can be used to target scattered weeds within vegetation, in particular weeds that are within the proximity of sensitive sites.

Lantana is best controlled via this method.

4.1.2 Chemical Weed Control

Chemical weed control employs the use of chemicals, such as herbicides, that destroy, suppress or prevent the spread of weeds. The treatment of weeds with herbicides is subject to strict statutory guidelines and should also be undertaken in a responsible manner to avoid injury to persons, damage to property or harm to a non-target plants or animals.

There are two broad types of herbicides available:

• **pre-emergent herbicides** that treat plants as the seed germinates to prevent the plant emerging. These herbicides are unsuitable in environmentally sensitive area; and

• **post-emergent herbicides** used to treat the established plants. Three general classes of post-emergent herbicide are available:

• non-selective herbicides - will destroy most species including monocots

(grasses, lilies, sedges etc) dicots (woody plants) and some ferns;

• monocot selective - herbicides that target monocots and have limited impact to dicots; and

• dicot selective - herbicides that target dicots and have limited impact to monocots.

Some weed control techniques are more suitable for control of particular species and in different situations than are others.

4.1.3 Weed Prevention

Physical and chemical weed control techniques are used to treat weeds once they are established (with the exception of pre-emergent herbicides). Measures that prevent the movement of weeds, including soil laden with weed seed or propagules and measures that suppress the germination of weeds will be the most effective means to achieve the objective of this plan.

Weed control is important to reduce fuel loads and stop noxious and environmental weeds from invading bushland proposed for protection and restoration.

4.1.4 Staging of weed control

The extent of weeds does not require staged weed removal. However, it should be noted that *Lantana camara* provides small habitat for birds. If weeds are not managed properly and do extend for area greater than a 20 x 20 m area over time then it shall be removed in stages under the direction of the contract bush regenerator.

Weed control from areas of high resilience to low resilience, upper slope to lower slope in accordance with the Bradley Method (Buchanan 1989) is to be undertaken in 3 stages described below:

1) Primary weed control: The first step. Targets primary weeds but does not remove all weeds as the soil will be eroded (DEC 2005). Areas identified with the greatest resilience (e.g. around the base of remnant trees) should be cleared first to encourage regeneration from the soil seed bank. Involves getting rid of larger debris and raking up areas of invasive creepers. All non-exotic woody material is to be retained within the BGHF zone as fauna habitat.

2) Secondary weed control: Intensive follow up weeding straight after primary weeding and treating weed seedlings as they germinate (Buchanan 1989). The weeds progress is monitored and some are allowed a month or two of annual weed growth before they are

treated. Sites in good condition require little follow-up while others in worse condition require more effort.

3) Maintenance weeding: Maintain and controlling low weed levels ensuring new weeds that have moved into the area or have had the chance to germinate are eliminated.

4.2 Weed Management Techniques

Weeds are to be progressively removed in accordance with the following techniques recommended by the National Trust, NSW National Parks and Wildlife Service and Australian Association of Bush Regenerators.

Bush regeneration techniques are described as a guide to infer their intended performance. These techniques are to be implemented by a qualified and experienced bush regeneration company. The use of trained personnel will ensure correct plant identification, work methods and compliance with required Occupational Health and Safety standards.

Woody Weeds Removal Techniques

1) Cut and Paint

This technique involves cutting the weed (using chainsaw, bush/ pruning saw, secatuers or loppers) at the base of the stem an immediately painting them.

- Make a horizontal cut close to the ground using secateurs, loppers or a bush saw; and
- Immediately apply herbicide to the exposed flat stump surface.

Considerations:

- Cuts should be horizontal to prevent herbicide from running off the stump, sharp
- angle cuts are hazardous;
- Herbicide must be applied immediately before the plant cells close (within 30
- seconds) and translocation of herbicide ceases;
- If plants re-sprout, cut and paint the shoots after sufficient regrowth has occurred; and
- Stem scraping can be more effective on some woody weeds.

2) Stem Injection

- At the base of the tree drill 10mm diameter holes at a 45 degree angle into the
- sapwood;
- Fill each hole with herbicide immediately; and

- Repeat the process at 5 cm intervals around the tree.

3) Frilling

- At the base of the tree make a cut into the sapwood with a chisel or axe;
- Fill each cut with herbicide immediately; and
- Repeat the process at 5 cm intervals around the tree.

Considerations:

- Plants should be actively growing and in good health;
- Deciduous plants should be treated in spring and autumn when leaves are fully formed;
- For multi-stemmed plants, inject or chip below the lowest branch or treat each
- stem individually; and
- Herbicides must be injected immediately before plant cells close (within 30
- seconds) and translocation of herbicide ceases.

<u>Small Hand-Pullable Plants Removal Techniques</u>

1) Hand Removal

- Remove any seeds or fruits and carefully place into a bag;
- Grasp stem at ground level, rock plant backwards and forwards to loosen roots
- and pull out; and
- Tap the roots to dislodge any soil, replace disturbed soil and pat down.

Considerations:

- Leave weeds so roots are not in contact with the soil e.g. Rafted in a dedicated area, composted in dedicated bin or removed from the site via green waste bin.

<u>Vines and Scramblers Removal Techniques:</u>

1) Hand Removal

- Take hold of one runner and pull towards yourself;
- Check points of resistance where fibrous roots grow from the nodes;
- Cut roots with a knife or dig out with a trowel and continue to follow the runner;

- The major root systems need to be removed manually or scrape/cut and painted with herbicide; and
- Any reproductive parts need to be bagged.

2) Stem Scraping

- Scrape 15 to 30 cm of the stem with a knife to reach the layer below the
- bark/outer layer; and
- Immediately apply herbicide along the length of the scrape.

Considerations:

- A maximum of half the stem diameter should be scraped. Do not ringbark;
- Larger stems should have two scrapes opposite each other; and
- Vines can be left hanging in trees after treatment.

<u>Weeds with Underground Reproductive Structures Removal Techniques</u>

1) Hand Removal of Plants with a Taproot

- Remove and bag seeds or fruits;
- Push a narrow trowel or knife into the ground beside the tap root, carefully loosen
- the soil and repeat this step around the taproot;
- Grasp the stem at ground level, rock plant backwards and forwards and gently pull removing the plant; and
- Tap the roots to dislodge soil, replace disturbed soil and pat down.

2) Crowning

This technique is useful when the weed may regenerate from root material left in the soil.

- Remove and bag stems with seed or fruit;
- Grasp the leaves or stems together so the base of the plant is visible;
- Insert the knife or lever at an angle close to the crown;
- Cut through all the roots around the crown; and
- Remove and bag the crown.

Herbicide Treatment – Stem Swiping

- Remove any seed or fruit and bag; and
- Using a herbicide applicator, swipe the stems/leaves.

Considerations:

- Further digging may be required for plants with more than one tuber;
- Some bulbs may have small bulbils attached or present in the soil around them
- which need to be removed;
- It may be quicker and more effective to dig out the weed;
- Protect native plants and seedlings; and
- For bulb and corm species the most effective time to apply herbicide is after
- flowering and before fruit is set.
- Exotic vegetation should be removed and stockpiled in a clear area away from adjoining bushland. This stockpile should be removed from the site at a convenient time. As part of the regular maintenance of the restored area any regrowth of the exotic plant species should be removed and disposed of appropriately.

Use of Herbicides

Herbicides are required for use with the cut and paint technique to control woody weeds and spraying exotic herbs and grasses.

IMPORTANT NOTE: Herbicides can cause serious environmental harm if not used properly and enter waterways. Roundup Biactive ® is recommended near waterways.

Herbicides should not be applied 0 to 12 hours prior to rain occurring. This reduces the herbicides effectiveness as well as being transported in runoff to creek lines and waterways. An advantage of herbicide use is the low time taken to spray weeds as compared to physically removing them, particularly for large infestations of weeds.

The use of herbicides should be considered when:

- There are small areas of dense weeds with few or no native plants to protect;
- There are large areas of weeds;
- The weeds are growing too rapidly for physical removal; and
- The weeds are located in areas with a high potential for erosion if vegetation is removed.

- The success of each treatment must be evaluated by the operator after a set period of time

- The dominant weed species and their methods of control are listed in Table 3. The one species of noxious weed listed in Table 1 should be considered for preferential control over weed species, when all ecological and planned treatment outcomes are considered, such as threatened species and their habitat, erosion management, and broad ecological resilience

4.3 Bushfire asset protection zone management (Management Zone 1- APZ)

Figure A shows the location of trees that are recommended for removal to establish the bushfire asset protection zone by Trevor Hawkeswood for Management Zone 1.

In addition to this tree removal, we have also recommended that two (2) trees are pruned to ensure there is no into canopy connectivity (depicted as yellow circles in Figure A). The understorey shall be treated as a fuel management zone.

The objective of this zone is to reduce the fuel load within the nearest hazard. This includes the removal of leaves, bark, logs, twigs and other debris as well as the slashing of any grasses (>100mm). All trees, shrubs and ferns will be retained and not be impacted.

Any revegetation works with the APZ of all lots shall comply with Appendix 4 'Standards for Asset Protection Zones' RFS published document (refer to Appendix B).

The Asset Protection Zone should not extend past the boundaries shown in Figure A.

The IPA ensures that the presence of fuel, which could become involved in fire, is minimised. Minimum fine fuel is permitted at ground level, which could be set alight by bushfire. This area should be regularly maintained and all fuel removed e.g. fallen branches, leaf build-up.

IPA vegetation requirements:

- No vegetation is to touch or overhang the building;
- Are well spread out and do not form a continuous canopy;
- Are not species that retain dead material or deposit excessive quantities of
- ground fuel in a short period; and
- Are located far enough away from the house so that they will not ignite the
- house by direct flame contact or radiated heat emissions.

General recommendations for maintenance of IPA zones:

- All vegetation will be maintained in a fuel free condition;
- Controlled burning is not required. Manual fuel reduction will sufficiently
- reduce fuel loads surrounding the proposed development;
- All trees will be maintained so that a continuous canopy is not formed;
- All regrowth of shrubs and bushes will be removed.

Refer to Appendix B of this report for more information.

4.4 Landscaping (general recommendations)

A Landscape Plan has been prepared by SPACE Landscapes for the area south east of the proposed dwelling (Provide on the following pages). If in the future any additional landscaping takes place it shall comply with the following:

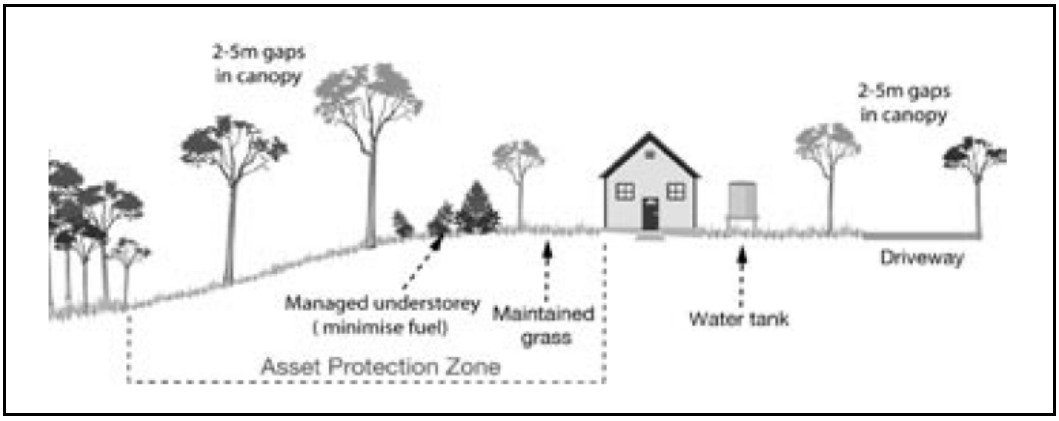
- Prevent flame impingement on dwellings;
- Provide a defendable space for property protection;
- Reduce fire spread;
- Deflect and filter embers;
- Provide shelter from radiant heat; and
- Reduce wind speed.

The above can be achieved via appropriate species selection, plant location, planting density and ongoing maintenance. It is recommended that all species used for landscaping comply with the approved Landscape Plan and the revegetation requirements provided in Section 4.7 (below).

Vegetation Management is the responsibility of individual landowners and should include (as per PBP):

- Keeping areas around the garden free of fuel;
- Utilising non-combustible fencing materials;
- Breaking up tree and shrub canopies by defining garden beds;
- Using non-flammable mulch;
- Ensuring tree branches do not overhang roofs;
- Ensuring tree canopies are not continuous

Refer to Appendix B of this report for standards for APZs.


2-5m gaps
in canopy
2-5m gaps
in canopy
Driveway
Managed understorey
(minimise fuel)
Maintained
grass
Water tank
Asset Protection Zone

4.5 Property Maintenance

Sensible arrangements for landscaping and maintenance of the property are critical in the prevention of losses. In considering property maintenance the following items should therefore be implemented in advance of the bush fire season (October):

- removal of material such as litter from the roof and gutters;
- ensure painted surfaces are in good condition with decaying timbers being given particular attention to prevent the lodging of embers within gaps;
- check pumps and water supplies are available and in working order;
- driveways are in good condition with trees not being too close and forming an obstacle during smoky conditions;
- check tiles and roof lines for broken tiles or dislodged roofing materials;
- screens on windows and doors are in good condition without breaks or holes in flyscreen material and frames are well fitting into sills and window frames;
- drenching or spray systems are regularly tested before the commencement of the fire season;
- hoses and hose reels are not perished and fittings are tight and in good order;
- doors are fitted with draught seals and well maintained;
- mats are of non combustible material or in areas of low potential exposure; and
- woodpiles, garden sheds and other combustible materials are located down slope and well away from the house.

4.6 Maintenance of Fuel Loading in APZ

Vegetation in the APZ will be maintained in such a manner that the vegetation is not continuous and fuel loadings will be maintained to a maximum dry litter weight of less than 3 tonnes/hectare during the prescribed 'Bushfire Danger Period'.

Assessment of fuel loadings will be undertaken annually by the land-owner.

Due to the lack of a NSW guide, a link to West Australian fuel load assessment methodology is provided below:

https://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/VisualFuelLoadsPublications/FESA-Pilbara_Visual_Fuel_Load_Guide_Pilbara_09.pdf

The Bushland Regeneration Contractor will establish the APZ and will manually remove fuel based on levels and recommendations of Bushfire Consultant in accordance with the methods outlined in the Rural Fires Service (RFS) document "Standards for Asset Protection Zones". This may include methods such as:

- Raking or manual removal of fine fuels;
- Mowing grass;
- Removal or pruning of trees, shrubs and understorey;
- Slashing;
- Ploughing or grading; or
- Hazard reduction burning (will require a HR certificate from the RFS).

4.7 Revegetation works

No native revegetation works have been recommended as part of this plan. This is because the focus of management zone shall be natural regeneration from the native soil seed bank after weed control has taken place.

However, if there appears to be erosion control issues and no native revegetation after 12 months of weed removal works then it is recommended that native groundcovers are planted at a density of four per square metre ($4/m^2$).

We have provided a list of plant species to be used below.

Recommended groundcovers:

- *Lomandra longifolia* (Mat Grass)
- *Microlaena stipoides* (Weeping Grass)

- *Dianella caerulea* (Blue Flax Lily)
- *Gahnia siberiana* (Saw Sedge Grass)
- *Gahnia clarkei* (Sedge Grass)
- *Themeda australia* (Kangaroo Grass)
- *Echinopogon caespitosus* (Tufted Hedgehog Grass)

In general, plantings are to be varied and any monocultures of planting areas when observed within a 20x20m area are to be supplemented with a diversity of additional plants to ensure site-wide diversity.

Naturally occurring remnant vegetation (preferably from the works area or otherwise sourced locally) is the best source of seed and / or vegetative material for revegetation. Generally, these plants will have evolved to suit local environmental conditions and have a broad genetic base. Ecologically and genetically, local seed complements other plants and animals in the area and poses the least potential threat of genetic contamination.

Therefore, commercially acquired seed and other material must be sourced from an approved local supplier and collected from good parent specimens of local provenance (see Appendix A for suggested suppliers). All commercially acquired plant stock must be free of Phytophthora fungus and Myrtle Rust, pests and other diseases.

All watering requirements to be provided by landowner. A temporary irrigation system should be considered.

Planting quantities must allow for plant failures or damage during the establishment period. Small plants may be used (e.g. enviro-cells and tubestock) as they tend to establish more successfully and are also cheaper. A list of local recognised native nurseries is provided in Appendix A. These plantings will be installed by the contract bush regeneration company.

All planted stock should be protected with tree guards until established.

Any dead plant shall be replaced within a calendar month.

4.8 Hollow bearing trees

Council's comments with regards to hollow bearing trees as part of the assessment process to date have been:

'During a site visit conducted by Council's Biodiversity officers, several hollow-bearing trees were identified within the site. Some hollows were suitable for supporting breeding by threatened species listed under the BC Act including Powerful Owl and Barking Owl, both of which have been recorded within 200m of the Subject Site.

As the trees on site were not tagged by the Arborist, it was difficult to determine which trees these were in the Arborist report. Further clarification is required by the Ecologist/Arborist.

Hollow-bearing trees within the site must be retained and protected throughout the development and associated APZ works.

Such trees are to be identified for retention by the Ecologist and specified within the VMP. Council's Biodiversity referrals team maintain the request for more information and justification for the removal of the following trees which appear to be outside of the development footprint. Trees 27, 28, 29, 37, 38, 39, 40, 49, 50, 51, 80, 81, 86, 87, 88, 109, 117, 130, 131, 134, 135, 141, 142, 144, 145, 148, 151, 158.

Clarification is required to be included in the amended Arborist Report. '

Three (3) hollow bearing trees were observed and confirmed to be on site. Fraser Ecological recently tagged these trees so that the surveyor could update the overall site survey plan to show exactly where these trees occur what tree numbers corresponded with the arborist impact assessment report prepared by Trevor Hawkeswood (refer to Figure B on following pages). The recently updated survey identified these trees to be numbered 52, 57 and 59 in relation to the tree location plan prepared by Trevor Hawkeswood (not tree 28 and 29 - *taking into light that it is very difficult to work out the location of trees in this heavily treed site*).

The most significant hollow bearing tree is numbered 52. It provides potential habitat for threatened Powerful Owl (*Ninox strenua*). Unfortunately, it is located very close to the proposed dwelling and has been marked for removal.

Ideally it would be good T.52 could be retained. However, if Council agrees to its removal, pre-clearing surveys would be required under the supervision of a fauna ecologist, and genuine efforts shall be made to relocate and salvage the hollows from Tree 52 and 59 (one spout only) and re-attached to trees at the rear of the property.

This should be done under a specific schedule of works (pre-clearing protocols & habitat hollow salvage/ relocation/reattachment) prepared by the Project Fauna Ecologist. Fraser Ecological works with a contractor 'Treehouse Ecology' (Corey Mead) who specialises in these works (his CV is attached to the end of this document).

Prior to the construction phase of the development, the proponent will be required to commission the services of a qualified and experienced Ecologist with a minimum tertiary degree in Science, Conservation, Biology, Ecology, Natural Resource Management, Environmental Science or Environmental Management.

The Project Fauna Ecologist must be licensed with a current Department of Primary Industries Animal Research Authority permit and New South Wales Scientific License issued under the BC Act.

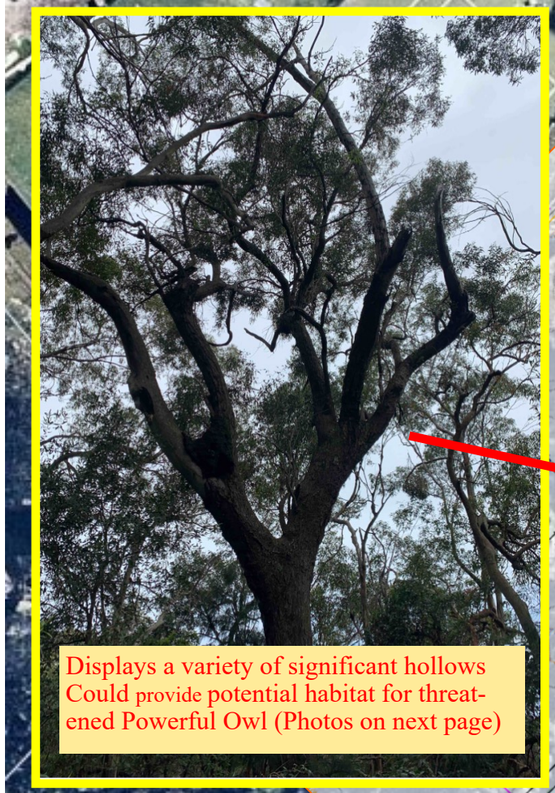
Prior to the release of the Construction Certificate, the Project Fauna Ecologist will be commissioned to:

- specific schedule of works (pre-clearing protocols & habitat hollow salvage/ relocation/reattachment)
- Undertake an extensive pre-clearing survey; delineating habitat-bearing trees and shrubs to be retained/removed; and
- Supervise the clearance of trees and shrubs (native and exotic) in order to capture, treat and/or relocate any displaced fauna
- Attempt to salvage and relocate hollows from trees approved for removal, and reattach them to trees within Management zone 2.
- In the event that the existing hollows are not relocatable, then a minimum of five nest boxes shall be installed on site (3x microbat, 1 x possum, 1x Large Forest Owl boxes).
- **All of the above works shall be certified by Council's Natural Resources Unit once completed.**
- **After the release of the Construction Certificate, the project fauna ecologist will undertake nest box monitoring for the five year duration of the VMP every six months and report these findings to Council's Natural Resources Unit**

Figure B: Location of hollow bearing trees on site

The arborist consultant (Trevor Hawkeswood) updated the Arborist Impact Assessment Report (dated 26/11/21) to identify which treea require removal (including those for the APZ) as follows: '*Trees 27, 28, 29, 37, 38, 39, 40, 49, 50, 51, 80, 81, 86, 87, 88, 109, 117, 130, 131, 134, 135, 141, 142, 144, 145, 148,151, 158 are to be removed because of bushfire concerns, i.e. they are within the APZ (Asset Protection Zone) or allowing access to construction etc'.*

Fraser Ecological's Note: The hollow– bearing trees shown as blue dashed lines on this plan (trees numbered 52, 57 and 59 are not noted in arborist's comments above

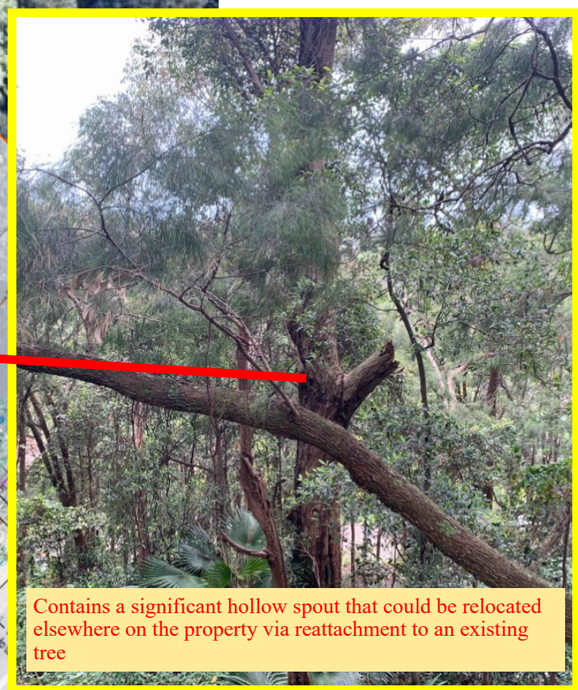


Displays a variety of significant hollows Could provide potential habitat for threatened Powerful Owl (Photos on next page)

Tree #52

Tree #59

Tree #59



Contains a significant hollow spout that could be relocated elsewhere on the property via reattachment to an existing tree

Contains only one insignificant hollow—But could be used as a temporary roosting habitat for micro bats

Fraser Ecological

665 Scenic Road Macmasters Beach NSW 2251
042323 8193
alohafraser@gmail.com

Photographs of significant hollow bearing tree Number 52
******Ideally it would be great if could be further explored to try and retain this tree in its current position***

4.9 Performance criteria

Performance criteria are required to objectively measure the success or otherwise of the methods employed to achieve the stated aims and objectives of the VMP.

Critical stage performance criteria are to be developed based on primary, secondary and maintenance phases for the first 5 years of the project.

- Performance criteria for the first 5 years are to be derived from the current site conditions in relation to the aims and objectives. Performance criteria for the first 5 years of both native vegetation management zones:
- annual reduction targets for priority weeds to achieve a less than 2% cover at the end of the secondary weeding phase for Management Zone 1 and 2;
- annual reduction targets for environmental weeds (everything other than Priority weeds) to achieve a less than 4% cover at the end of 5 years for Management Zone 1 and 2;
- annual reduction targets for priority weeds to achieve a less than 70% cover at the end of the secondary weeding phase, less than 50% cover at the end of the 2nd year, less than 25% cover at the end of the 3rd year, less than 10% cover at the end of the 4th year and less than 5% cover at the end of the 5th year for Management Zone 1 and 2;
- plant species richness and cover abundance for each structural layer within Management Zone 1 and 2;
    - Canopy foliage projection cover of 70% for all retained bushland
    - Shrub density of 50% for all retained bushland
    - Groundcover density of 75% for all retained bushland
- 90% percentage survival rate for plantings. Where the survival rate is below the target, replacement plants will be required within a calendar month.
- no encroachment of exotic lawn/plants into both management zones 1 and 2
- no dumped garden waste within retained bushland; and
- no erosion from exposed surfaces

Once the year 1 performance criteria are satisfactorily completed, year 2 works can commence and so forth. The commencement of subsequent annual works are to be determined by the achievement of previous annual performance criteria. This means that if performance criteria have not been achieved for any annual reporting period that the timing

of works will be adjusted and lengthened to ensure that adequate site management is undertaken to achieve the VMP aims and objectives.

In perpetuity (post 5 year) performance criteria for retained bushland are as follows;

- Maintain priority and environmental weed targets as less than 2 and 4% respectively; and
- for each structural native vegetation layer (groundcover, shrubs, small trees and trees, the native plant species cover abundance and species richness is to be maintained at levels based on the climax conditions of the native vegetation communities.:
- no encroachment of exotic lawn/plants within Management Zones 1 and 2;
- no dumped garden waste into bushland on site Management Zones 1 and 2; and
- no erosion from exposed surfaces.

4.10 Monitoring and reporting of performance criteria

Monitoring and reporting are required for in perpetuity management of the VMP zones.

This will be done by establishing reference monitoring points (as provided below).

Photographs can be taken to qualitatively measure performance.

Quadrats will also be repeated as a quantitative measurement.

Monitoring of key performance criteria and reporting on results is required. Monitoring and reporting of progress and success of the VMP works is to be provided at the following critical stages:

- Council-certified completion of primary works such as hollow bearing tree investigations, hollow-re-location/ nest box installation and weeding). This certification date initiates the commencement of the 5 year maintenance period. (Certification to be provided to Council's Natural Resources Unit)
- Monitoring reports to Council every six months

Native species richness and cover abundance for groundcovers, shrubs and canopy species and weed cover abundance can be measured quantitatively within a quadrat. Quadrat data collected prior to works commencing forms the baseline for monitoring performance criteria. Data collected is to include native species richness and cover abundance and also weed distribution.

Each quadrat should be a minimum 20x20m in size. Where appropriate a nested quadrat may be provided to reduce survey effort. Trees and shrubs should be measured over the entire area, while ground covers will be measured within a smaller quadrat nested within the large quadrat.

Additional quadrats may be required at any critical stage inspection to demonstrate compliance with performance criteria.

At a minimum the following information is to be included within monitoring reports:

- the time period for which the report relates to;
- date and times of site visits and summary of works completed on the site at each visit (maintenance log);
- the qualifications and experience of contractors;
- certification of seed and local provenance stock;
- a table totalling person hours for each task undertaken on site;

- methods of weeding undertaken and chemicals used;
- current weed cover maps (to be prepared by engaged bush regeneration contactor as part of the first monitoring report period);
- numbers of local provenance tubestock planted or methods of assisted natural regeneration techniques used to support the germination of natives in disturbed areas;
- photo and/or monitoring results and an analysis of these against performance criteria;
- details regarding threatened entities found on site, their persistence (or survival) and any specific actions required to be undertaken; and
- a statement as to the efficacy of the VMP works in achieving the aims and objectives and any adjustments that may be required.

The performance criteria is required to objectively measure the success or otherwise of the methods employed in trying to achieve the stated aims and objectives of the VMP.

<u>General performance criteria for all of the vegetation management zones:</u>

- commencement of all tasks outlined in the plan or evidence of planning for their implementation
- primary and follow up (secondary) weeding needs to be undertaken at the appropriate time, in this case, if primary weeding spraying, cut and paint) is undertaken now, then autumn and spring would be an appropriate time to follow up if necessary. Extensive primary weeding may be totally negated if follow up weeding is not undertaken or inappropriate control is implemented.
- no adult seeding woody weeds present by the end of the 5 year period no evidence of seeding annual weeds present across the site
- evidence that existing weed patches have been contained and are not spreading
- the site is to be maintained in a tidy order and kept free of waste litter
- All priority weeds listed under the Biosecurity Act to be less than 2% cover by the end of each maintenance period and other weeds to be less than 4% by the end of each maintenance period.
- No encroachment of exotic lawn beyond management zone boundary; and
- No erosion or sedimentation beyond the boundary of the development lot

5.0 Corrective actions and post VMP period obligations

Based on the monitoring report results corrective actions must be implemented where performance targets are not on track or past the 5 year VMP period.

Table 10 (below) details corrective actions for potential management issues which may be identified during the monitoring stage. Corrective actions must be provided in the monitoring report when required either during or after the 5 year VMP period.

Table 4: Potential management issues and corrective actions to be implemented in perpetuity (after 5 years)

Management Issue	Corrective Action
Weed cover exceeding targets by 4% or more.	Increase weed control visits by a qualified bush regenerator. Frequency of visits to be determined by a qualified ecologist or bush regenerator to meet KPI's.
Ineffective sediment fencing or in disrepair	Repair existing fencing. Add additional fencing where required to ensure no sediment is entering drainage lines, bushland or stormwater.
Planting survival rate below 80%	If replacement planting is required in exceptional circumstances advised by the bush regeneration company the survival rate shall be 80% or higher (no planting is currently recommended) as the site contains high native resilience

.

6.0 Photo reference Points for VMP monitoring

Reference points should be established before vegetation management begins. The locations of these points may be marked permanently on the ground by iron stake, rock cairn or similar, or the location simply recorded by GPS.

Once established, standard photographs should be taken before this plan is implemented and then again immediately before submitting each progress report. The aim of the reference photographs is to provide a pictorial record that will aid in the judgement of the effectiveness of the vegetation management strategies. Some recommended reference points are provided on the following pages.

The rehabilitation actions identified in this VMP are to be monitored by a suitably qualified and experienced bush regenerator or ecologist. Monitoring should occur throughout the entire contract period. If planting is required, then this too will be supervised by the contract bush regenerator or ecologist.

The main objective of the monitoring program is to evaluate the effectiveness of the weed management program, to determine if adequate natural regeneration is occurring and monitor the success of plantings. If, after monitoring, it is deemed that the weed eradication techniques are ineffective, then the plan can be altered at any time to reduce the weed biomass. Likewise, if natural regeneration is failing then corrective measures will need to be implemented, including planting of tube stock from local provenance material.

The formal monitoring program will start immediately after acceptance of this plan and continue for a period of up to five years. Progress reports will be provided to Council and PCA at the following intervals after initial works have commenced every 6 months for the five (5) year life of this VMP.

These progress reports shall be in the form of the template provided overleaf.

Progress Report for Vegetation Management Works

1.	**Date of plan approval:**	
2.	**Tick report interval from date of council consent**	□ 6 month □ 1 Year □ 1.5 years □ 2 years □ subsequent …….
3.	**Weed cover (%):**	
4.	**Major weeds:**	
5.	**Regeneration success:**	
6.	**Will revegetating be required?**	
7.	**Number of plants planted.**	
8.	**Source of plant material.**	
9.	**Success rate (%):**	

10.	**Additional plants required/comments:**
11.	**General progress/Comments:**
12.	**Assistance required:**
13.	**Compiled by:**
14.	**Contact details:**
15.	**Date:**
16.	**Signature:**

Provide photographs from reference points with monitoring reports

6.1 VMP Personnel

All vegetation management actions should only be carried out under the supervision of a suitably qualified and experienced bush regeneration contractor (contact Fraser Ecological for list of suitable contractors).

General maintenance duties outside sensitive areas of the site can be undertaken by the land-owner in consultation with the contracted bush regeneration company responsible for implementation works and monitoring actions.

Please refer to section 4.8 regarding the use of a fauna ecologist for habitat hollow relocation and pre-clearing protocols

All responsibilities for implementation of the VMP is the landowner.

7.0 Hygiene Protocols

Hygiene is particularly important to prevent the transfer of plant diseases. The following simple procedures can reduce the chance of transferring diseases:

- use of sharp equipment (i.e. knifes and secateurs) that are regularly cleaned with methylated spirits;
- cleaning of loose soil from boots and tools with bleach;
- keeping vehicles out of the works area as soil could be attached to the tyres; and
- ensuring all plants brought onto the site are free of Phytophthora fungus and invasive Myrtle Rust.

Hygiene protocols (Myrtle Rust) to be implemented during clearing works as part of the IBVMP (to be done in accordance with the DPIE (2020) *Hygiene guidelines: Protocols to protect priority biodiversity areas in NSW from Phytophthora cinnamomi, myrtle rust, amphibian chytrid fungus and invasive plants* (Appendix D).

8.0 General description of works schedule

Phase	Activity	Details	Timing	Responsible parties
1. Preparatory Works	Photographic record	Establish photographic reference points	Prior to the release of the Construction Certificate	Bush regeneration contractor, Project fauna ecologist and Owner
	Hollow bearing trees investigation (Hollow relocation/ nest box installation)	The applicant shall engage a fauna ecologist to undertake aerial inspections of the hollow bearing trees proposed for removal. Once pre-clearing inspections have been undertaken, the fauna ecologist shall investigate relocating the hollows to trees elsewhere on the property as per Section 4.8. In the event that the existing hollows are not relocatable, then a minimum of five nest boxes shall be installed on site (3x microbat, 1 x possum, 1x Large Forest Owl boxes). **These works shall be certified by Council's Natural Resources Unit once completed**		
	Weed mapping survey	Undertake another plant survey to check for weed plumes		
	Engage bush regeneration contractor	Engage bush regeneration contractor		
	Primary weed	Undertaken by the engaged bush		

Phase	Activity	Details	Timing	Responsible parties
	control and Soil protection	regeneration contractor **These works shall be certified by Council's Natural Resources Unit once completed**		
		Cautious use of glyphosate based herbicide acceptable and hand removal methods (as much as possible) as per Section 4		
		Apply certified weed free native mulch to exposed soils where larger weed outbreaks occur		
5. Secondary weed control	Weed management	Weed herbaceous and woody weeds using techniques appropriate to the species and scale of outbreak.	Within a month of the release of the Construction Certificate	Bush regeneration contractor and Owner
		Monitoring photos from standard locations to be taken.		
		Appropriate responses to weeds formulated according to status of rehabilitation works as per Section 4		
6. Revegetation works	Revegetation	**As per Section 4.7**	When required	Bush regeneration contractor

Phase	Activity	Details	Timing	Responsible parties
7. Maintenance weed control and Nest box monitoring	Weed management	Cautious use of glyphosate based herbicide acceptable and hand removal methods (as much as possible) as per Section 4. After the second year of the VMP works the landowner can undertake maintenance weeding under the supervision and guidance of the contract bush regenerator. The Contract bush regenerator will under monitoring reporting for the five year duration of the VMP every six months and report these findings to Council's Natural Resources Unit.	Every 4 months from the release of the Construction Certificate Weed levels to be maintained to the Performance Criteria in Section 6	Bush regeneration contractor and Landowner
	Nest box monitoring	The project fauna ecologist will undertake nest box monitoring for the five year duration of the VMP every six months and report these findings to Council's Natural Resources Unit	After the release of the Construction Certificate Every six months	Project fauna ecologist
8. Reporting and	Monitoring and	Monitoring photos from standard	6 months after	Bush

Phase	Activity	Details	Timing	Responsible parties
Maintenance Phase	reporting	locations to be taken.	work begins	regeneration contractor
		Inspection report provided to Body Corporate/ certifying bodies		
	Maintenance	Continue weed control on at least a four-monthly basis	Between inspections	
		Carry out actions determined necessary at inspection.		
		Inspection report provided to Council and Private Certifying Authority		

Table 5: GANNT Chart showing summary timing of required actions over 60 month VMP life

Action	Responsibility	Important Milestones	2	4	6	8	12	16	18	20	24	30	34	36	40	42	48	54	60
Photographic record for baseline monitoring and engage bush regeneration supervisor Primary weed control and revegetation works	Bush regenerator	Prior to the release of the Construction Certificate																	
Hollow bearing trees investigation (Hollow relocation/ nest box installation)	Project Fauna ecologist	Prior to the release of the Construction Certificate																	
Secondary weed control	Bush regenerator	Within 1 month of primary weed control and Release of construction certificate																	
Maintenance weed control	Bush regenerator	Every 4 months until																	

Action	Responsibility	Important Milestones	2	4	6	8	12	16	18	20	24	30	34	36	40	42	48	54	60
		5 year VMP period completed																	
Revegetation maintenance	Landowner	During entire 5 year VMP period																	
Nest box monitoring	Project fauna ecologist	Every 6 months until 5 year VMP period completed																	
Weed monitoring and reporting	Bush regenerator	Every 6 months until 5 year VMP period completed																	

9.0 References

Bradley, J. (1988) *Bringing back the bush: The Bradley method of bush regeneration.* Lansdowne Publishing. The Rocks, NSW

Buchanan, R. A. (1989) *Bush Regeneration: Recovering Australian Landscapes*. TAFE Student Learning Publications, NSW

Department of Environment and Climate Change (2008) Soil and Land Resources of the Hawkesbury-Nepean Catchment. NSW Soil and Land Resource Series. Department of Environment and Climate Change, Parramatta

Department of Environment and Conservation (2004) *Darwinia biflora Recovery Plan*. Department of Environment and Conservation NSW, Sydney

Department of Environment and Conservation (2005) *Recovering Bushland on the Cumberland Plain: Best practice guidelines for the management and restoration of bushland*. Department of Environment and Conservation NSW, Sydney

Department of Infrastructure Planning and Natural Resources (2007) Attachment A: How to prepare a Vegetation Management Plan. Draft version 6: January 07

NSW National Parks and Wildlife Service (no date) Checklist for Bush Regeneration Activities in the Habitat of Threatened Species, Endangered Populations and Endangered Ecological Communities

Robertson, M. (1994) *Stop Bushland Weeds: A guide to successful weeding in South Australia's bushland*. The Nature Conservation Society of South Australia Inc

Royal Botanic Gardens and Domain Trust (2014) PlantNET - The Plant Information Network System of The Royal Botanic Gardens and Domain Trust, Sydney (http://plantnet.rbgsyd.nsw.gov.au)

APPENDIX A: Recognised native nurseries

Wariapendi Nursery – Colo Vale

Tel: (02) 4889 4327

Toolijooa Nursery – Dural

628 Old Northern Rd, Dural

Tel. (02) 9651 3859

Toolijooa Nursery – West Hoxton

Tel. (02) 9606 2333

ReVeg- It – Hornsby
Nursery Operator, Mr Fardin Pelarek, (02) 4356 1427 or 0402 659 653

Ku-ring-gai Community Nursery – St Ives

Tel. (02) 9498 0825

Harvest Seeds and Native Plants – Terrey Hills

Tel. (02) 9450 2699

Wirreanda Nursery – Ingleside

Tel. (02) 9450 1400

Sydney Wildflower Nursery – Terrey Hills

Tel. (02) 9450 1555

Tharwa Propagation Nursery – Terrey Hills

Tel. (02) 9450 1967

APPENDIX B: Planning for Bushfire Protection 2019 standards for asset protection zones

APPENDIX 4

ASSET PROTECTION ZONE REQUIREMENTS

In combination with other BPMs, a bush fire hazard can be reduced by implementing simple steps to reduce vegetation levels. This can be done by designing and managing landscaping to implement an APZ around the property.

Careful attention should be paid to species selection, their location relative to their flammability, minimising continuity of vegetation (horizontally and vertically), and ongoing maintenance to remove flammable fuels (leaf litter, twigs and debris).

This Appendix sets the standards which need to be met within an APZ.

A4.1 Asset Protection Zones

An APZ is a fuel-reduced area surrounding a building or structure. It is located between the building or structure and the bush fire hazard.

For a complete guide to APZs and landscaping, download the NSW RFS document *Standards for Asset Protection Zones* at the NSW RFS Website www.rfs.nsw.gov.au.

An APZ provides:

- a buffer zone between a bush fire hazard and an asset;
- an area of reduced bush fire fuel that allows for suppression of fire;
- an area from which backburning or hazard reduction can be conducted; and
- an area which allows emergency services access and provides a relatively safe area for firefighters and home owners to defend their property.

Bush fire fuels should be minimised within an APZ. This is so that the vegetation within the zone does not provide a path for the spread of fire to the building, either from the ground level or through the tree canopy.

An APZ, if designed correctly and maintained regularly, will reduce the risk of:

- direct flame contact on the building;
- damage to the building asset from intense radiant heat; and
- ember attack.

The methodology for calculating the required APZ distance is contained within Appendix 1. The width of the APZ required will depend upon the development type and bush fire threat. APZs for new development are set out within Chapters 5, 6 and 7 of this document.

In forest vegetation, the APZ can be made up of an Inner Protection Area (IPA) and an Outer Protection Area (OPA).

A4.1.1 Inner Protection Areas (IPAs)

The IPA is the area closest to the building and creates a fuel-managed area which can minimise the impact of direct flame contact and radiant heat on the development and act as a defendable space. Vegetation within the IPA should be kept to a minimum level. Litter fuels within the IPA should be kept below 1cm in height and be discontinuous.

In practical terms the IPA is typically the curtilage around the building, consisting of a mown lawn and well maintained gardens.

When establishing and maintaining an IPA the following requirements apply:

Trees

- tree canopy cover should be less than 15% at maturity;
- trees at maturity should not touch or overhang the building;
- lower limbs should be removed up to a height of 2m above the ground;
- tree canopies should be separated by 2 to 5m; and
- preference should be given to smooth barked and evergreen trees.

Shrubs

- create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings should be provided;
- shrubs should not be located under trees;
- shrubs should not form more than 10% ground cover; and
- clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of the vegetation.

Grass

- grass should be kept mown (as a guide grass should be kept to no more than 100mm in height); and
- leaves and vegetation debris should be removed.

A4.1.2 Outer Protection Areas (OPAs)

An OPA is located between the IPA and the unmanaged vegetation. It is an area where there is maintenance of the understorey and some separation in the canopy. The reduction of fuel in this area aims to decrease the intensity of an approaching fire and restricts the potential for fire spread from crowns; reducing the level of direct flame, radiant heat and ember attack on the IPA.

Because of the nature of an OPA, they are only applicable in forest vegetation.

When establishing and maintaining an OPA the following requirements apply:

Trees

- tree canopy cover should be less than 30%; and
- canopies should be separated by 2 to 5m.

Shrubs

- shrubs should not form a continuous canopy; and
- shrubs should form no more than 20% of ground cover.

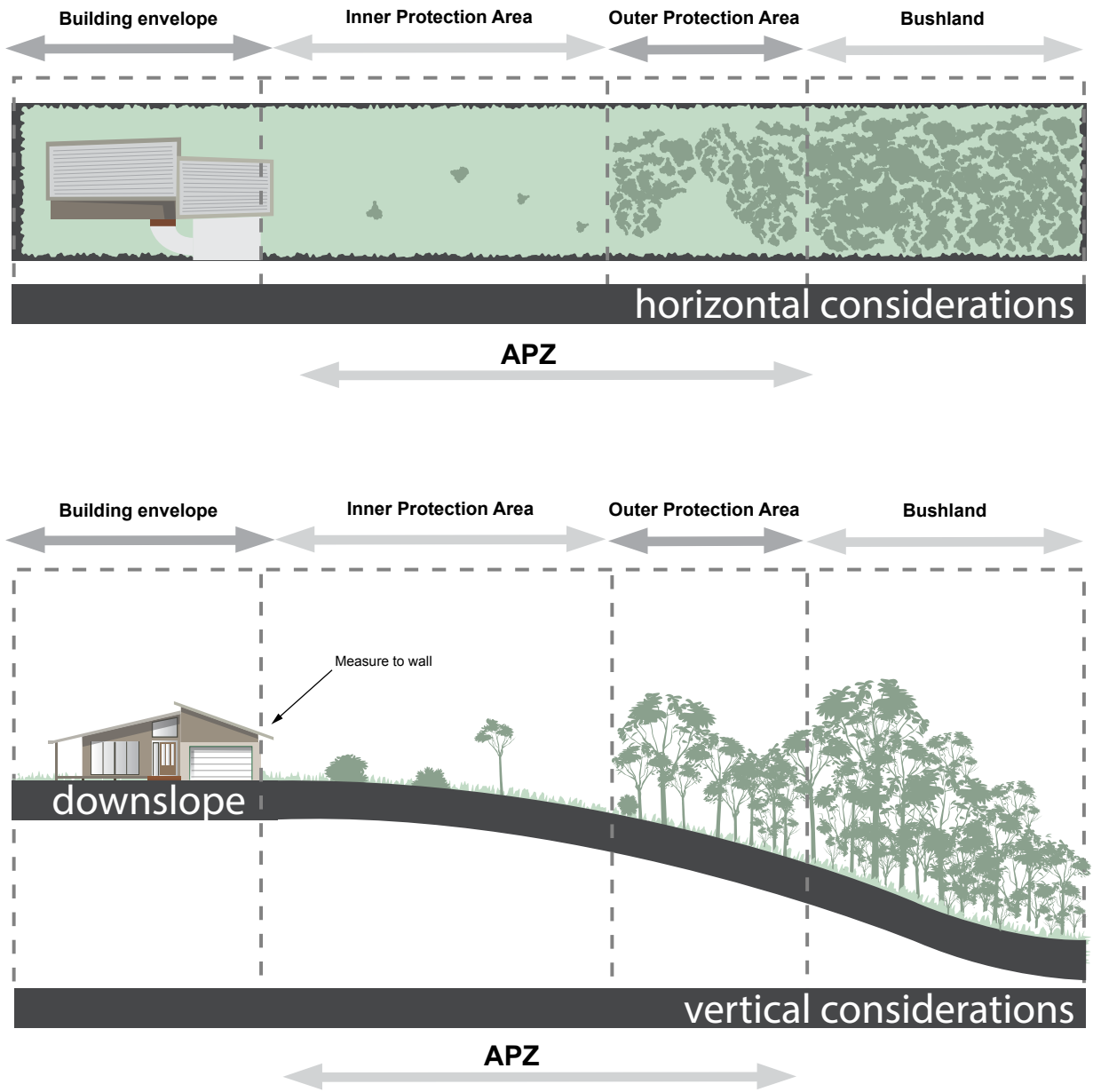
Grass

- grass should be kept mown to a height of less than 100mm; and
- leaf and other debris should be removed.

An APZ should be maintained in perpetuity to ensure ongoing protection from the impact of bush fires. Maintenance of the IPA and OPA as described above should be undertaken regularly, particularly in advance of the bush fire season.

Figure A4.1

Typical Inner and Outer Protection Areas.



Appendix C: RELEVANT QUALIFICATIONS & EXPERIENCE OF THE AUTHOR

Alex Fraser (Fraser Ecological Consulting) has over 10 years experience in ecological assessment and on-ground bushland restoration management. Previous work roles include ecological consulting with Parsons Brinckerhoff (large infrastructure), NPWS (biodiversity surveys), NSW Department of Environment and Climate Change (SIS DGRs) and Hornsby Shire Council (residential and light industrial development) have focussed primarily on ecological survey, development assessment, project management and policy development for consent authorities. Alex also has practical experience in landscape construction, bushland restoration and property management. A full list of flora and fauna assessments & vegetation management plans previously undertaken can be provided upon request.

Professional Affiliations include the Australian Association of Bush Regenerators, Ecological Society of Australia, Royal Zoological Society of NSW, Birds Australia, Australasian Bat Society, Urban Feral Animal Action Control Group (Sydney North Councils), Surfrider Foundation & Fred Hollows Foundation.

Relevant qualifications and training:

- Bachelor of Applied Science – Coastal Resource Management (Honours)
- Certificate 3 Natural Area Restoration (Ryde Horticultural College)
- Chemcert (Department of Natural Resources)
- Chainsaw Cross Cutting Techniques (Ryde Horticultural College)
- Certificate 3 Vertebrate Animal Pest Control (NSW DPI, Orange)
- OH&S General Induction for Construction Work (Work Cover NSW)
- Senior First Aid (St. Johns Ambulance Australia) and Project Management 'the hard and soft skills' (NPWS- 2004)
- Frog, Bat and Reptile: species identification and survey skills (Forests NSW)
- Certificate 3&4 Japanese language proficiency (The Japan Foundation)
- Advanced Open Water SCUBA diver (PADI Australia)
- State Rail Contractor Safety Awareness (State Rail Authority)
- NPWS Scientific Licence (NSW Office of Environment and Heritage)
- Animal Ethics Authority (NSW DPI)
- BAM accredited assessor (DPIE) and Ecological Consultants Association (practising member)

COREY MEAD

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Brighton Downs Qld – Night Parrot re-discovery 2013

With over 15 years' experience in undertaking fauna surveys and preparing habitat and impact assessment reports for threatened biodiversity and 25 years' working generally with wildlife, I feel fortunate to do what I do. From finding rare animals in remote parts of Australia to appreciating locally common species, I love the challenges of working out both habitat values and outcomes for clients. In more recent years I have gained valuable insights from working alongside several industry recognised experts, yet still feel most comfortable connecting on my own. My current interest is enhancing / relocating natural large hollows and complete trunk sections or excavating hollows in living trees for forest owls and cockatoos to avoid and minimise impacts.

EDUCATION / QUALIFICATIONS

- Southern Cross University – B App. Sc 1994
- BAM Accredited Assessor (BAAS.19050)
- Accredited Biobanking Assessor (No.231)
- NSW NPWS – Introduction to Arcview GIS
- Frog, Reptile & Bat Survey, ID & Mgt Training – NSW Forestry
- Anabat Techniques Training – Titley Scientific – Smiths Lake
- Report Writing – Pollack Learning Alliance
- Tree climbing techniques and chainsaw operation
- Risk Assessment Training (Taronga Zoo)
- Australian bat Lyssavirus vaccinations
- NSW RFS – Firefighters Certificate
- Cert III – Building & Carpentry (nest boxes)
- First Aid Certificate (St John's Ambulance Service)
- Class C vehicle, Boat & Divers Licences

SKILLS / EXPERIENCE

- Report writing (BDAR / BCAR / BSSAR / KAR / and other fauna related assessment, monitoring and management reports)
- Maintain ecological report templates, content and formatting
- Remote and independent terrestrial vertebrate surveys
- Threatened fauna target surveys & assessment
- BAM-C fauna data and credit assessment
- Fauna support for Land & Environment Court cases
- Microbat ultrasonic call identification & active monitoring
- AnalookW, Anapocket, Insight & CFC Read bat analysis software
- Kaleidoscope Pro song-meter clustering & classifier analysis
- Prepare song classifiers for threatened owls, frogs & gliders
- Radio-tracking Surveys
- Owl roost and nest locations
- Coordinate the relocation of large owl hollow sections and entire 9 tonne trees containing large hollows with cranes and climbers
- Tree climbing and chainsaw qualified
- Project Ecologist during habitat clearance
- Habitat tree assessment / Audits
- Construct and supply long-life nest boxes
- Advanced animal captive management
- Fire trail audits & bushfire risk analysis
- Advanced venomous snake handling & training for zoo staff
- Education/training program development
- Sub-1m GPS data collection, transfer and management
- Scientific License & Animal Ethics License

EMPLOYMENT HISTORY

- May 2011 – Recent – Senior Fauna Ecologist – Travers Bushfire & Ecology
- Oct 2007 – May 2011 – Fauna Ecologist – Travers Bushfire & Ecology
- Jan 2006 – Oct 2007 – Field Tech / Fauna Ecologist – Conacher Travers Environmental Consultants
- Feb 2003 – Jan 2006 – Head Reptile Keeper – Australian Reptile Park
- Jan 2003 – Sept 2005 – Visitor Services Officer – National Parks & Wildlife Service
- Dec 2002 – Jan 2003 – Marine Turtle Project Officer – National Park & Wildlife Service
- Aug 2000 – Feb 2003 – Venom Room Attendant – Australian Reptile Park
- Apr 1997 – Sept 2000 – Environmental Education Officer – Australian Reptile Park

COREY MEAD

FAUNA ECOLOGIST

PHONE REFEREES

- John Travers - Director *Travers Bushfire & Ecology* - 0418 630 048
- Elizabeth Ashby - Director *Keystone Ecology* - 0418 680 566
- Rochelle Lawson - Senior Ecologist Central Coast Council - 0429 124 316

FIELDWORK WITH SPECIALISTS

- **Dr Steve Phillips** in the application of Koala grid based surveys (Glenning Valley).
- **John Young** on owl nest/roost searches (Lake Macquarie, Spring Farm, Chain Valley Bay) and rare birds through remote Queensland
- **Gerry Swan** on Heath Monitor ecology (Beacon Hill and Belrose)
- **Prof Michael Mahony** on Giant Burrowing Frog target surveys (Belrose)
- **Dr Ross Goldingay** on Yellow-bellied Glider target surveys, monitoring and seasonal habitat resources (Cattai)
- **Dr Ross Goldingay** on Eastern Pygmy Possum target surveys and detailed habitat assessments (Belrose)
- **Ross Wellington** on Green-thighed Frog, Giant Barred Frog and Stuttering Frog habitat assessments (Mardi)
- **Dr Richard Noske** on assessment of Varied Sittella (Spring Farm)

SIGNIFICANT CAREER ACHIEVEMENTS

- Prepared the ***Guideline for the Relocation of Large Tree Hollows*** for Central Coast Council and cited by the BCT
- Assisted John Young in the re-discovery of the **Night Parrot** recording the first call and breeding location in over 100 years in 2013.
- Provided the only then capture of ***Pseudechis weigeli*** brown snake in remote Kimberley's for Discovery Channel documentary in 2002.
- Provided Western Diamondback Rattlesnake handling assistance for **Steve Irwin**.
- Assisted **Malcolm Douglas** in breeding and management of Saltwater Crocodiles
- Captures of ***Morelia carinata*** python in remote WA providing new understanding of the species ecology.
- Article on Australian Snakes for **Outdoor Magazine Australia**.
- Developed and implemented a **Wildlife Education Program** for schools across Australia.
- Developed a **Fire Trail Auditing** system for Gosford City Council Natural Areas.
- Collation of state-wide **Marine Turtle records** for NSW National Parks & Wildlife Service and development of awareness programs.
- Developed a comprehensive **staff training program** at the Australian Reptile Park.
- Venomous Snake Handling Training for **Dreamworld** and **Currumbin Sanctuary** zoo staff.
- Undertaken independent travel with fauna experience through the Americas and Africa.

NOTABLE PROJECTS

Surveys and BDAR at a 223 ha site (183 ha vegetated) at Mardi for a 244 lot residential subdivision in 2019. Twenty threatened fauna species were recorded. Eight breeding locations were recorded for **Green-thighed Frog** (known to only call on one or two nights in the year) and subsequent detailed habitat mapping of the floodplain contours to identify all breeding potential and PCT overlays for species polygons calculations. Eighteen frog species were recorded. Despite specialist advice to assume presence, target surveys ruled out **Green and Golden Bell Frog, Stuttering Frog and Giant Barred Frog** from the extensive floodplain and moist forest creeks from detailed surveys combined with song-meters and preparation of recogniser files, saving over $6,000,000 in species credits.



Squirrel Glider target trapping and radio-tracking surveys were undertaken at Morrisett Country Club in 2012 as part of ecological constraints investigations. The radio-transmitter collars were found to be faulty after capturing the first male so a makeshift collar was constructed from cable-tie, tape and an old working bandicoot transmitter. This animal was recaptured and the collar was replaced when the new batch arrived. Den sites, road crossing points and foraging areas were mapped to guide appropriate course expansion and design.

Subdivision site at Duffy's Forest recorded presence of a female **Rosenberg's Goanna** in 2011. Extensive previous surveys of this site by other consultants, which included SIS and Land and Environment Court proceedings, all failed to identify the importance of the subject plateau for the species. By applying knowledge from keeping goannas as Head Keeper of Reptiles (Aust. Reptile Park) I undertook detailed habitat assessment of the plateau and demonstrated it to be a critical breeding area. Nesting mounds were not otherwise present in the adjacent and extensive National Park. Surveillance cameras placed on burrows also identified a suspected important winter burrow for the local female. Winter burrows are central to core home ranges.

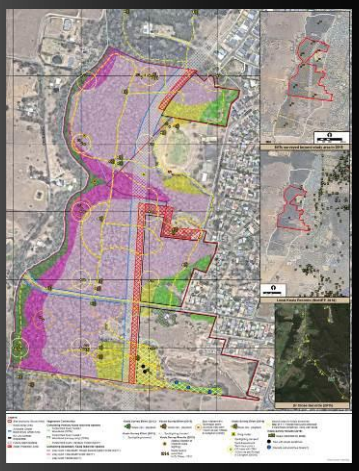
Rosenberg's goanna target surveys and habitat assessments have also been applied to large sites at Belrose, Beacon Hill and Narraweena. Burrows were searched for recent tracks indicating activity and these were inspected for presence using an industrial endoscope with a camera / video screen. The adjacent image is of a juvenile in the burrow as well as a plateau habitat assessment of the site and the adjacent Garigal National Park. This showed the local extent of high, moderate and low quality habitats.

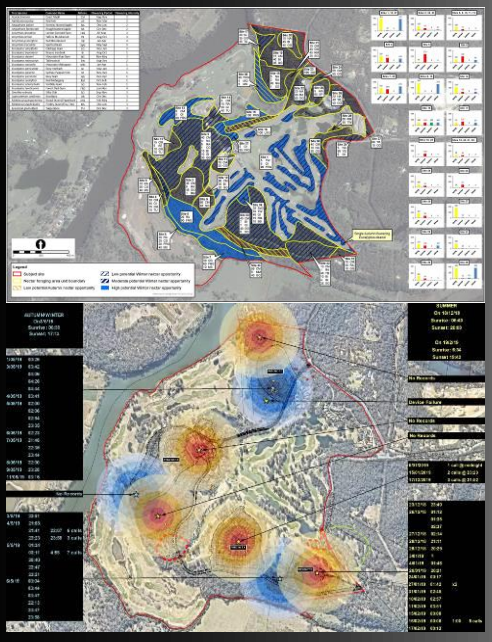


Constraints level surveys for the Aboriginal Lands Council at North Hawkes Nest recorded a relatively concentrated population area of **Spotted-tailed Quoll**. Photos of trapped quolls and surveillance camera images of characteristic markings gave an estimate of the number of individuals utilising the 110 ha study area. Some threatened fauna also recorded included **New Holland Mouse, Long-nosed Potoroo and Glossy Black-Cockatoo**.

Analysis of important roosting and nesting habitat areas for **Bush Stone-curlew** within a holiday estate at Kingscliff, Northern NSW. This was to determine connectivity impacts and appropriate mitigation measures for a proposed residential subdivision on adjacent lands. Localised wetland surveys also recorded **Beach Stone-curlew, Black-necked Stork, Black Bittern, Eastern Curlew** and **Pied Oystercatcher** amongst others.

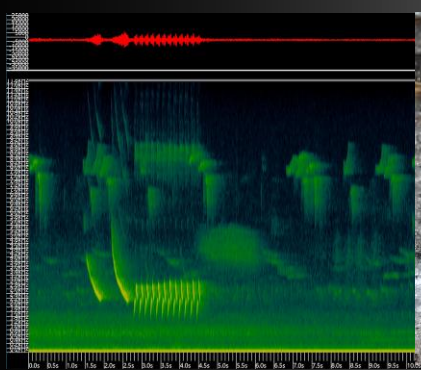

The Georges River **Koala** population occurs in areas of low soil fertility, subsequently this region has a low carrying capacity to support Koala activity. They can be extra difficult to locate with females occupying a home range of approx 50ha and males up to 100 ha. Target grid based Koala surveys were undertaken to review the extents of use and activity levels within a 58 ha rezoning site at Appin containing just over 50 ha of forest and woodland vegetation. SAT points recorded varying activity ratings assisting in determining habitat use areas. It was also suspected that the recognised primary feed tree Forest Red Gum in other locations within the state and located within much of the proposed development footprint, were of lesser local value compared to Grey Gums and Blue-leaved Stringybark. Therefore SATs also recorded additional data on scratches on these trees (which may last longer than scats). This more long-term data was able to support regional findings by Koala experts *Biolink* and demonstrate how the proposed 34.9 ha of conserved areas were of greater value to Koalas and how activity had increased in the site between 2015 and 2018.





Preparation of a **Yellow-bellied Glider Habitat Assessment and Monitoring** report under the guidance of glider expert Dr Ross Goldingay for a revised masterplan development at Cattai. The site contains up to 100 ha of available remnant dry open forest habitat with additional narrow canopy corridors between golf course fairways. Initial species monitoring included observations of YBG foraging movements and preferences of sap, manna, honeydew, invertebrates and nectar. Sap feed trees were identified however local floristics were considered most important for consideration of habitat retention. The habitat assessment incorporated a detailed analysis of seasonal flowering trees species within sub-communities across the entire area to ascertain any unique areas of retention value. Following this and request by The Hills Shire Council, seasonal monitoring of the site use by glider family groups was undertaken by use of long-deployment song-meters. External 12V 17Ah deep cycle batteries were allied with SM4 devices to permit a nocturnal recording schedule over a 3 month period. A Yellow-bellied Glider recognizer file (advanced classifier) was constructed from recorded vocalisations. This was applied to clustered recordings within Kaleidoscope Pro V5.1.9 software to identify all recorded calls in the period. Song-meter locations over the two recording periods (summer & autumn) and trends of site use were summarised on the adjacent lower image.

Historical **Squirrel Glider** records on the Coal Point peninsula at Lake Macquarie prompted council to request an analysis of glider connectivity and impacts from a proposed residential development at Carey Bay. Glider movement options through the residential landscape at road crossing points were identified and the viability of these were considered based on **gliding ratios**.



Red-crowned Toadlet breeding locations have been identified from habitat and tadpole searches across numerous sites on the Central Coast and northern Sydney. These are typically allied with the more selective and periodic breeding of Giant Burrowing Frog target surveys using song-meters and constructed recogniser files on Kaleidoscope Pro software. Four **Giant Burrowing Frog** breeding locations at Belrose, Beacon Hill and Narraweena have be found using this method.

LARGE HOLLOW / TRUNK SECTION RELOCATIONS

My mission is to provide services to relocate large hollows and trunk sections in order to avoid impacts on large hollow dependent species...and bring back the birds! *TreeHouse Ecology* does not support the relocation of hollows occupied by rare or threatened species. Often however, large hollows are not found to be occupied by such animals during surveys for development. For example, Masked Owl males will use a number of satellite roosting hollows to defend the core nesting area occupied by the female during breeding, and more at other times of the year. So such hollows in proposed development landscapes may have been previously occupied or are an opportunity for future use. As a tree climbing ecologist with now many years of owl roost and nest experience, I can first provide assistance to projects by analysing the termite mud in the base of hollows for evidence of historical use. Where large hollows are cleared for removal, these may in fact be an otherwise limited natural resource in the locality, therefore relocation is a potentially important opportunity to enhance remaining conservation and stewardship areas and minimise indirect impacts on large hollow-dependent fauna…

Above, middle & far below: A Barn Owl roost tree was proposed for removal for subdivision road access at Wadalba in 2016.

Given (1) the apparent quality of two large hollows within this tree (one at approximately 28m high); (2) that a Powerful Owl breeding pair were already known in the locality; and (3) that similar large hollows were otherwise absent in the adjacent conservation corridor, I suggested to council to relocate the hollow. Owl expert John Young further suggested relocating the entire tree. This way the height of the hollow in the crown could be maintained. Following the previous success of relocating a large hollow section into the corridor (next page), this was a new opportunity to develop the process again at a much larger scale. A large ironbark with two trunks growing side-by-side was selected within the corridor as the recipient tree. A 65 tonne crane secured the hollow tree trunk whilst the base of the tree was cut. After lowering the trunk section it was left for a few months whilst the cambium dried. During this time excavations of termite material allowed for the shaping of 4 large hollows of varying aspects and entry. The base was treated against termites and the entire external surface was sprayed with lanolin oil for protection from drying and cracking. Two franna cranes then carried the trunk section along road and fire trail access to the recipient tree and the larger crane lifted it vertically and slewed it into place. Heavy duty steel cable with turnbuckles used at the local TreeTops Adventure Park was used to secure the trees together. Powerful Owl was recorded inspecting the hollows for nesting during the follow up surveillance camera monitoring (image of Bingo provided by Central Coast Council below).





Above: During pre-clearance surveys I found Powerful Owl nesting in an approved development area at Wadalba in June 2011. Despite suitable nesting opportunities in this footprint, the previous ecologists failed to identify this potential and allocate appropriate seasonal survey. Adjacent conservation areas were also established prior to knowing owl nesting locations and were themselves deficient in such quality large hollows. I recommended and co-ordinated the relocation of this 3m hollow section. Whilst working at *Travers bushfire & ecology* this was my first attempt to co-ordinate cranes and tree climbers and design a strong attachment method to support the heavy weight of a large hollow in a recipient tree without compromising its health or public safety. Metal strapping is held off the cambium of the living tree by pine blocks and permits ongoing natural growth. Following this success, as well as the relocation of an entire 9 tonne trunk section (previous page), Central Coast Council requested I prepare the *Guideline for the Relocation of Large Tree Hollows (2016)*.

Middle: In early 2020 I was requested by *Central Coast Council* to provide advice on hollows located within the approved trunk water main route linking the Mardi Water Treatment Plant to the Hunter Water Corporations trunk line at Warnervale. A 40m tall Spotted Gum was identified as an expected Masked Owl tree given the presence of a known local breeding pair.




An inspection hole was cut in the side wall of the 5m+ deep hollow section during pre-clearing climbing inspections. Termite mud was inspected and found deep traces of terrestrial mammal bones, confirming it as a historic *Tyto* owl tree and expected periodic Masked Owl roost. Given the quality deep mid hollow as well as additional large hollows at the crown, the 9 tonne tree was recommended for relocation. The tree is currently being prepared for placement in the adjacent reserve.

Below: Whilst undertaking surveys for a Stage 2 development at Kembla Grange in February 2017 I recorded a Greater Broad-nosed Bat roosting colony within a large hollow located within the already approved Stage 1 development area. Based on the threatened status of this species and also supported by the Conditions of Consent the hollow section was relocated into the adjacent reserve. A high powered cordless drill and long auger bit was used in an elevated work platform to prepare inspection holes for a videoscope probe with rotational camera head. When bats were absent the tree was secured with a Hiab (truck-mounted crane) for the cut and then lowering / transport / lifting. The section was fitted onto a pre-cut limb to take the weight, then strapped to mimic the previous height angle and aspect.





OWL HOLLOW INSPECTIONS / SURVEILLANCE

Rosenberg's Goanna | Eastern Pygmy Possum | Large Bent-winged Bat | Monocled Cobra | New Holland Mouse | Squirrel Glider tracking | Large-footed Myotis | Little Bent-winged Bat | Green and Golden Bell Frog

TREEHOUSE nestboxes

SUPPLY / INSTALLATION / MONITORING

COREY MEAD

FAUNA ECOLOGIST

THREATENED FAUNA SPECIES RECORDED

Presumed Extinct (NSW)

- Night Parrot n/a

Critically Endangered Species (NSW)

- Regent Honeyeater **
- Beach Stone-curlew **

Endangered Species (NSW)

- Green and Golden Bell Frog *
- Giant Barred Frog *
- Mahony's Toadlet *
- Stuttering Frog *
- Loggerhead Turtle *
- Leatherback Turtle *
- Dugong n/a
- Grey Falcon
- Southern Giant Petrel n/a
- Black-necked Stork
- Pied Oystercatcher *
- Plains Wanderer **
- Bush Stone-curlew *
- Swift Parrot **
- Black-striped Wallaby
- Cumberland Plain Land Snail *
- Maroubra Woodland Snail *

Vulnerable Species (NSW)

- Wallum Froglet *
- Red-crowned Toadlet *
- Giant Burrowing Frog *
- Green Turtle *
- Flatback Turtle
- Hawksbill Turtle n/a
- Stimson's Python *
- Western Blue-tongue Lizard
- Rosenberg's Goanna
- Osprey **
- Little Eagle **
- White-bellied Sea Eagle **
- Black-breasted Buzzard **
- Spotted Harrier
- Square-tailed Kite **
- Magpie Goose
- Black Bittern
- Sooty Oystercatcher *
- Greater Sand Plover **
- Lesser Sand Plover **
- Bar-tailed Godwit **
- Red-tailed Black-Cockatoo **
- Glossy Black-Cockatoo **
- Gang-gang Cockatoo **
- Major Mitchell's Cockatoo **
- Swift Parrot **
- Little Lorikeet
- Wompoo Fruit-dove
- Superb Fruit-dove
- Rose-crowned Fruit-dove
- Painted Honeyeater
- Black-chinned Honeyeater
- Grey-crowned Babbler
- Hall's Babbler
- Powerful Owl **
- Barking Owl **
- Masked Owl **
- Sooty Owl **
- Marbled Frogmouth
- Speckled Warbler
- Brown Treecreeper
- White-fronted Chat
- Varied Sittella
- Hooded Robin
- Scarlet Robin
- Flame Robin
- White-eared Monarch *
- Diamond Firetail
- Spotted-tailed Quoll
- Long-nosed Potoroo *
- Brush-tailed Phascogale *
- Eastern Pygmy Possum *
- Koala **
- Squirrel Glider *
- Yellow-bellied Glider
- Grey-headed Flying-fox **
- Yellow-bellied Sheathtail-bat
- Large-footed Myotis *
- Little Bent-winged Bat **
- Large Bent-winged Bat **
- Greater Broad-nosed Bat
- Eastern Cave Bat *
- Eastern Coastal Free-tailed Bat
- Eastern False Pipistrelle
- Eastern Long-eared Bat
- Large-eared Pied Bat *
- Hoary Wattled Bat
- Golden-tipped Bat

EPBC Listed & Migratory Protected Species (not otherwise listed above)

- New Holland Mouse
- Greater Glider
- White-throated Needletail
- Fork-tailed Swift
- Rainbow Bee-eater
- Black-faced Monarch
- Spectacled Monarch
- Satin Flycatcher
- Rufous Fantail

* species credit species
** dual credit species

Appendix D: DPIE (2020) Hygiene guidelines: Protocols to protect priority biodiversity areas in NSW from Phytophthora cinnamomi, myrtle rust, amphibian chytrid fungus and invasive plant

NSW GOVERNMENT

SAVING OUR SPECIES

Hygiene guidelines

Protocols to protect priority biodiversity areas in NSW from *Phytophthora cinnamomi*, myrtle rust, amphibian chytrid fungus and invasive plants

environment.nsw.gov.au/sos

Cover photo: Wollemi pine (*Wollemia nobilis*). Rosalie Nicolai/DPIE

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April 2020

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Foreword

This document sets out guidelines to reduce the risks of introducing pathogens (*Phytophthora cinnamomi*, myrtle rust and chytrid fungus) and invasive plants into new areas of New South Wales, especially those with susceptible threatened species, threatened ecological communities and areas of outstanding biodiversity value. The procedures in this document can also be applied to protect non-threatened species.

These guidelines promote the adoption of basic hygiene procedures into daily routines when working in the field. They are simple procedures to ensure potentially-contaminated material is not transferred to a new, susceptible area.

Under select circumstances, more strict hygiene procedures are recommended. These circumstances include when a general biosecurity eradication or containment effort is underway or when undertaking activities that could expose susceptible threatened species, threatened ecological communities or areas of outstanding biodiversity value to a new threat. Strict hygiene procedures are similar to the basic measures but include more thorough cleaning or disinfection.

These protocols and their application should be reviewed five years from the date of publication or if significant new information becomes available.

This document was developed as part of the NSW Government's *Saving our Species* program.

Who should use this guide?

This guide should be used by NSW Department of Planning, Industry and Environment (DPIE) employees, and contractors and volunteers undertaking works on behalf of DPIE, on public or private land.

This guide may also be used by private individuals or businesses working in conservation and revegetation, agriculture, construction, forestry, other primary industries or fields involving work in the agricultural or natural environments.

How to use this guide

Follow the steps below to determine which hygiene measures you should incorporate into your work plan. Clicking on an underlined word or phrase will take you to the relevant section of this document.

1. Read the section on planning considerations. This section provides information on what is likely to influence the risks a certain activity poses, but will not affect the level of hygiene recommended.
2. Read the section on determining your hygiene requirements, and review Appendix B and Appendix C to identify whether any species you are working with or near are susceptible to *Phytophthora cinnamomi* or myrtle rust infection. For *Phytophthora cinnamomi* and myrtle rust, use Decision tree 1 for Phytophthora and myrtle rust to determine which protocols are suitable for your work. If you are working on an island, use Decision tree 2 for visiting or working on islands. For invasive plants and amphibian chytrid fungus (*Batrachochytrium dendrobatidis*), there are set protocols that should be applied in all circumstances.
3. Incorporate the relevant procedure(s) into your work activities.

Useful tools in this document

A list of species known to be susceptible to *Phytophthora cinnamomi* infection can be found at Appendix B.

A list of species known to be susceptible to myrtle rust infection can be found at Appendix C.

Lists of significant invasive non-native plants can be found at Appendix A and Appendix D.

Additional advice for working with and handling amphibians can be found at Appendix E.

A template for a hygiene management plan can be found at Appendix F.

Contents

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Introduction

Purpose

This document provides guidance for people undertaking activities that have the potential to spread or introduce specific pathogens or invasive plant propagules in the natural environment of New South Wales. The protocols outlined in this document are recommended to ensure the risks of spreading pathogens and invasive plants are effectively managed to protect biodiversity in New South Wales.

Objective

The objective of these guidelines is to outline hygiene practices that can help avoid or minimise introduction of pathogens or invasive plants to areas in New South Wales with threatened species and threatened ecological communities. The guidelines were developed to address the following key threatening processes (KTPs) listed under the *Biodiversity Conservation Act 2016* (BC Act):

- infection of native plants by *Phytophthora cinnamomi*
- introduction and establishment of exotic rust fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae (myrtle rust)
- infection of frogs by amphibian chytrid causing the disease chytridiomycosis (chytrid fungus).

These guidelines can also be applied to invasive plant-related KTPs (see Invasive plants) and invasive plants identified in National Parks and Wildlife Service branch pest management strategies. They may also have relevance to other disease and pest (including invertebrate and microbial pest) organisms, particularly those borne in soil or water, although these may require additional case-specific protocols (see Biosecurity Hotline contacts below).

The protocols in this document are also relevant to a number of KTPs listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Use of these guidelines may also reduce the risk from a number of pathogens and diseases yet to arrive in Australia, but assessed as being likely to do so and of high environmental risk (see Priority list of exotic environmental pests and diseases, last reviewed 4 February 2020).

For more general information on managing disease risks in wildlife, including hygiene recommendations, see the National Wildlife Biosecurity Guidelines (PDF 2.3MB) (Wildlife Health Australia 2018).

Scope and application

In New South Wales, the most practical, outcomes-based approach to hygiene is to focus on protecting areas that are: (1) not infested, (2) habitat for threatened species and threatened ecological communities, and (3) not subject to high visitation by people. The protocols in this document can help to achieve this for *Phytophthora cinnamomi*, myrtle rust, chytrid fungus and invasive plants. They may also be useful in reducing risks associated with other pathogens. In the latter case, further information about the risks of transmission will help determine when and where the protocols should be applied.

Some sites or projects may require a specific hygiene management plan. If a hygiene management plan has been developed for your site or project, that plan should take precedence. This document is a guide and should not replace the development of specific hygiene management plans for areas, sites and projects. A template for a hygiene management plan can be found at Appendix F. The template can be used to record the specific hygiene actions for your work.

Hygiene measures should be applied by people working in areas of high biodiversity importance across New South Wales, where appropriate (see Determining your hygiene requirements). People working with Bellinger River snapping turtles (*Myuchelys georgesi*) in the Bellinger River may need to take extra hygiene precautions due to the presence of Bellinger River virus. Those people should first contact the NSW Department of Primary Industries Aquatic Biosecurity Hotline on 02 4916 3877 or 131 555 or by email to confirm what hygiene precautions they should take.

This document does not:

- address biosecurity risks associated with handling animal biological samples, carcasses and waste (see the National Wildlife Biosecurity Guidelines (Wildlife Health Australia 2018) for general information on managing those risks)
- address the risks that native and pest animals play in transferring pathogens and invasive plants between locations, but acknowledges that control of pest animals may be important in reducing the spread of pathogens and invasive plants in some landscapes
- provide species-specific guidance for invasive plants
- replace the benefit or need for developing tailored landscape-, project- or site-specific hygiene management strategies for pathogens and invasive plants.

Pathogens

Pathogens are organisms that can cause disease, and they have the potential to cause significant declines in species and disrupt ecological communities. Preventing entry of pathogens is always the most cost-effective management strategy; however, when pathogens are detected, eradication should be the next option considered, followed by containment (when eradication is not feasible). When containment is not feasible, protecting susceptible threatened species, threatened ecological communities and areas of outstanding biodiversity value is of paramount importance.

Phytophthora cinnamomi

Phytophthora cinnamomi (Phytophthora) is a soil-borne water mould that attacks the roots of susceptible plants, destroying the root system and reducing the ability of the plant to conduct water and nutrients, which can sometimes kill the infected plant (Makinson 2018b).

Any activity that moves soil or plant matter can spread Phytophthora. Clothing, equipment, footwear and vehicles that can carry soil are potential vectors for transmission (NSW TSSC 2011). In most situations, Phytophthora is impossible to eradicate from infested areas, so the current approach to management aims to prevent its introduction to unaffected areas to protect threatened species and ecological communities that are most at risk.

The development of phytosanitary protocols to reduce risks of spreading Phytophthora is a strategic objective of the draft *Saving our Species* (SoS) Phytophthora KTP strategy. This document directly addresses that objective.

Other *Phytophthora* species (e.g. *P. aggregate*, *P. multivora*) are emerging as threats to biodiversity in New South Wales. They have similar dispersal characteristics to *P. cinnamomi* and so the application of hygiene measures outlined in this document will be effective in also containing their spread.

Myrtle rust

Myrtle rust is a disease caused by the fungus *Austropuccinia psidii* (Beenken 2017; Makinson 2018b). It affects trees and shrubs in the Myrtaceae family by attacking young, soft, actively-growing leaves, shoot tips, young stems, fruits and flower parts.

The primary vector of myrtle rust at local and intermediate scales is wind (Makinson 2018b; Pegg et al. 2014); however, myrtle rust spores can quickly spread via people on contaminated clothing, footwear, tools, vehicles and machinery, as well as on animals. While good hygiene practices cannot control the spread of myrtle rust by wind, they can help slow the spread by people to areas that are not yet infested.

The hygiene management approach outlined in this document is consistent with Action 2 of the Management plan for myrtle rust on the national parks estate (PDF 1.4MB) to limit the spread of myrtle rust from infested sites and limit the introduction of myrtle rust to non-infested sites (OEH 2015). No hygiene actions have been identified in the draft SoS myrtle rust KTP strategy; nevertheless, it is important to enact due diligence and ensure it is not spread to areas with susceptible species through poor hygiene. The protocols set out in this document are also consistent with the draft action plan for myrtle rust in Australia (Makinson 2018a).

Amphibian chytrid fungus

Amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) is a fungal pathogen that causes the disease chytridiomycosis, which has led to the decline and extinction of frog populations globally and in Australia (OEH 2018). Chytridiomycosis has been detected in over 40 species of native Australian frogs (DECC 2008).

The fungus is transferred by direct contact between frogs and tadpoles or via zoospores in infected water (OEH 2018). Humans can spread the disease by contaminated footwear and equipment and by (illegally) moving frogs from one area to another.

Batrachochytrium dendrobatidis is listed as prohibited matter under the *Biosecurity Act 2015*. Consequently, it is an offence to knowingly spread chytrid in New South Wales. Implementing the protocols detailed in this document will help people to carry out their general biosecurity duty to prevent, eliminate or minimise risk posed by chytrid fungus.

The protocols outlined in this document replace the *Hygiene protocol for the control of disease in frogs* (DECC 2008).

Invasive plants

Invasive plants are (generally) non-native to Australia and have an adverse effect on, or are suspected of having an adverse effect on, the environment, the economy or the community (Biosecurity Act). The financial impact of invasive plants in New South Wales on agriculture alone is approximately $4.3 million every year (DPI 2017). Impacts on the environment have not been quantified but are likely equal to or greater than those on agriculture. Many invasive plants can occupy natural areas and disturb ecosystems by altering plant and animal community composition, nutrient cycles and fire regimes (DoE 2015).

Invasive plants can be spread by dispersal of seed and vegetative material on wind, animals, waterways and people (via contaminated clothing, hats, footwear, tools, equipment, machinery and vehicles; DoE 2015). Although non-human vectors are difficult to control, the dispersal capacity of humans can be reduced by modifying behaviour. Implementing hygiene protocols will assist with controlling the spread of invasive plants by preventing the transportation of plant material that is capable of proliferating in new sites. The primary approach to preventing spread of invasive species is through effective project planning and cleaning of clothing, equipment and vehicles.

The following KTPs under the BC Act involve one or more invasive plant species:

- invasion and establishment of exotic vines and scramblers
- invasion and establishment of Scotch broom (*Cytisus scoparius*)
- invasion, establishment and spread of lantana (*Lantana camara* L. *sens*. *lat*.)

- invasion of native plant communities by African olive *Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.
- invasion of native plant communities by *Chrysanthemoides monilifera*
- invasion of native plant communities by exotic perennial grasses
- loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Some invasive plants may be subject to targeted eradication or containment programs and may have increased hygiene requirements. Outside of those programs, the procedures in these guidelines can be used to reduce the likelihood of spreading invasive plants to new areas.

Invasive plants in New South Wales are regulated under the *Biosecurity Act 2015*. The Biosecurity Act establishes the concept of a 'general biosecurity duty', which requires that any person who deals with (e.g. possesses, breeds, propagates, moves, displays, acquires) a plant and knows (or ought to know) of any biosecurity risks associated with the plant, has a duty to ensure the risk is prevented, eliminated or minimised, as far as is reasonably practical.

Some invasive plants are listed as 'prohibited matter' under the Biosecurity Act. Invasive plants that are prohibited matter are more heavily-regulated than other invasive plants. Any dealing with prohibited matter (including movement) in New South Wales is an offence. Any person who becomes aware of or suspects the presence of prohibited matter must notify the Department of Primary Industries immediately on 1800 680 244 or by email at weeds@dpi.nsw.gov.au. Visit NSW WeedWise for details of the biosecurity duties for each invasive plant species.

See Appendix D for a list of invasive non-native plants that are listed as prohibited matter. You can contact the Botanical Information Service (Royal Botanic Gardens and Domain Trust) at botanical.is@rbgsyd.nsw.gov.au to confirm plant identification and lodge voucher specimens in the National Herbarium of New South Wales.

Hygiene management

Hygiene refers to specific measures to prevent the spread of pathogens and invasive plant propagules by removing seeds, spores, contaminated soil, water, and organic materials from machinery, vehicles, equipment, footwear and clothing.

The appropriate level of hygiene (basic or strict) is dependent on whether the location is already infested and whether you are working near any susceptible threatened species, threatened ecological communities or declared areas of outstanding biodiversity value, as well as any non-listed species known to be highly susceptible to a pathogen or threat process (susceptible high-risk entities). A list of known susceptible high-risk entities can be found at Appendix B (for *Phytophthora cinnamomi*) and Appendix C (for myrtle rust).

Where a pathogen is not present at a site but there are susceptible animals or plants present, hygiene measures should be more stringent.

Maintaining good hygiene is consistent with the management principles for national parks, historic sites, state conservation areas, regional parks, karst conservation areas, nature reserves and Aboriginal land set out in the *National Parks and Wildlife Act 1974*. Those management principles include conserving natural values and conserving biodiversity, maintaining ecosystem function and maintaining natural landscapes.

Good hygiene standards are also consistent with the national standards for implementing ecological restoration activities (Standards Reference Group SERA 2017).

Planning considerations

Below is a list of factors that can decrease the likelihood of transmitting pathogens and invasive plants. It is not intended as a list of activities prescribed by this document for all circumstances (because they may be impractical in many cases) but can help readers recognise risk factors when planning and undertaking their work.

Factors that can reduce the risk of introducing or spreading pathogens or invasive plants include:

- scheduling work during dry weather (and not immediately following wet weather) to reduce adhesion of soil to footwear, clothing, equipment and vehicles
- (when working across multiple field sites) visiting known non-infested sites first, followed by sites with unknown infestation status and lastly sites known to be infested
- scheduling activities so they do not immediately follow warm, moist conditions (which are favourable for spore production) or during times of peak seed production by invasive plants
- restricting movement of soil and plant material to and from a site
- keeping vehicles, machinery and people to dry surfaces, formed roads and walking trails
- maintaining drainage to prevent flooding or pooling
- planning to use methods that minimise soil disturbance.

Additional planning considerations for fire management work

The primary focus of emergency bushfire operations is the protection of life and property. It is rarely practical to implement strict hygiene procedures under those circumstances; however, it is advisable to maintain a basic level of hygiene wherever practical to reduce the spread of plant pathogens.

For non-emergency fire management practices (e.g. prescribed burning, firebreak construction and maintenance), appropriate hygiene measures should be incorporated. We recommend using Decision tree 1 and/or Decision tree 2 (when relevant) to identify suitable hygiene measures before undertaking fire management activities.

There are additional fire management planning actions that can be considered to reduce risks of spreading plant pathogens and invasive plants. These include:

- avoiding construction of firebreaks near susceptible threatened species and threatened ecological communities, where practical and where it does not increase risk to life and property
- constructing firebreaks in areas with good drainage
- preferentially burning areas bound by well-formed hard surfaces.

Determining your hygiene requirements

During the project planning phase, it is important to determine whether basic or strict hygiene protocols are appropriate. For example, when working in areas unsuitable for establishment of a pathogen or invasive plants, it may not be necessary to implement strict hygiene measures. Basic hygiene protocols should always be applied at a minimum.

You can use the hygiene management plan at Appendix F to summarise the relevant risks and record the recommended hygiene measures for your project.

Phytophthora cinnamomi

Phytophthora cinnamomi (Phytophthora) establishment typically occurs in areas with warm conditions (optimal spore production occurs at 24–25°C under laboratory conditions; Nesbitt et al. 1979) and average annual rainfall of >500 millimetres (*Phytophthora* Technical Group 2006). In New South Wales, Phytophthora has established in the following Local Land Services regions:

- Greater Sydney (including the Greater Blue Mountains World Heritage Area; Newby 2014)
- Hunter
- North Coast
- Northern Tablelands
- Central Tablelands
- South East.

Phytophthora is also present in parts of the Central West, Riverina and Murray regions.

Strict hygiene measures are recommended at sites in these regions where:

- susceptible high-risk entities exist
- Phytophthora is not present
- there is no public access OR there is public access with hygiene measures already in place (e.g. boot-cleaning stations)
- environmental conditions are conducive to the establishment of Phytophthora.

The aim of this approach is to reduce the introduction of Phytophthora to non-infested areas.

Decision tree 1 can help you determine your hygiene requirements with respect to Phytophthora; however, if working on an island, see Visiting or working on islands.

Myrtle rust (*Austropuccinia psidii*)

There are varied reports of climatic preferences for myrtle rust spore germination (Makinson 2018b). For example, Kriticos et al. (2013) found that laboratory germination occurred between 8.8 and 29.7°C, but was optimal between 12 and 20°C. Ruiz et al. (1989) reported a thermal tolerance range of 5–25°C on a eucalypt host. Myrtle rust prefers moist environments and incidence tends to decrease during dry periods (Carnegie et al. 2016).

Myrtle rust has established throughout coastal New South Wales (including some areas of the lower Blue Mountains) and spores are likely to have spread throughout almost all moist terrestrial habitats in the region due to high dispersal capacity by wind (DPI 2015). Consequently, it is not always practical or cost-effective to implement strict hygiene procedures for myrtle rust in this region.

Hygiene measures can go some way to reducing the spread of myrtle rust to some non-infested areas such as potential habitat on or west of the Great Dividing Range in New South Wales and jurisdictions not yet affected by myrtle rust (e.g. South Australia and Western Australia). Before travelling to other states and territories not affected by myrtle rust, you should launder all of your fieldwork clothes if you have been working in an area infested with myrtle rust.

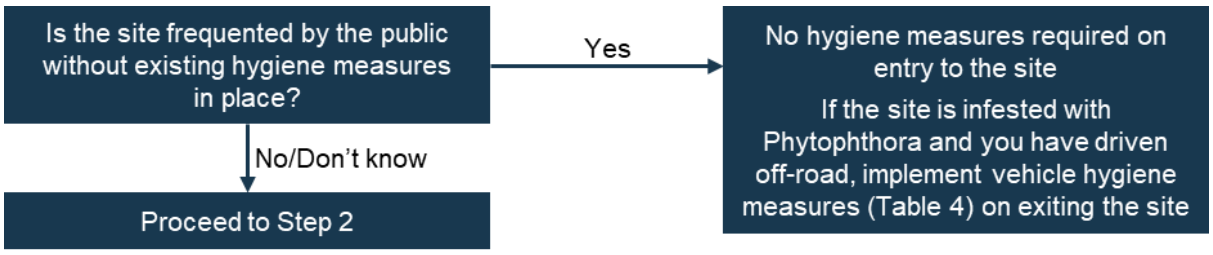
The far south-west of Western Australia contains approximately 40% of Australia's myrtaceous species (Makinson 2018b). Consequently, if introduced, myrtle rust has the potential to cause significant damage to the region. The continued exclusion of the pathogen from south-west Western Australia is a national biosecurity priority.

Decision tree 1 can help you determine your hygiene requirements with respect to myrtle rust; however, if working on an island, see Visiting or working on islands.

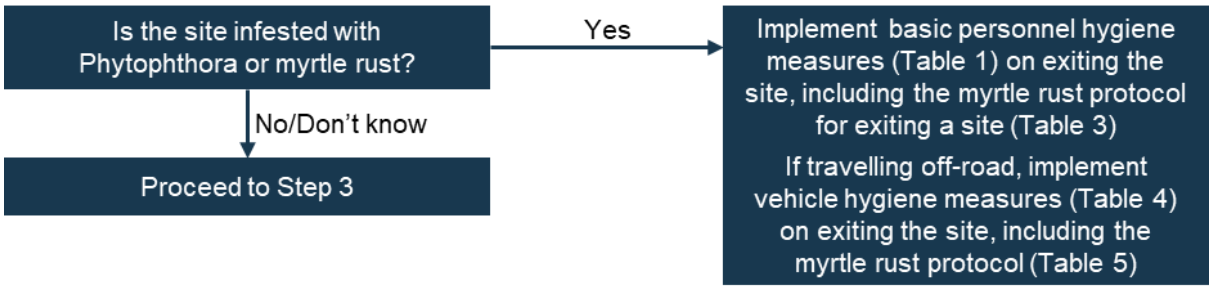
Decision tree 1: Phytophthora and myrtle rust

This decision tree should only be used when there is no site-specific hygiene protocol for the area you are visiting or working in.

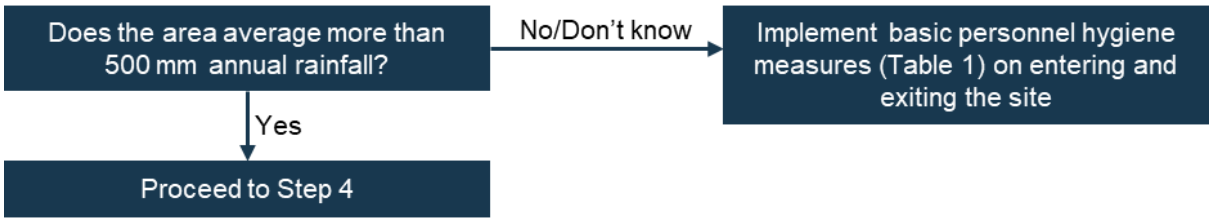
Step 1: Determine nature of public access



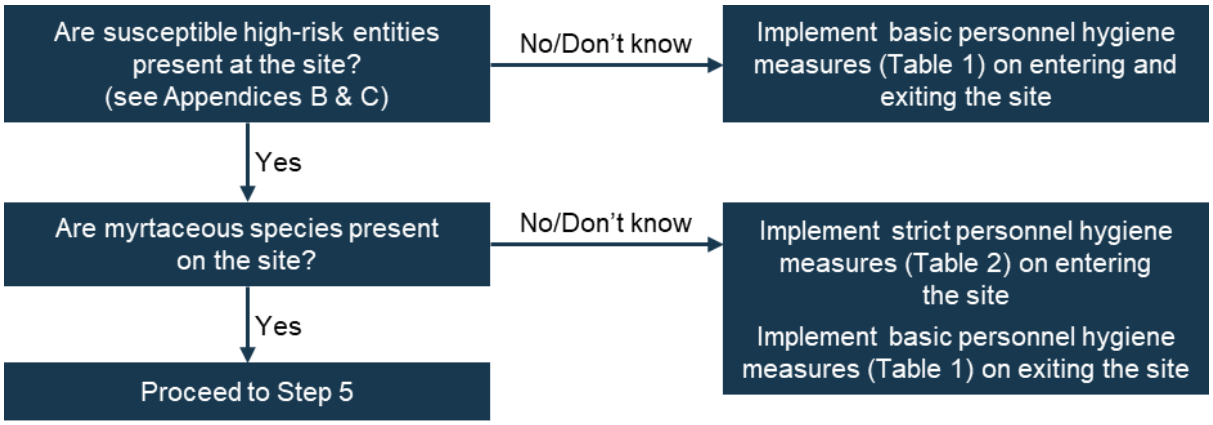
Step 2: Determine presence of Phytophthora or myrtle rust



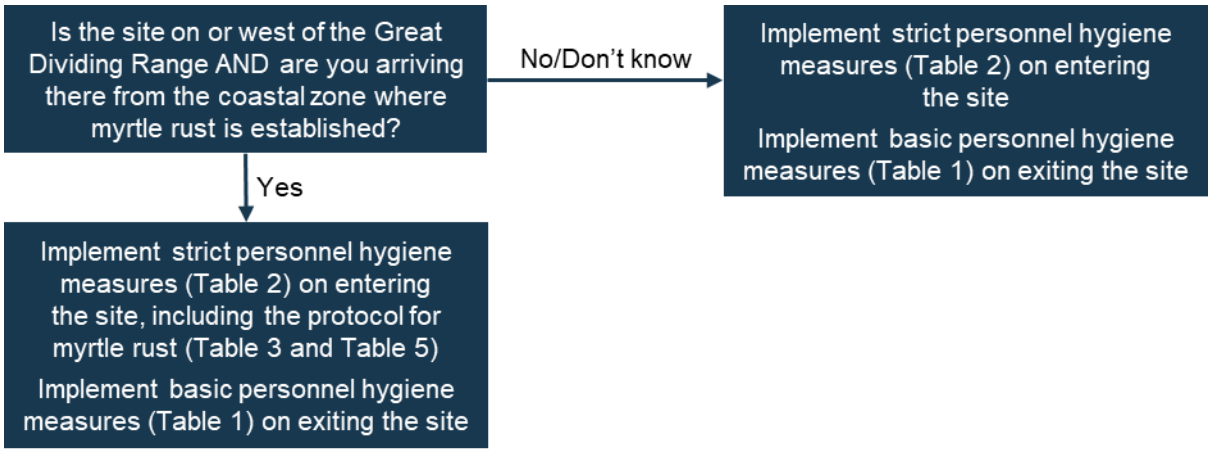
Step 3: Determine average annual rainfall



Step 4: Determine presence of susceptible entities and/or myrtaceous species



Step 5: Determine risk of spread of myrtle rust to or beyond the Great Dividing Range



Invasive plants

Appendix A and Appendix D list invasive plants listed as KTPs or prohibited matter under the BC Act and Biosecurity Act, respectively. It is recommended that hygiene measures are implemented whenever working with these species or in areas where these species occur.

The basic hygiene procedure (Table 1) and the vehicle hygiene procedure (Table 4) recommend checking and removing seed and plant debris from clothing, footwear, equipment and vehicles. These measures are sufficient to remove invasive plant propagules under most circumstances, but people should be particularly vigilant when checking and cleaning after work on sites with KTP-listed plants, weeds of national significance or regional priority invasive plants (see the NSW WeedWise website).

During peak seed production, consideration should be given to additional measures, such as designating site-specific shoes, clothing or equipment that are used only at a single site and are bagged prior to leaving that site. When operating heavy machinery that captures a lot of soil in an infested site, implement strict vehicle hygiene measures (Table 4).

Amphibian chytrid fungus (*Batrachochytrium dendrobatidis*)

Reducing the spread of amphibian chytrid fungus between sites and between frogs should be a central objective when working with or near amphibians or in habitats where amphibian chytrid fungus is pervasive. Consequently, strict hygiene should be practised under all circumstances for personnel, clothing, footwear, tools and equipment. See Table 6 for details; however, if working on an island, see Visiting or working on islands.

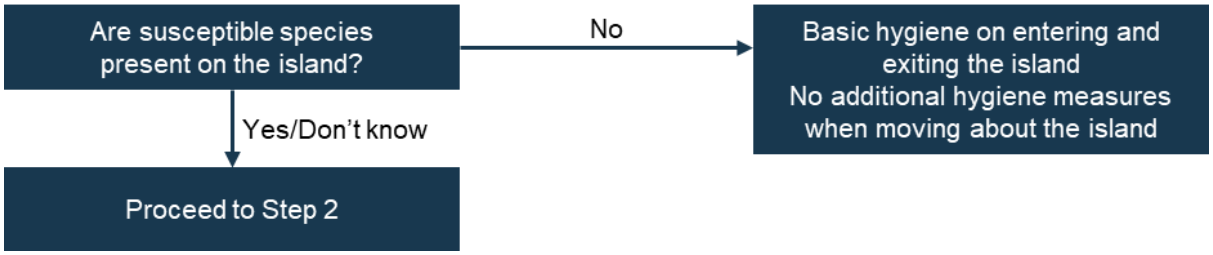
Visiting or working on islands

When visiting or working on islands, the recommended level of hygiene depends on whether or not the island is affected by pathogens and if so, to what extent. In some cases, this may be difficult to determine, so a cautious approach may be sensible. Decision tree 2 is a general guide to the 'when' and 'what' of hygiene on islands. It can be applied to Phytophthora, myrtle rust and amphibian chytrid fungus. For invasive plants, follow the advice above under Invasive plants.

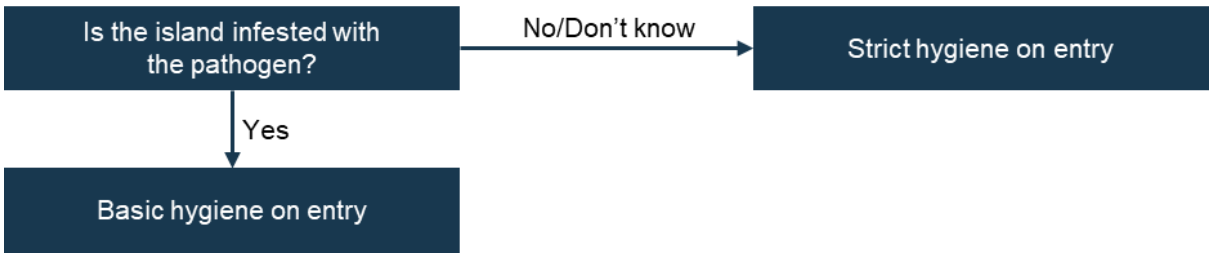
Where hygiene measures are recommended for moving about an island (see Step 3 below), it will be important to establish hygiene points at the boundary of the infested area(s).

Decision tree 2: visiting or working on islands

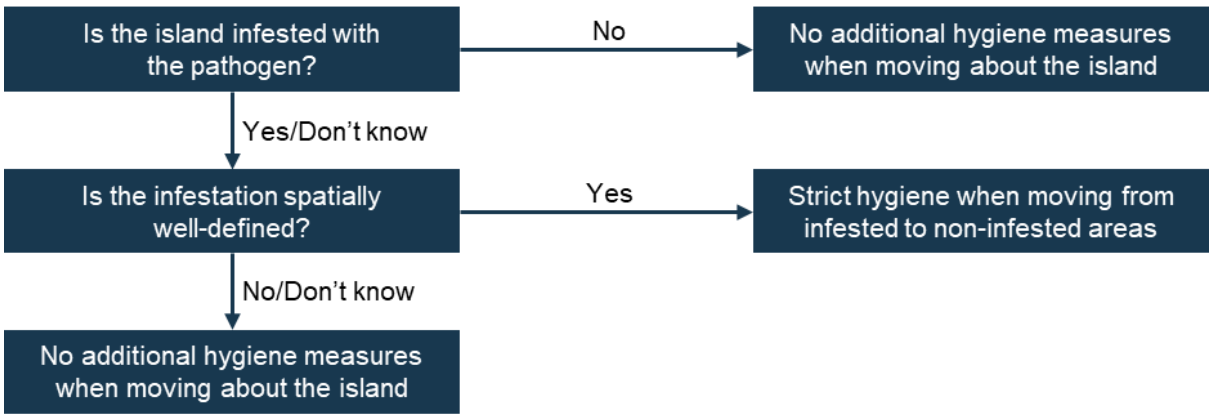
Step 1: Determine presence of susceptible species



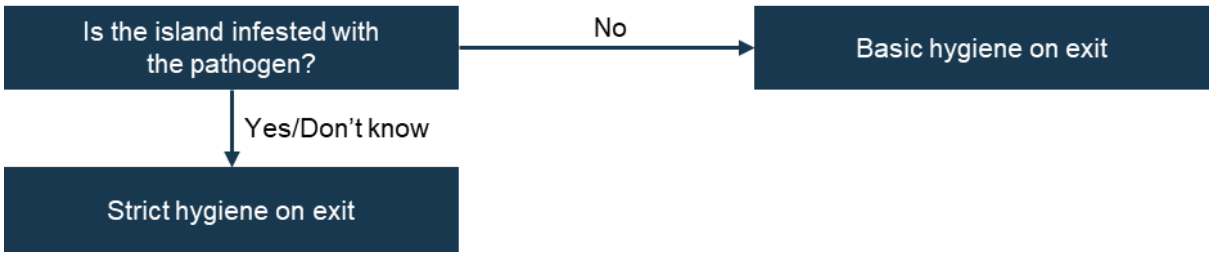
Step 2: Determine hygiene measures before entry to the island



Step 3: Determine hygiene measures for moving about the island



Step 4: Determine hygiene measures for exit from the island



Recommended hygiene protocols

Personnel, clothing, footwear, tools and equipment

Basic hygiene measures

Table 1 Basic hygiene protocol for personnel, clothing, footwear, tools and equipment

Step	Description
1. Check	• Check personnel, clothing, footwear, backpacks and equipment for soil, plant material/propagules and other debris.
2. Clean	• Remove all soil, plant material and other debris using a hard brush and (if required) clean water. • If dirty, wash hands with soap and water[1]. • Remove seeds from clothing, footwear, tools and equipment by hand. Seeds that are difficult to remove can sometimes be scraped off clothing with a sharp implement (e.g. a knife), but use caution. Where possible, have a co-worker double-check that you have removed all seeds.
3. Dry	• Where practical, ensure hands, clothing, footwear, and equipment are dry before proceeding.

Strict hygiene measures

Where possible, strict hygiene procedures should be implemented at a set hygiene point at the site boundary. The site boundary should be defined by the project or site manager. It could be the boundary of a national park. If not on-park, the boundary could be identified based on the distribution of the threatened entities at risk. Where a site boundary is unclear, it should be determined at the project or site manager's discretion.

Where possible, disinfectant should be applied and disposed of in a dry area that is at least 30 metres from a waterway or drainage channel, and where there is limited possibility of it running into a waterway or sensitive environmental area. The complete elimination of all spores on contaminated materials (e.g. boots, vehicles) is an unreasonable expectation, so the goal of disinfection is to *reduce* the spore load present.

Table 2 Strict hygiene protocol for personnel, clothing, footwear, tools and equipment

Project planning

Step	Description
1. Check	• Ensure you have a fully stocked hygiene kit, or easy access to one.
2. Select	• Where practical, select clothing, footwear, tools and equipment that are easy to clean (e.g. non-absorbent).
3. Clean	• Make sure all equipment is clean before use (routinely following this protocol will achieve this).

[1] For general information on hand hygiene, refer to the *National Wildlife Biosecurity Guidelines* (Wildlife Health Australia 2018).

Table 2, continued…

Protocols

Step	Description
1. Check	• Thoroughly check all clothing, footwear, backpacks tools and equipment for soil, water, organic material or other debris. Where possible, have a co-worker double-check for you.
2. Clean	• Remove all soil, water, organic material and debris using a hard brush and clean water. • Remove any residual seeds from clothing, footwear, tools and equipment by hand. Where possible, have a co-worker double-check that you have removed all seeds. • If dirty, wash hands with soap and water.
3. Disinfect	• Spray or soak potentially contaminated materials (e.g. footwear, equipment) with disinfectant (Table 7). Leave for 30 seconds before proceeding. • Where practical, rinse with clean water.
4. Dry	• Where practical, ensure all personnel, clothing, footwear, tools and equipment are dry before proceeding.

Myrtle rust

Decision tree 1 identifies when hygiene measures specifically for myrtle rust should be considered. Generally, this will only be after visiting a site that is infested with myrtle rust or when travelling from an infested area to a non-infested site.

Table 3 Myrtle rust hygiene protocol for personnel, clothing, footwear, tools and equipment

Step	Description
1. Disinfect	• Spray equipment and clothing with disinfectant.
2. Clean	• At the end of the day, launder all hats and clothing using detergent and warm or hot machine wash to kill residual spores. • At the end of the day, shower thoroughly to remove residual spores from skin and hair.

Vehicles and heavy machinery

Generally, protocols for vehicles and heavy machinery (Table 4) only need to be implemented when you have driven off-road. The myrtle rust protocol (Table 5) is an exception and should be implemented whenever you have driven in a site infested with myrtle rust, because spores can adhere to clothing and be transferred to the vehicle's interior.

Table 4 Hygiene protocol for vehicles and heavy machinery

Step	Description
1. Check	• Check the exterior and interior of vehicles and machinery for soil, plant material and other debris. Use Figure 2 as a guide for where to focus your attention.
2. Clean	• Remove large clods of dirt and soil using a stiff brush or crowbar. • Remove all soil, plant material and other debris from the interior using a vacuum or dustpan and brush. Focus on the cabin floor, floor mats and pedals. Place debris in a bag and dispose of in a commercial waste bin. • *If returning from a potentially-contaminated area*, wash vehicle and/or machinery as soon as possible (e.g. at a commercial carwash) before heading back to base. If a carwash facility is not available, spray tyres thoroughly with a disinfectant (Table 7). • *If leaving a potentially-contaminated area and travelling to a new site*, reassess your hygiene requirements using Decision tree 1 for Phytophthora and myrtle rust.
3. Dry	• Where practical, allow vehicle or machinery to dry before proceeding.

Myrtle rust

Table 5 Myrtle rust hygiene protocol for vehicles and heavy machinery

Step	Description
1. Disinfect	• Use 70% alcohol wipes or a spray bottle to apply disinfectant (Table 7) to the interior of vehicle (focus on seats, steering wheel, gear stick, pedals and floor). • Spray the exterior with disinfectant or hand pressure sprayer. Allow the disinfectant to remain in contact with the surface for at least 30 seconds before rinsing with clean water.

Amphibian fieldwork

Table 6 Strict hygiene protocols for undertaking amphibian fieldwork

Project planning

Step	Description
1. Select	• Where practical, select clothing, footwear, tools and equipment that are easy to clean (e.g. non-absorbent). • Where practical, when visiting multiple sites, pack separate sets of equipment (including shoes) for use at each site.

Before arriving at a site and on leaving a site

Step	Description
1. Check	• Thoroughly check all personnel, clothing, footwear and equipment for soil, water, organic material or other debris. Where possible, have a co-worker double-check for you.
2. Clean	• Remove all soil, water, organic material or other debris using a hard brush and clean water.
3. Disinfect	• Spray or soak potentially-contaminated materials with disinfectant (Table 7). Leave for 30 seconds before proceeding. Where practical, rinse with clean water.
4. Dry	• Where practical, ensure all clothing, footwear, tools and equipment are dry before proceeding.

When in the field

- Wear disposable, non-powdered gloves when handling amphibians.
- Use new gloves or a new bag for handling each individual amphibian.
- Wear well-rinsed (with water) vinyl gloves when handling tadpoles.
- If gloves are not available, wash hands with 70% alcohol between handling each animal. Make sure hands are dry before handling amphibians as alcohol exposure may be toxic to them. Rinse hands with potable water (if available) after disinfecting.
- Keep individual amphibians in separate containers. Dispose of containers after use.
- Where possible, keep tadpoles in separate containers. If necessary, tadpoles from the same pond or stream section can be grouped in one container but avoid overcrowding.
- Never mix amphibians from different sites.
- Amphibians should be released where they were captured.
- If using toe clipping or Passive Integrated Transponder (PIT) tagging, use disinfected instruments (preferably unused disposable instruments). Open wounds should be sealed using an appropriate tissue adhesive, followed by application of a topical anaesthetic disinfectant.

Hygiene tools

Hygiene kits

A simple hygiene kit should be kept in each field vehicle to allow staff to implement hygiene measures as required. At a minimum, hygiene kits should contain a stiff brush (for removing soil from boots, bags, etc.), a spray bottle and a container of disinfectant solution (with enough volume for several refills of the spray bottle).

A more comprehensive hygiene kit should include:

- stiff brush
- nail brush
- dustpan (for removing soil from vehicle interior)
- spray bottle
- container of disinfectant solution (enough for several refills of spray bottle)
- container of clean water (for disinfectant dilution and hand washing)
- disposable garbage bags for waste
- plastic tubs that can be used to carry items and for soaking equipment
- alcohol wipes or gel
- soap
- towel
- disposable gloves for handling disinfectant (long-arm waterproof gloves can further reduce risk of skin exposure when diluting disinfectant)
- non-powdered gloves (if working with amphibians).

Disinfectants

Disinfectants should be used for personnel, field equipment and tools, clothing, footwear, vehicles, machinery and personal items to reduce the number of residual spores and other pathogens. For disinfectants to be effective, all surfaces must first be cleaned of soil and organic matter.

All people must take reasonable care for their health and safety, and the health and safety of others, by following product safety instructions and wearing appropriate personal protection equipment when preparing and using disinfectants. Commercially-available fungicides should generally not be mixed with other chemicals (unless the manufacturer explicitly states it is safe to do so). This is especially important for chlorine-based compounds as these may produce toxic vapours when mixed with fungicides (Allan & Gartenstein 2010).

Table 7 Disinfectants

Disinfectant	Application	Notes
70% methylated spirits in water	Spraying absorbent and non-absorbent materials, including vehicle interiors. Can also be used to disinfect hands.	Store in a closed container to reduce evaporation. Solutions at lower or higher concentrations may be less effective or even completely ineffective. Can be used on clothing.
1% sodium hypochlorite in water	Soaking non-absorbent materials	Dilution of household bleach is sufficient. Use only in a well-ventilated area. Do not use on clothing. Bleach has a limited shelf life. Degradation increases with exposure to UV light and at higher temperatures. See manufacturer's details for further information.
Benzalkonium chloride (various concentrations)	Spraying or soaking materials (e.g. equipment, vehicles, boot-cleaning stations)	Some commercial fungicidal products are available (e.g. Phytoclean®). Use as per manufacturer's instructions. Avoid contact with skin or items likely to come into contact with skin (e.g. clothing).
Industrial strength detergent	Cleaning and disinfecting vehicle exteriors, shoes and equipment	There are several commercial products available. Use as per manufacturer's instructions.
Chloramine and chlorhexadine-based products	Disinfecting hands, footwear and equipment	Examples include *Halamid*®, *Halasept*® and *Hexifoam*®. Use as per manufacturer's instructions.
Alcohol wipes	Wiping down vehicle interiors	For multi-use packets, ensure the packaging is properly sealed between uses.
Alcohol gel	Disinfecting hands	

Boot-cleaning stations

Installation of boot-cleaning stations along popular walking trails can help to mitigate the risk of bushwalkers spreading Phytophthora and other soil-borne pathogens, as well as some invasive plant propagules. Where present, they are a suitable alternative to a stiff brush for cleaning boots. Boot-cleaning stations can vary in complexity from simple systems with fixed brushes that people can use to scrub their shoes (see Figure 1), or a bench with a hand brush attached by chain, to mechanisms that deliver disinfectant to footwear (O'Gara et al. 2005). Boot-cleaning stations accompanied by instructional material and signage about Phytophthora increase awareness and provide context for users, and may increase compliance (Massenbauer 2018).

It is recommended that disinfectant solutions in boot-washing stations are regularly monitored and replaced as necessary. Solutions may need to be replaced more frequently in high traffic areas.

Figure 1 Boot-cleaning station in Barrington Tops National Park

Photo: Peter Beard/DPIE

Vehicle and machinery cleaning checklist

When you are likely to drive off-road or use heavy machinery, it is useful to develop a cleaning checklist during the planning phase of the project. The checklist should include components of the vehicle or machinery that are likely to come into contact with soil or plant material, whether through direct contact (e.g. tyres) or by transfer (e.g. cabin floor, gear stick). An example illustrated cleaning checklist can be found at Figure 2.

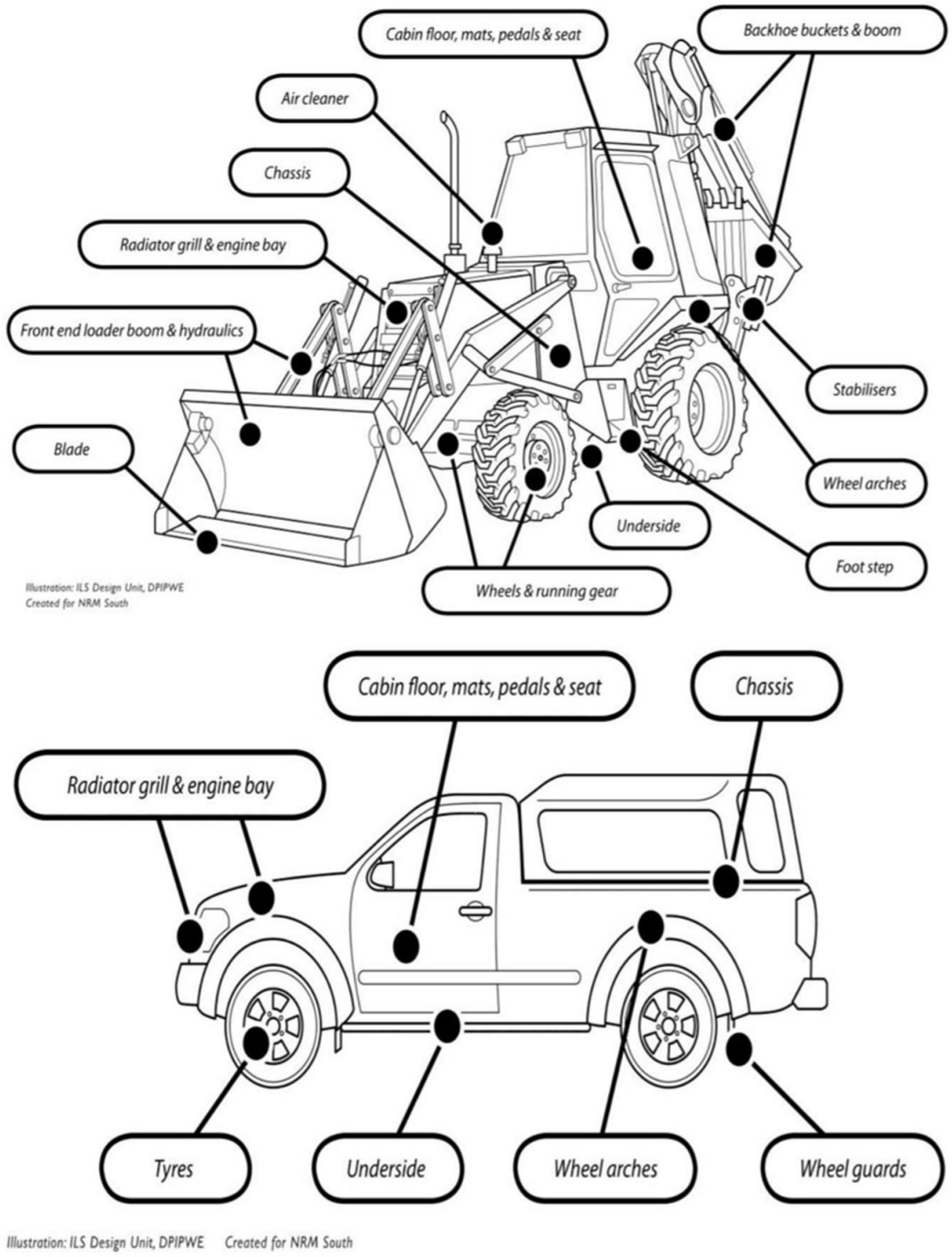


Figure 2 Example illustrated machinery and vehicle cleaning checklists

These are the parts of the vehicle that should be checked and cleaned. Reproduced from DPIPWE (2015) with permission. Original image credit: Allan and Gartenstein (2010).

Appendix A: Legislation

Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) is the primary piece of legislation that protects biodiversity in New South Wales. One of the purposes of the BC Act is to assess the extinction risk of species and ecological communities, and identify key threatening processes (KTPs), through an independent and rigorous scientific process (BC Act s.1.3(f)).

A threat may be listed as a KTP if, in the opinion of the Threatened Species Scientific Committee (NSW TSSC), it:

- adversely affects threatened species, populations of a species or ecological communities
- could cause species, populations of a species or ecological communities to become threatened.

There are several pathogen and weed-related threats that are listed KTPs under the BC Act, including:

- infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- infection of native plants by *Phytophthora cinnamomi*
- introduction and establishment of exotic rust fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae
- invasion and establishment of exotic vines and scramblers
- invasion and establishment of Scotch broom (*Cytisus scoparius*)
- invasion, establishment and spread of lantana (*Lantana camara* L. *sens. lat*)
- invasion of native plant communities by African olive (*Olea europaea* subsp. *cuspidata* (Wall. ex G. Don) Cif.)
- invasion of native plant communities by *Chrysanthemoides monilifera*
- invasion of native plant communities by exotic perennial grasses
- loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.

Division 6 of Part 4 of the BC Act establishes the Biodiversity Conservation Program, known as *Saving our Species* (SoS). The objectives of SoS are:

1. to maximise the long-term security of threatened species and ecological communities in nature and
2. to minimise the impacts of KTPs on biodiversity and ecological integrity.

This document helps to achieve the second objective of SoS by outlining means of reducing the introduction and spread of pathogens and invasive plants throughout New South Wales.

National Parks and Wildlife Act 1974

The main act governing the management of national parks and reserves in New South Wales is the *National Parks and Wildlife Act 1974* (NPW Act). The NPW Act contains provisions for the reservation of land as:

- a national park
- a historic site
- a state conservation area
- a regional park
- a karst conservation reserve
- a nature reserve
- an Aboriginal area.

The National Parks and Wildlife Service administers the NPW Act and is responsible for managing reserved land. Implementation of hygiene measures in national parks helps to meet the obligation to manage national parks in accordance with the management principles set out in Division 2 of Part 4 of the NPW Act, which include conserving biodiversity, maintaining ecosystem function and maintaining natural landscapes.

Biosecurity Act 2015

The *Biosecurity Act 2015* provides a framework for managing biosecurity risks in New South Wales while promoting that biosecurity is a shared responsibility between government, industry and the public. The Biosecurity Act establishes the general biosecurity duty (s.22), which requires any person who knows or ought to know about a biosecurity risk to (so far as is reasonably practical) ensure that risk is prevented, eliminated or minimised.

The Biosecurity Act also establishes prohibited matter, which includes certain plant and animal pests and diseases listed in Schedule 2 of the Act. Any dealing with prohibited matter throughout New South Wales is an offence. An additional biosecurity duty applies to some people who become aware of prohibited matter, including those in charge of premises on which the prohibited matter occurs, as well as consultants who become aware of prohibited matter during the provision of professional services. Those people also have a duty to notify the Department of Primary Industries of any biosecurity event. Additional details of affected people can be found in Divisions 3 and 4 of Part 2 of the Act.

Adopting hygiene into fieldwork routines is a way that people can manage their biosecurity risks and meet their general biosecurity duty under the Biosecurity Act.

Appendix B: NSW species that are susceptible to *Phytophthora cinnamomi*

Phytophthora cinnamomi (Phytophthora) is as a threat to several threatened species and ecological communities. Further surveys and species-susceptibility testing is required to identify additional species and ecological communities that are susceptible to Phytophthora in New South Wales. The research is ongoing and, therefore, the list below is likely to be incomplete. Staff should check the best available and most recent information on any species or ecological community of interest.

Table 8 NSW plant species that are susceptible (or suspected to be susceptible) to *Phytophthora cinnamomi*

NSW conservation status in parentheses: Protected (P), Vulnerable (V), Endangered (E), Critically endangered (CE), Extinct (Ex).

Species	Reference(s)	Species	Reference(s)
Acacia buxifolia subsp. *buxifolia*	NSW TSSC (2011)	*Angophora costata*	NSW TSSC (2011)
Acacia genistifolia	NSW TSSC (2011)	*Aotus ericoides*	Podger et al. (1990); Schahinger et al. (2003); Weste (2001)
Acacia siculiformis	NSW TSSC (2011)	*Astroloma humifusum*	NSW TSSC (2011)
Actinotus helianthin (P)	Fraser (1956)	*Banksia cunninghamii*	Weste (2001); McDougall and Summerell (2003b)
Acrotriche serrulata	NSW TSSC (2011)	*Banksia ericifolia*	NSW TSSC (2011)
Allocasuarina rigida	NSW TSSC (2011)	*Banksia marginata*	Pratt and Heather (1973); Podger et al. (1990); Lee and Wicks (1977); Vickery (1997); Schahinger et al. (2003); Weste (2001)
Allocasuarina verticillata	NSW TSSC (2011)	*Banksia serrata*	Pratt and Heather (1973); Podger et al. (1990); Schahinger et al. (2003); Weste (2001)
Amperea xiphoclada (Ex)	NSW TSSC (2011)	*Banksia spinulosa* var. *cunninghamii* (P)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Bauera rubioides	Podger and Brown (1989); Podger et al. (1990); Schahinger et al. (2003); Weste (2001)	*Daviesia mimosoides*	NSW TSSC (2011)
Boronia anemonifolia (P)	NSW TSSC (2011)	*Daviesia wyattiana*	McDougall and Summerell (2003b)
Boronia deanei (V)	NSW TSSC (2011)	*Dianella longifolia sens. lat.*	NSW TSSC (2011)
Bossiaea cinerea	Podger et al. (1990); Schahinger et al. (2003); Weste (2001)	*Dillwynia cinerascens*	Weste (2001)
Bossiaea obcordata	NSW TSSC (2011)	*Dillwynia glaberrima*	Podger et al. (1990); Weste (2001); Schahinger et al. (2003)
Bossiaea prostrata	Weste (2001)	*Dillwynia phylicoides*	NSW TSSC (2011)
Brachyloma daphnoides	Weste (2001)	*Dillwynia sericea*	NSW TSSC (2011)
Callitris preissii	NSW TSSC (2011)	*Dillwynia tenuifolia* (V)	NSW TSSC (2011)
Calytrix tetragona	Podger et al. (1990); Weste (2001); Schahinger et al. (2003)	*Diplarrena moraea*	NSW TSSC (2011)
Cassinia aculeata	NSW TSSC (2011)	*Dodonaea boroniifolia*	NSW TSSC (2011)
Conospermum taxifolium	NSW TSSC (2011)	*Dodonaea viscosa*	NSW TSSC (2011)
Correa reflexa	Podger et al. (1990); Weste (2001)	*Epacris hamiltonii* (E)	NSW TSSC (2011)
Crowea exalata (P)	NSW TSSC (2011)	*Epacris impressa*	Weste (2001)
Crowea saligna (P)	NSW TSSC (2011)	*Epacris paludosa*	NSW TSSC (2011)
Darwinia biflora (V)	NSW TSSC (2011)	*Epacris purpurascens* (V)	Fraser (1956)
Darwinia peduncularis (V)	NSW TSSC (2011)	*Epacris sparsa* (V)	NSW TSSC (2011)
Daviesia leptophylla	Weste (2001)	*Eriostemon myoporoides* (P)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Eucalyptus baxteri	NSW TSSC (2011)	*Grevillea irrasa* subsp. *irrasa*	McDougall and Summerell (2003b) (NSW TSSC (2011))
Eucalyptus camfieldii (V)	NSW TSSC (2011)	*Grevillea juniperina sens. lat.*	NSW TSSC (2011)
Eucalyptus imlayensis (CE)	NSW TSSC (2011)	*Grevillea lanigera*	NSW TSSC (2011)
Eucalyptus macrorhyncha	NSW TSSC (2011)	*Grevillea linsmithii*	NSW TSSC (2011)
Eucalyptus niphophila	NSW TSSC (2011)	*Grevillea molyneuxii* (V)	NSW TSSC (2011)
Eucalyptus obliqua	NSW TSSC (2011)	*Grevillea mucronulata*	NSW TSSC (2011)
Eucalyptus polyanthemos	NSW TSSC (2011)	*Grevillea oleoides*	McDougall and Summerell (2003b)
Eucryphia moorei	NSW TSSC (2011)	*Grevillea parviflora* subsp. *parviflora* (V)	NSW TSSC (2011)
Exocarpus cupressiformis	NSW TSSC (2011)	*Grevillea parviflora* subsp. *supplicans* (E)	NSW TSSC (2011)
Genoplesium rhyoliticum (E)	NSW TSSC (2011)	*Grevillea polybractea*	NSW TSSC (2011)
Goodenia hederacea subsp. *hederacea*	Weste (2001)	*Grevillea rivularis* (CE)	NSW TSSC (2011)
Goodenia humilis	Weste (2001)	*Grevillea rosmarinifolia*	NSW TSSC (2011)
Grevillea acanthifolia subsp. *paludosa* (E)	NSW TSSC (2011)	*Grevillea victoriae sens. lat.*	NSW TSSC (2011)
Grevillea acanthifolia subsp. *stenomera*	NSW TSSC (2011)	*Grevillea wilkinsonii* (E)	NSW TSSC (2011)
Grevillea alpina	NSW TSSC (2011)	*Hakea bakeriana*	NSW TSSC (2011)
Grevillea caleyi (CE)	NSW TSSC (2011)	*Hakea ulicina*	NSW TSSC (2011)
Grevillea granulifera	NSW TSSC (2011)	*Hakea dohertyi* (E)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Haloragodendron monospermum	NSW TSSC (2011)	*Leionema lachnaeoides* (E)	NSW TSSC (2011)
Helichrysum collinum	NSW TSSC (2011)	*Leionema ralstonii* (V)	NSW TSSC (2011)
Hibbertia calycina	NSW TSSC (2011)	*Leptospermum coriaceum*	NSW TSSC (2011)
Hibbertia circinate (CE)	Wan et al. (in prep.)	*Leptospermum juniperinum*	Lee and Wicks (1977); Vickery (1997); McDougall and Summerell (2003b)
Hibbertia cistiflora	Weste (2001)	*Leptospermum lanigerum* (P)	NSW TSSC (2011)
Hibbertia fasciculata	Weste et al. (2002)	*Leucopogon collinus*	NSW TSSC (2011)
Hibbertia marginata (V)	NSW TSSC (2011)	*Leucopogon confertus*	NSW TSSC (2011)
Hibbertia obtusifolia	NSW TSSC (2011)	*Leucopogon ericoides*	Podger et al. (1990); Weste (2001); Schahinger et al. (2003)
Hibbertia procumbens (E)	NSW TSSC (2011)	*Leucopogon esquamatus*	NSW TSSC (2011)
Hibbertia villosa	NSW TSSC (2011)	*Leucopogon exolasius*	NSW TSSC (2011)
Hibbertia virgata	NSW TSSC (2011)	*Leucopogon fletcheri* subsp. *fletcheri* (E)	NSW TSSC (2011)
Hovea linearis	Weste (2001)	*Leucopogon lanceolatus*	NSW TSSC (2011)
Isopogon fletcheri (V)	NSW TSSC (2011)	*Leucopogon maccraei*	NSW TSSC (2011)
Isopogon petiolaris (P)	NSW TSSC (2011)	*Leucopogon microphyllus* var. *pilibundus*	NSW TSSC (2011)
Kennedia prostrata	NSW TSSC (2011)	*Leucopogon virgatus*	Taylor (1974); Lee and Wicks (1977); Podger et al. (1990); Weste (2001)
Kunzea ambigua	NSW TSSC (2011)	*Lissanthe strigose*	Weste (2001)
Lasiopetalum joyceae (V)	NSW TSSC (2011)	*Lomatia fraseri*	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Macrozamia communis	Pratt and Heather (1973); McDougall and Summerell (2003b)	*Persoonia glaucescens* (E)	NSW TSSC (2011)
Macrozamia johnsonii (E)	NSW TSSC (2011)	*Persoonia hindii* (E)	NSW TSSC (2011)
Melaleuca biconvexa (V)	NSW TSSC (2011)	*Persoonia hirsuta* (E)	NSW TSSC (2011)
Melaleuca squamea	NSW TSSC (2011)	*Persoonia juniperina* (P)	Weste (2001)
Melaleuca uncinate	NSW TSSC (2011)	*Persoonia marginata* (V)	NSW TSSC (2011)
Melichrus urceolatus	NSW TSSC (2011)	*Persoonia mollis* subsp*. maxima* (E)	NSW TSSC (2011)
Monotoca elliptica	Podger et al. (1990); McDougall and Summerell (2003b); Schahinger et al. (2003)	*Persoonia nutans* (E)	NSW TSSC (2011)
Monotoca scoparia	Taylor (1974); Weste (2001)	*Persoonia pauciflora* (CE)	NSW TSSC (2011)
Nematolepis rhytidophylla (V)	Wan et al. (accepted)	*Persoonia sylvatica* (P)	McDougall and Summerell (2003b)
Oxylobium ellipticum	Podger et al. (1990); McDougall and Summerell (2003a)	*Petrophile pulchella* (P)	NSW TSSC (2011)
Ozothamnus obcordatus subsp*. major*	NSW TSSC (2011)	*Phebalium phylicifolium*	NSW TSSC (2011)
Patersonia sericea	NSW TSSC (2011)	*Phebalium squamulosum* spp*. alpinum* (P)	Rigg et al. (2018)
Persoonia acerosa (V)	NSW TSSC (2011)	*Philotheca myoporoides* (P)	Taylor (1974)
Persoonia bargoensis (E)	NSW TSSC (2011)	*Phyllanthus hirtellus*	NSW TSSC (2011)
Persoonia cornifolia (P)	McDougall and Summerell (2003b)	*Phyllota humifusa* (V)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Pimelea linifolia subsp. *linifolia*	Weste (2001); Weste et al. (2002)	*Prostanthera ringens*	NSW TSSC (2011)
Podocarpus lawrencei	NSW TSSC (2011)	*Prostanthera saxicola* var. *montana*	NSW TSSC (2011)
Pomaderris delicata (CE)	Wan et al. (in prep.)	*Pultenaea altissima*	NSW TSSC (2011)
Pomaderris intermedia	NSW TSSC (2011)	*Pultenaea aristata* (V)	NSW TSSC (2011)
Prostanthera askania (E)	NSW TSSC (2011)	*Pultenaea baeuerlenii* (V)	NSW TSSC (2011)
Prostanthera cineolifera (V)	NSW TSSC (2011)	*Pultenaea benthamii*	McDougall and Summerell (2003b)
Prostanthera cryptandroides (V)	NSW TSSC (2011)	*Pultenaea daphnoides*	Pratt and Heather (1973); Podger et al. (1990); McDougall and Summerell (2003b); Schahinger et al. (2003)
Prostanthera cuneata	NSW TSSC (2011)	*Pultenaea flexilis*	NSW TSSC (2011)
Prostanthera decussata	Weste (2001)	*Pultenaea glabra* (V)	NSW TSSC (2011)
Prostanthera densa (V)	NSW TSSC (2011)	*Pultenaea humilis* (V)	NSW TSSC (2011)
Prostanthera discolour (V)	NSW TSSC (2011)	*Pultenaea mollis*	Barker and Wardlaw (1995); Weste (2001)
Prostanthera junonis	NSW TSSC (2011)	*Pultenaea parrisiae*	Wan et al. (in prep.)
Prostanthera lasianthos	NSW TSSC (2011)	*Pultenaea parrisiae* subsp. *elusa* (V)	NSW TSSC (2011)
Prostanthera marifolia (CE)	Wan et al. (accepted); NSW TSSC (2011)	*Pultenaea parrisiae* subsp. *parrisiae* (V)	NSW TSSC (2011)
Prostanthera ovalifolia	NSW TSSC (2011)	*Pultenaea parviflora* (E)	NSW TSSC (2011)
Prostanthera palustris (V)	NSW TSSC (2011)	*Pultenaea pedunculata* (E)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Pultenaea procumbens	NSW TSSC (2011)	*Tetratheca glandulosa* (V)	NSW TSSC (2011)
Pultenaea pycnocephala	NSW TSSC (2011)	*Tetratheca juncea* (V)	NSW TSSC (2011)
Pultenaea sp. Genowlan Point (CE)	Wan et al. (accepted)	*Tetratheca pilosa* (Ex)	Podger et al. (1990); Weste (2001)
Pultenaea subcapitata	NSW TSSC (2011)	*Tetratheca subaphylla*	McDougall and Summerell (2003b)
Pultenaea villifera var. *villifera*	NSW TSSC (2011)	*Triplarina nowraensis* (E)	NSW TSSC (2011)
Rulingia prostrata	NSW TSSC (2011)	*Westringia davidii* (V)	NSW TSSC (2011)
Sprengelia incarnata (P)	Podger and Brown (1989); McDougall and Summerell (2003b); McDougall et al. (2018)	*Westringia kydrensis* (E)	NSW TSSC (2011)
Stylidium graminifolium	NSW TSSC (2011)	*Wollemia nobilis* (CE)	Bullock et al. (2000)
Styphelia adscendens	Weste (2001); Schahinger et al. (2003)	*Woollsia pungens*	Fraser (1956)
Styphelia perileuca (V)	NSW TSSC (2011)	*Xanthorrhoea australis* (P)	Weste (2001); McDougall and Summerell (2003b)
Tasmannia glaucifolia (V)	NSW TSSC (2011)	*Xanthorrhoea glauca* subsp. *glauca* (P)	McDougall and Summerell (2003b)
Tasmannia lanceolata	NSW TSSC (2011)	*Xanthorrhoea resinifera* (P)	Weste (2001); McDougall and Summerell (2003b)
Tasmannia purpurascens (V)	McDougall and Summerell (2003a)	*Xanthosia dissecta*	Weste (2001); Weste et al. (2002)
Telopea mongaensis (P)	NSW TSSC (2011)	*Xanthosia tridentata*	Fraser (1956)
Telopea speciosissima (P)	Taylor (1974)	*Zieria adenophora* (CE)	NSW TSSC (2011)
Tetratheca ciliata	Weste (2001); Schahinger et al. (2003)	*Zieria baeuerlenii* (E)	NSW TSSC (2011)

Species	Reference(s)	Species	Reference(s)
Zieria buxijugum (CE)	NSW TSSC (2011)	*Zieria murphyi* (V)	NSW TSSC (2011)
Zieria covenyi (E)	NSW TSSC (2011)	*Zieria parrisiae* (CE)	NSW TSSC (2011)
Zieria formosa (CE)	NSW TSSC (2011)	*Zieria prostrata* (E)	NSW TSSC (2011)
Zieria laevigata	NSW TSSC (2011)	*Zieria tuberculate* (V)	NSW TSSC (2011)
Zieria lasiocaulis (E)	NSW TSSC (2011)		

Appendix C: NSW species that are susceptible to myrtle rust (*Austropuccinia psidii*)

Myrtle rust affects plants in the Myrtaceae family. There are over 300 native species known to be susceptible to myrtle rust (Makinson 2018b). The Myrtaceae family is ecologically important in Australia, accounting for about 10% of Australia's native flora, with many Australian plant communities primarily comprised of myrtaceous species. Consequently, there are also many species of native fauna, which depend on the Myrtaceae family, that are also indirectly threatened by the impacts of myrtle rust.

Table 9 NSW endemic species susceptible to myrtle rust (Makinson 2018b; Soewarto et al. 2019)
NSW conservation status in parentheses: Protected (P), Vulnerable (V), Endangered (E), Critically endangered (CE), Extinct (Ex).

Species	Species	Species
Angophora costata subsp. uncertain	*Backhousia subargentea* (Synonym: *Choricarpia subargentea*)	*Callistemon salignus* (Synonym*: Melaleuca salicina*)
Angophora floribunda	*Baeckea gunniana*	*Callistemon sieberi (*Synonym*: Melaleuca paludicola)*
Angophora subvelutina	*Baeckea linifolia* (P)	*Callistemon* sp. 'Rock of Gibraltar' (LM Copeland 3618)
Archirhodomyrtus beckleri [southern chemotype]	*Callistemon citrinus* (Synonym: *Melaleuca citrina*)	*Callistemon viminalis* (Synonym*: Melaleuca viminalis*)
Austromyrtus dulcis	*Callistemon linearifolius* (Synonym: *Melaleuca linearifolia*) (V)	*Calytrix tetragona*
Austromyrtus tenuifolia	*Callistemon linearis* (Synonym: *Callistemon rigidus*)	*Corymbia citriodora* subsp*. citriodora* and subsp. uncertain
Backhousia leptopetala (Synonym: *Choricarpia leptopetala*)	*Callistemon pachyphyllus* (Synonym: *Melaleuca pachyphylla*)	*Corymbia citriodora* subsp*. variegata*
Backhousia myrtifolia	*Callistemon pallidus* (Synonym: *Melaleuca pallida*)	*Corymbia gummifera*
Backhousia sciadophora	*Callistemon pinifolius* (Synonym*: Melaleuca linearis* var*. pinifolia*)	*Corymbia henryi*

Species	Species	Species
Corymbia intermedia	*Eucalyptus cinerea*	*Eucalyptus microcorys*
Corymbia maculata	*Eucalyptus crebra*	*Eucalyptus moluccana*
Corymbia tessellaris	*Eucalyptus dalrympleana* subsp. *dalrympleana*	*Eucalyptus nitens*
Corymbia variegata [= *citriodora*] x *C. torelliana*	*Eucalyptus deanei* (Synonym: *Eucalyptus brunnea*)	*Eucalyptus obliqua*
Darwinia glaucophylla (V)	*Eucalyptus delegatensis*	*Eucalyptus olida*
Darwinia procera	*Eucalyptus dunnii*	*Eucalyptus ovata* var. *ovata*
Decaspermum humile [Southern metapopulation]	*Eucalyptus elata*	*Eucalyptus pauciflora* subsp. *pauciflora*
Eucalyptus agglomerata	*Eucalyptus fastigata*	*Eucalyptus perriniana*
Eucalyptus baileyana	*Eucalyptus gillii*	*Eucalyptus pilularis*
Eucalyptus baueriana subsp. *baueriana*	*Eucalyptus globoidea*	*Eucalyptus planchoniana*
Eucalyptus burgessiana	*Eucalyptus globulus* subsp. *bicostata* (Synonym: *Eucalyptus bicostata*)	*Eucalyptus populnea* subsp. uncertain
Eucalyptus camaldulensis subsp. uncertain	*Eucalyptus globulus* subsp. *Globulus* (Synonym: *Eucalyptus globulus* [*sens. strict.*])	*Eucalyptus punctata* (Synonym: *Eucalyptus biturbinata*)
Eucalyptus camfieldii (V)	*Eucalyptus globulus* subsp. uncertain	*Eucalyptus radiata* subsp. *radiata*
Eucalyptus campanulata (Synonym: *E. andrewsii* subsp. *campanulata*)	*Eucalyptus goniocalyx* subsp. uncertain	*Eucalyptus resinifera* [subsp. uncertain]
Eucalyptus camphora subsp. uncertain	*Eucalyptus grandis*	*Eucalyptus resinifera* subsp. *hemilampra*
Eucalyptus carnea	*Eucalyptus haemastoma*	*Eucalyptus robusta*
Eucalyptus cephalocarpa	*Eucalyptus laevopinea*	*Eucalyptus rubida* subsp. *rubida*

Species	Species	Species
Eucalyptus saligna	*Lenwebbia prominens*	*Leptospermum trinervium*
Eucalyptus siderophloia	*Lenwebbia* sp. Main Range (P.R.Sharpe+ 4877) (CE)	*Leptospermum whitei*
Eucalyptus sieberi	*Leptospermum brachyandrum*	*Lophostemon suaveolens*
Eucalyptus smithii	*Leptospermum continentale* 'cv. Horizontalis'	*Melaleuca alternifolia*
Eucalyptus tereticornis subsp. uncertain	*Leptospermum deuense*	*Melaleuca armillaris* [subsp. uncertain]
Eucalyptus tindaliae	*Leptospermum juniperinum*	*Melaleuca biconvexa* (V)
Eucalyptus viminalis [*sens. str.;* = subsp. *viminalis*]	*Leptospermum laevigatum*	*Melaleuca comboynensis*
Gossia acmenoides	*Leptospermum lanigerum* (P)	*Melaleuca decora*
Gossia bidwillii	*Leptospermum liversidgei*	*Melaleuca howeana*
Gossia floribunda	*Leptospermum luehmannii*	*Melaleuca linariifolia*
Gossia fragrantissima (E)	*Leptospermum morrisonii* 'cv. Burgundy'	*Melaleuca nodosa*
Gossia hillii	*Leptospermum myrsinoides*	*Melaleuca quinquenervia*
Gossia punctata	*Leptospermum petersonii*	*Melaleuca sieberi*
Homoranthus flavescens	*Leptospermum polygalifolium* [subsp. uncertain]	*Melaleuca squamea*
Homoranthus melanostictus	*Leptospermum polygalifolium* x *L. scoparium*	*Melaleuca squarrosa*
Homoranthus prolixus (V)	*Leptospermum rotundifolium* (P)	*Melaleuca styphelioides*
Homoranthus virgatus	*Leptospermum scoparium*	*Metrosideros nervulosa*
Homorathus croftianus (E)	*Leptospermum scoparium* x *L. macrocarpum*	*Metrosideros sclerocarpa*
Kunzea baxteri	*Leptospermum semibaccatum*	*Pilidiostigma glabrum*
Kunzea ericoides	*Leptospermum spectabile* (P)	*Rhodamnia argentea*

Species	Species	Species
Rhodamnia maideniana	*Syzygium francisii*	*Syzygium oleosum*
Rhodamnia rubescens (CE)	*Syzygium fullagarii*	*Syzygium smithii* (Synonym: *Acmena smithii*)
Rhodomyrtus psidioides (CE)	*Syzygium hemilamprum* [subsp. uncertain] (Synonym: *Acmena hemilampra*)	*Syzygium wilsonii* x *luehmannii* (Synonym: *S. luehmannii* x *wilsonii*)
Syncarpia glomulifera subsp. uncertain	*Syzygium hodgkinsoniae* (V)	*Tristania neriifolia*
Syzygium anisatum (Synonym: *Backhousia anisata*, *Anetholea anisata*)	*Syzygium ingens* (Synonym: *Acmena ingens*)	*Tristaniopsis collina*
Syzygium australe	*Syzygium luehmannii*	*Tristaniopsis laurina*
Syzygium corynanthum	*Syzygium moorei* (V)	*Uromyrtus lamingtonensis*
Syzygium floribundum (Synonym: *Waterhousea floribunda*)		

Appendix D: Invasive non-native terrestrial plants that are prohibited matter under the *Biosecurity Act 2015*

The *Biosecurity Act 2015* identifies prohibited matter in Schedule 2. Any person who deals with prohibited matter is guilty of an offence under that Act.

The definition of dealing includes moving, releasing, propagating, experimenting with, disposing, acquiring and possessing plants or animals that are listed prohibited matter.

Table 10 Invasive non-native terrestrial plants that are prohibited matter

Scientific name	Common name	Related BC Act KTP
Andropogon gayanus	Gamba grass	Invasion of native plant communities by exotic perennial grasses
Annona glabra	Pond apple	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Asparagus declinatus	Bridal veil creeper	Invasion and establishment of exotic vines and scramblers
Bassia scoparia (excluding subsp. *trichophylla*)	Kochia	
Centaurea stoebe subsp. *micranthos*	Spotted knapweed	
Centaurea x moncktonii	Black knapweed	
Chromolaena odorata	Siam weed	
Clidemia hirta	Koster's curse	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Cryptostegia grandiflora	Rubber vine	Invasion and establishment of exotic vines and scramblers
Hieracium (all species except *H. murorum*) and *Pilosella* spp. (all species)	Hawkweed	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Miconia spp. (all species)	Miconia	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Mikania micrantha	Mikania vine	Invasion and establishment of exotic vines and scramblers
Mimosa pigra	Mimosa	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Nassella tenuissima (syn. *Stipa tenuissima*)	Mexican feather grass	Invasion of native plant communities by exotic perennial grasses

Scientific name	Common name	Related BC Act KTP
Orobanche spp. (all species except the native *O. cernua* var. *australiana* and *O. minor*)	Broomrape	
Parthenium hysterophorus	Parthenium weed	
Striga spp. (except the native *S. parviflora*)	Witchweed	
Vachellia karroo (syn. *Acacia karroo*)	Karoo acacia	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants
Vachellia nilotica (syn. *Acacia nilotica*)	Prickly acacia	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants

Appendix E: Additional considerations for amphibian chytrid fungus

Captive frog hygiene management

Frogs and tadpoles should only be removed from a site when absolutely necessary. When holding frogs in captivity, it is important to maintain a high level of hygiene because turnover of frogs in a facility can lead to potentially high risk of amphibian chytrid transmission.

The risks of transmitting amphibian chytrid among captive frogs can be reduced by:

- keeping frogs collected from different sites separate from each other
- reducing the amount of water, equipment or filtration systems shared between tanks or aquaria that are housing frogs
- cleaning, disinfecting and drying tanks and aquaria immediately after removing frogs.

When removal of a frog from the wild is essential (e.g. for research purposes), you should keep frogs from different sites separate (as above) while you monitor for signs of illness or disease. If signs of illness or disease are detected, seek advice from a veterinarian to determine the nature of the problem.

If a frog (or frogs) is infected with chytrid, seek advice from a licensed veterinarian. Common treatments including anti-fungal agents such as *Itraconazole*© can be used to treat chytrid infection. Carefully controlled, ramping heat treatment can be an effective chytrid treatment or prevention strategy in some frog species, but this method can be lethal to native species that cannot withstand high temperatures. This approach should only be considered by experienced laboratories and only with authorisation from a relevant animal ethics committee.

If tadpoles have been bred or held in captivity, they should not be released into the wild. If considering a release of captive tadpoles, you should contact the National Parks and Wildlife Service wildlife team at wildlife.licensing@environment.nsw.gov.au (or 02 9585 6406) to determine your licensing requirements. Pathological testing should be undertaken prior to any release, to reduce the likelihood of releasing individuals infected with amphibian chytrid fungus.

Displaced frogs

Frogs may be inadvertently transported long distances in fruit and vegetable shipments and landscape supplies (this commonly occurs to *Litoria gracilenta*, *L. bicolor* and *L. caerulea*). These frogs pose a risk for the spread of disease and it is rarely feasible to return them to their place of origin with any accuracy.

If you encounter a displaced frog, you should contact a local wildlife carer organisation to collect the animal. The frog should be monitored for signs of infection.

Frogs found on or around roads, dwellings, gardens or swimming pools should not be considered displaced.

Sick and dead frogs

Symptoms

Frogs infected with amphibian chytrid fungus may exhibit a range of physical and/or behavioural symptoms, including:

- discoloured skin
- swollen hind limbs
- emaciation

- skin lesions, increased sloughing (shedding of skin)
- showing little or no response to physical stimuli
- being lethargic or having no appetite.

What to do with sick or dead frogs

Unless part of a licensed research project, sick or dead frogs encountered in the wild should not be touched, collected or moved due to risks of spreading disease.

If collection of a sick or dead frog is part of a licensed research project, you should first (i.e. before you encounter a sick or dead frog) establish what you intend to do with it. This may include preserving it at your own research institute for testing or sending it to a research institute for testing.

When handling sick or dead frogs, wear a new pair of disposable gloves for handling each frog, use a clean plastic bag for transporting each frog (for live frogs, ensure the bag is not airtight) and keep the frog cool during transport.

If the frog is dead, you should preserve it as soon as possible. A frog can be preserved in 10 times its own volume of preservative (70% ethanol or 10% buffered formalin). The frog's belly should be cut open prior to preservation to maximise preservation of internal organs. Alternatively, frogs can be frozen, although freezing can make tissues unsuitable for some laboratory tests.

Euthanasia

If the frog is sick and unlikely to survive, it should be euthanased using an acceptable method. The American Veterinary Medical Association's Guidelines for the Euthanasia of Animals (PDF 11.8MB) (AVMA 2020) prescribes a number of acceptable euthanasia methods, including using injectable and topical agents. These methods should only be undertaken by a licensed veterinarian.

Where other methods are not available, the generally-accepted method of euthanasia is blunt force trauma to the head, followed by decapitation or pithing to ensure quick death. This should only be applied by trained and skilled people (AMVA 2020). Gradually cooling the animal in the refrigerator prior to applying blunt force trauma may reduce the risk of causing suffering.

Euthanasia of frogs associated with animal research must only be done in accordance with an animal research authority.

Appendix F: Template for a hygiene management plan

Team/region/area/park/project	Identify the team, region, area or park to which the hygiene management plan applies. If the plan applies to a specific project (e.g. construction works, conservation project, etc.) specify it here.
Background and infestation status	Provide relevant background information. Consider including: • infestation status (known, suspected, unknown) for pathogens of interest, or past occurrences • presence of susceptible species or ecological communities • the type of work generally being undertaken (earthworks, general maintenance, conservation projects, etc.). If the plan is for a specific project and/or species, specify why hygiene management is an important component.
Objective(s)	What are your specific objectives as they relate to your team, region or area? This could include: • restricting the entry of pathogens to certain locations • restricting exit of pathogens from infested locations in the area • prioritising specific sites or locations for protection • determining the extent of pathogen distribution.
Mapping and risk assessment	Do you propose to undertake any mapping exercises to determine the extent of pathogen distribution? Mapping can help to refine the objectives. What are the risks related to movement of the pathogen(s) throughout, into or out of the area? What are the potential consequences?
Hygiene measures	How will you apply the hygiene measures outlined in the hygiene guidelines? This should relate directly to your objectives and risks identified above and refer to both vehicle and personnel hygiene. For example, if the objective is to restrict pathogen entry to a specific site, strict hygiene measures could be applied at the border of the site prior to entry. Are there any circumstances or sites where additional hygiene measures might be required? Consider developing a tailored decision tree or simply identifying the sites or areas that are prioritised for strict hygiene. How (if at all) will you address hygiene risks posed by the general public? For example, through installation of boot-cleaning stations. Consider boot-cleaning station design and location.
Protecting vegetation	Will you consider any proactive treatments to protect susceptible plants from infection? If so, consider undertaking a risk assessment to help you prioritise areas (or species) for treatment.

Prescriptions for external parties undertaking work on-park	Will you place any prescriptions on external parties undertaking work on-park? Work may include (but should not be limited to) contractors undertaking maintenance or earthworks, research or bush regeneration. If the prescriptions are different from the 'Hygiene measures' above, explain why. These should be included in contracts or agreements when engaging third parties to undertake work on your behalf.
Education and communication	How will you inform people about this hygiene management plan (or appropriate hygiene practices generally)? Consider relevant audiences, including internal staff, contractors and the general public. Examples include signage, pamphlets, information on a website, etc.

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