Targeted Flora, Vegetation and *Phytophthora* Dieback Survey of Proposed Drill Lines at Bidaminna Survey Area

Prepared for Image Resources

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ecological assessment & management

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Terratree Pty Ltd

Executive Summary

Image Resources Limited (Image) commissioned Terratree Pty Ltd (Terratree) to conduct a Targeted Flora, Vegetation and *Phytophthora* Dieback (Dieback) survey along 27km of proposed drill lines within exploration tenements E70/4794, E70/2844, E70/3298 and E70/4919 at Bidaminna, Western Australia (hereafter referred to as the 'survey area').

The survey area is located in the northern portion of the Swan Coastal Plain (Drummond Botanical Subdistrict) of the Southwestern Province (Beard, 1990). This region supports a mainly Banksia low woodland, however dune swales tend always to be swampy, with mainly heath communities of tea tree, paperbark and reed swamps in these conditions (Beard, 1990).

The survey was conducted during the peak flowering period between 29th of October and 2nd of November 2018, by Principal Ecologist Joseph Grehan and Graduate Ecologist Glenn Maslen of Terratree. The survey included a Targeted Flora and Vegetation survey and a linear *Phytophthora* Dieback assessment.

A total of 49 species, representing 38 genera from 18 families were recorded within the survey area. No introduced species were recorded. Families with the highest representation were the Proteaceae (16 taxa), Myrtaceae (16 taxa), Fabaceae (4 taxa) and Ericaceae (4 taxa) families.

One Priority Flora species was recorded within the study area, *Banksia dallanneyi* subsp. ?*pollosta.* This species is Priority 3, a 'poorly-known' species.

A total of 1378 specimens of *Banksia dallanneyi* subsp. *?pollosta* were discovered during the survey, with 231 specimens occurring within a 5m buffer of the supplied survey lines by Image. These plants are likely to be impacted by drilling activities. It is unlikely that drilling activities will have a significant impact on this population.

Three separate vegetation communities were found during the survey. The overstorey of community Types 1 and 2 is consistent with that of the Endangered Banksia woodland Threatened Ecological Community.

The entire study area was mapped as 'uninfested' for Dieback. Four samples were taken for diagnosis of potential symptoms of *Phytophthora cinnamomi*. Two samples returned negative resuts. One sample, BS3 returned a positive result for another *Phytophthora* species. This *Phytophthora* species was having a minor impact on the surrounding environment and was not causing any major ecological changes in the local area. One sample returned a positive result for *Aplosporella,* a pathogenic fungi species. This species was having a minor impact on the surrounding environment.

Terratree makes the following recommendations:

- Consider a referral to the Department of Environment and Energy as the proposed activities may constitute a significant impact on the Endangered Banksia Woodlands TEC;
- Is is strongly recommended that exploration activities should be conducted in accordance with Image's Bidaminna Project: Strategic Conservation Management Plan (Terratree, 2017). Specifically, exploration activities should adhere to the following management actions:
  - Avoid unnecessary disturbance to vegetation, clearing of large mature trees and shrubs;
  - Use a 'blade up' approach to track creation, rolling rather than clearing the vegetation;
  - If significant populations of Priority flora are to be impacted during exploration then every effort should be made to minimise impacts by demarcating populations prior to ground disturbance activities,
  - Ensure machinery entering site, especially earth-moving equipment, is 'clean on entry' to the project area i.e. free of soil and vegetative materials to prevent the introduction of weeds and pathogens.
  - Restrict driving to established tracks.
  - If exploration efforts intensify in the future, Image Resources should develop an Exploration Environmental Management Plan.

Terratree will to continue to work closely with Image Resources to implement best-practise environmental management procedures during exploration and can inform and train staff with regard to environmental matters within the study area in order to minimise disturbance to vegetation (disturbance footprint).

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1 Introduction

1.1 Background

Image Resources Limited (Image) commissioned Terratree Pty Ltd (Terratree) to conduct a Targeted Flora, Vegetation and *Phytophthora* Dieback (Dieback) survey along 27km of proposed drill lines within exploration tenements E70/4794, E70/2844, E70/3298 and E70/4919 at Bidaminna, Western Australia (hereafter referred to as the 'survey area').

1.2 Project Location

The survey area is located within mining tenements E70/4794, E70/2844, E70/3298 and E70/4919 and is approximately 23km south-east of Lancelin in the Shire of Gingin. The survey area is split into two sections, north and south of Orange Springs Road (**Figure 1**).

1.3 Scope of Work

The scope of work for the project included the following:

- Conduct an initial desktop assessment to determine the broad environmental values of the survey area.
- Undertake a comprehensive linear Dieback survey of the proposed areas of operation;
- Undertake a Targeted Flora and Vegetation survey.
- Produce an inventory of the flora and vegetation communities present.
- Identify the presence of any Threatened Ecological Communities (TECs), Priority Ecological Communities (PECs), Threatened (Declared Rare Flora) (DRF), or Priority Flora species and provide a map showing locations of these.
- Recommend best practice management techniques to avoid impacts to significant conservation values and, if unavoidable, to minimise and mitigate impacts associated with exploration activity.
- Prepare a comprehensive report detailing the results of the survey.

1.4 *Phytophthora* Dieback

Phytophthora Dieback is a soil borne pathogen with a range of hosts in the southwest of WA, predominantly from the Proteaceae, Ericaceae, Myrtaceae, Xanthorrhoeaceae and Fabaceae plant families. While some plant species are resistant, others are susceptible to the disease caused by the pathogen, which can result in chlorosis, dieback and usually death (Wills and Keighery, 1994).

Although a number of *Phytophthora* species exist in Western Australia, the most virulent and pathogenic is the introduced *P. cinnamomi*. References to *Phytophthora* Dieback refer to the disease caused by this species, unless otherwise specified.

According to the most recent Western Australian State of the Environment Report, Dieback is listed as a Priority 1 threat, and is the third greatest threat to biodiversity after salinity and climate change (EPA, 2011). It is considered a more serious threat than weeds, clearing of native vegetation, acid sulphate soils and soil erosion. The effect of Dieback is significant in WA because:

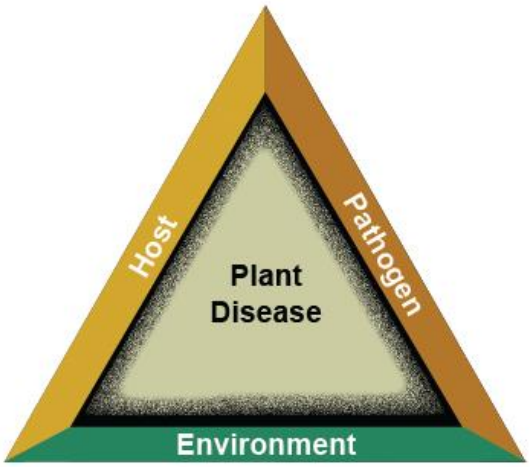
- Over 40% (2,300) of the native plant species, and half of endangered plant species, in the south-west of WA are susceptible to the pathogen;
- Changes in the composition and structure of floral communities as a result of Dieback has impacts throughout the whole ecosystem, including impacts on the indigenous fauna; and
- Dieback can lead to significant soil erosion as a result of the loss of susceptible vegetation.

Dieback is spread through the movement of water and soil within the landscape. Major vectors of Dieback include, but are not limited to, wet soil adhering to vehicle tyres/tracks and earthmoving equipment. Therefore, quarantine management procedures are an effective tool to reduce the spread of Dieback as a result of earthmoving activities.

Three variables are required to have disease expression caused by Dieback:

- **Host -** plant species present that are susceptible to *Phytophthora* spp. (i.e. *Banksia*, *Hakea*, *Leucopogon*, *Daviesia* spp.);
- **Pathogen -** The *Phytophthora* pathogen must be present either residing in susceptible or resistant species; and
- **Environment** - Soil temperatures 15-30° C and pH 5-6 (acidic) for *P. cinnamomi*. Some species including *P. multivora* can survive in alkaline soils (pH 7+).

The disease triangle below represents the three variables required for disease expression caused by Dieback.



The Dieback pathogen is widespread in areas with greater than 800mm of annual rainfall, less extensive in areas that receive between 600 – 800mm and mainly restricted to water-gaining sites in areas that receive 400 – 600mm. The pathogen very rarely occurs in areas receiving less than 400mm. In WA, Dieback is a significant environmental issue for projects between Geraldton in the Midwest and Esperance on the South Coast and is widespread in the Southwest region.

2 Regulatory Context

Legislation relevant to the protection of biodiversity in Western Australia includes, but is not limited to, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the State *Wildlife Conservation Act 1950* (WC Act) and *Environmental Protection Act 1986* (EP Act).

The Commonwealth EPBC Act was developed to provide protection for matters of National Environmental Significance (matters of NES). It includes provisions to protect threatened species and communities and the conservation of migratory species.

The State WC Act was developed to provide for the protection of wildlife in Western Australia. Under section 14 of this act, all flora and fauna are protected in Western Australia. In addition, the Minister has published a list of species in need of special protection because they are considered rare, likely to become extinct or presumed extinct. The current listing was published in the Western Australian Government Gazette on the 6th of November 2012.

The State EP Act was developed to ensure that impacts on native flora and fauna are considered in the assessment of development proposals. While the assessment of specific proposals is not within the scope of this report, the survey undertaken conforms to the requirements of the Environmental Protection Authority's Position Statement No. 3: *Terrestrial Biological Surveys as an Element of Biodiversity Protection* (EPA, 2002a) and *EPA Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* ('the Technical Guide') (EPA & DPaW, 2015).

Under the relevant legislation, certain species of flora and ecological communities are awarded protection in the interest of their conservation.

2.1 Threatened and Priority Flora

2.1.1 *Environment Protection and Biodiversity Conservation Act* (1999) (Commonwealth of Australia)

At a Commonwealth level, Threatened flora are protected under the EPBC Act, which lists species that are considered Critically Endangered, Endangered, Conservation Dependant, Extinct or Extinct in the Wild (Appendix A: Conservation Codes for Threatened and Priority Flora and Ecological Communities).

2.1.2 *Wildlife Conservation Act* (1950) (Western Australia)

Taxa which have been adequately searched for and are deemed to be either rare, in danger of extinction, or otherwise in need of special protection in the wild, are gazetted as Threatened Flora (Schedule 1, WC Act 1950). Threatened Flora (Schedule 1, December 2010) taxa are further categorised by the Department according to their level of threat using IUCN Red List criteria:

- CR: Critically Endangered – considered to be facing an extremely high risk of extinction in the wild;
- EN: Endangered – considered to be facing a very high risk of extinction in the wild; and
- VU: Vulnerable – considered to be facing a high risk of extinction in the wild.

These taxa are legally protected and their removal or impact to their surroundings cannot be conducted without Ministerial approval, obtained specifically on each occasion for each population (refer to **Appendix A** for conservation category definitions).

2.1.3 Priority Flora

The Department of Biodiversity, Conservation and Attractions (DBCA, formerly DPaW) maintains a list of Priority Flora taxa, which are considered poorly known, uncommon or under threat but for which there is insufficient justification, based on known distribution and population sizes, for inclusion in Schedule 1 of the WC Act. A Priority taxon is assigned to one of five priority categories (**Appendix A**: Conservation Codes for Threatened and Priority Flora and Ecological Communities

2.2 Threatened and Priority Ecological Communities

Ecological communities are naturally occurring biological assemblages located in a particular type of habitat. At a national level, Threatened Ecological Communities (TECs) are protected under the EPBC Act. TECs are listed under this Act as either 'Critically Endangered', 'Endangered' or 'Vulnerable'

The DBCA also maintains a list of TECs endorsed by the Minister of Environment (DBCA, 2018) that are classified as being either 'Presumed Totally Destroyed', 'Critically Endangered', 'Endangered' or 'Vulnerable'.

The DBCA maintains an additional list of Priority Ecological Communities (PECs), for communities that could potentially be classified as TECs, but are not currently adequately defined or surveyed. Communities are placed into one of five Priority categories (1-5).

Definitions of these conservation codes are provided in **Appendix A**: Conservation Codes for Threatened and Priority Flora and Ecological Communities

2.3 Introduced Flora

2.3.1 Weeds of National Significance (WONS)

At a national level there are twenty weed species listed as Weeds of National Significance (WONS). *The Commonwealth National Weeds Strategy: A Strategic Approach to Weed Problems of National Significance* (2012) describes the broad goals and objectives in managing these species.

2.3.2 Declared Plants

The *Biosecurity and Agriculture Management Act 2007* (BAM Act, DAFWA, 2007) seeks to prevent serious animal and plant pests and diseases from entering the State and becoming established, and to minimise the spread and impact of any that are already present. The BAM Act, and associated regulations, replace the *Agriculture and Related Resources Protection Act 1976* (and associated regulations). The BAM regulations were enacted on 1 May 2013, placing organisms into four categories:

- Permitted organism (listed under Section 11) – permitted in Western Australia subject to regulations;
- Prohibited organism (listed under Section 12) – prohibited in Western Australia subject to regulations (i.e. is a Declared Pest for the whole of the State);
- Permitted organism: permit required (under regulation 73) – must not be imported unless in accordance with an import permit; and
- Permitted organism: Declared Pests (under Section 22) – can apply to a part of, or the whole of, the State.

The current Western Australian Organism List (WAOL) (DAFWA, 2018) lists organisms in each of these categories. Unlisted organisms must not be imported (unless in accordance with an import permit and regulations). The BAM Act further categorises Declared Pests in one of three control categories (**Table 1**):

- C1 – Exclusion;
- C2 – Eradication; or
- C3 – Management.

Table 1: Control categories for declared pests.

Declared Plant Category	Description
C1 - Exclusion	Pests assigned to this category are not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2 - Eradication	Pests assigned to this category are present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3 - Management	Pests assigned to this category are established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

*Source: BAM Act 2007 and WAOL (DAFWA, 2018).

2.3.3 Environmental Weeds

A second and much more extensive categorisation of weeds has been developed by the DBCA (formerly the Department of Conservation and Land Management) in the Environmental Weed Strategy (Department of Conservation and Land Management, 1999). Species considered to adversely affect the communities they invade are evaluated on the following criteria:

- **Invasiveness:** ability to invade bushland in good to excellent condition, or ability to invade waterways (scored as yes or no);
- **Distribution:** wide current or potential distribution including consideration of known history of widespread distribution elsewhere in the world (scored as yes or no);
- **Environmental impacts:** ability to change the structure, composition and function of ecosystems; in particular, an ability to form a monoculture in a vegetation community (scored as yes or no).

Weeds listed as Environmental Weeds are ranked into four categories using the above criteria and scoring system:

- **High:** a species which scores yes to all three of the above criteria. A rating of high indicates a species that should be prioritised for control and/or research;
- **Moderate:** a species which scores yes for two of the above criteria. A rating of moderate indicates a species which should be monitored. Control or research should be directed to it if funds are available;
- **Mild:** a species which scores yes to one of the criteria. A mild rating indicates monitoring or control if appropriate; and
- **Low:** a species which does not score yes for any of the criteria. A low rating indicates a low requirement for monitoring.

2.4 Environmentally Sensitive Areas

Under section 51B of the *Environmental Protection Act* the Minister can, by notice, declare an area of the State specified in the notice or an area of the State to be an Environmentally Sensitive Area (ESA). ESAs are protected under the *Environmental Protection (Clearing of Native Vegetation) Regulation 2004* and are selected for their environmental values at state or national levels. Some of the reasons for assigning this status include:

- Protection of rare or threatened species of native plants;
- Protection of wetlands and water courses;
- Protection of sites that have other high conservation, scientific or aesthetic values; and
- Protection of Aboriginal or European cultural sites.

2.5 Government Policy and Guidelines

The following State Policies, EPA Position & Guidance Statements, and relevant environmental guidelines and codes of practice are considered relevant to the environmental impact assessment of the proposed project:

- EPA Position Statement No. 2 Environmental Protection of Native Vegetation (EPA, 2000);
- EPA Position Statement No. 3 Terrestrial Biological Surveys (EPA, 2002a);
- EPA Position Statement No. 7 Principles of Environmental Protection (EPA, 2002b);
- EPA Technical Guide - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment (EPA & DPaW, 2015).

2.6 *Phytophthora* Dieback

Phytophthora Dieback management is required under several regulatory mechanisms, including:

- *Phytophthora* Dieback is listed as a Key Threatening Process with the Federal Government under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Environmental Protection Act 1986* (EP Act) Part V S.50A "Serious Environmental Harm" provisions.

3 Existing Environment

3.1 Biogeography

There are 89 recognised Interim Biogeographical Regionalisation Areas (IBRA) Regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna. The study area lies in the Swan Coastal Plain region, within the Drummond Botanical Subdistrict of the Southwestern Botanical Province as described by Beard (1990).

The climate experienced in this district is described as dry warm Mediterannean and typically experiences 5-6 dry months a year, with an annual rainfall of 600 – 1000mm. The Southwestern Botanical Province is typified by plants from the families Fabaceae (*Acacia* spp.), Proteaceae (*Grevillea* spp.), Myrtaceae (*Melaleuca* spp.), Papilionaceae (*Daviesia* spp.), Casuarinaceae (*Allocasuarina* spp.) and Poaceae (grasses) (Mattiske, 2000). The Drummond Botanical Subdistrict is characterised by mainly *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; woodland of tuart (*Eucalyptus gomphocephala*), jarrah (*E. marginata*) and marri (*Corymbia callophylla*) on less leached soils.

The dominant land uses include urban development, dry land agriculture, Unallocated Crown Land and Crown reserves, conservation, forestry plantations and road easements and infrastructure.

3.2 Soils and Landforms

The Swan Coastal Plain is made up of mostly depositional material either from fluviatile or aeolian activity. The plain has coastal dunes, of which the Bassendean Dune System is the most easterly, followed by the Spearwood System and the Quindalup System fringing the coastline (McArthur 2004). Most of the Drummond Botanical Subdistrict is underlain with Mesozoic to recent sediments of the Perth Basin (Beard, 1990). The Bassendean Dunes on which the project area is located consist of low, vegetated hills of quartz sand with numerous interdunal swamps and lakes (Beard, 1990). The sands are bleached white at the surface, however, are yellow at depth (Beard, 1990). The Bassendean system soils vary based on drainage and depth to groundwater. Well drained sites on crests and upper slopes have depth to groundwater of over 10m, however areas where relief is very low the water table rises to within 2m of the surface (McArthur 2004).

3.3 Regional Vegetation

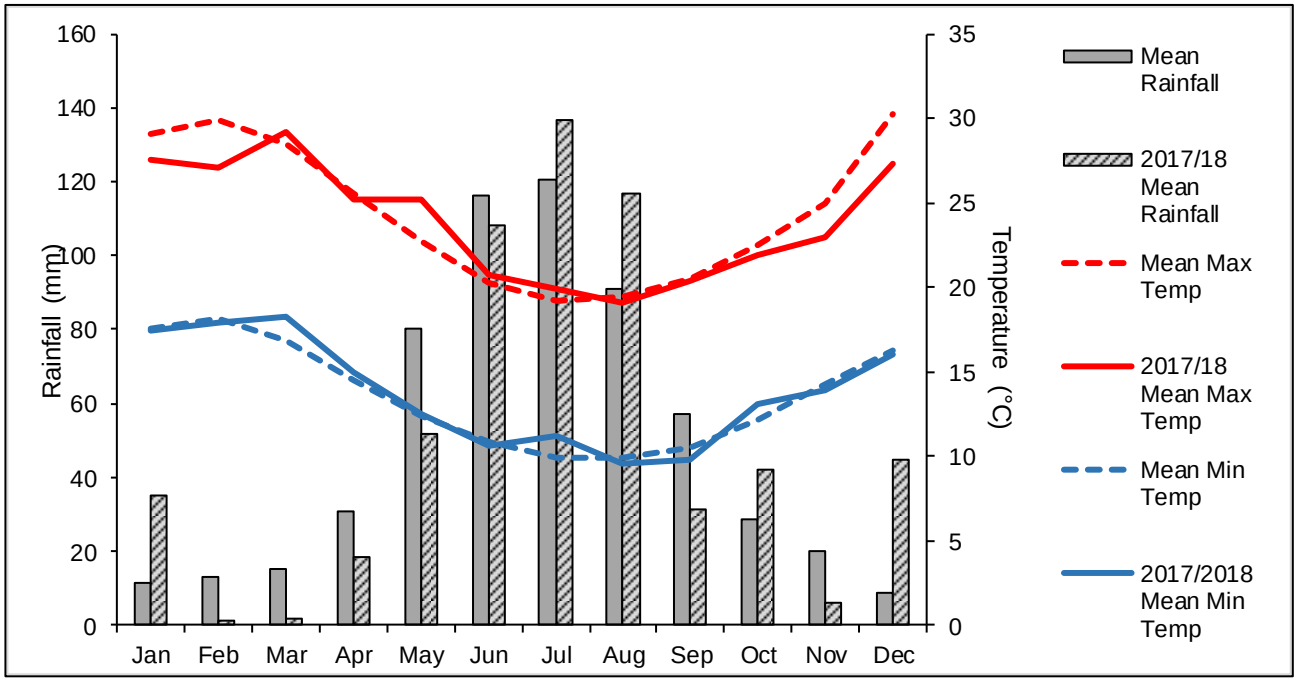
The study area is located in the northern portion of the Swan Coastal Plain (Drummond Botanical Subdistrict) of the Southwestern Province (Beard, 1990). This region supports a mainly banksia low woodland, however dune swales tend always to be swampy, with mainly heath communities of tea tree, paperbark and reed swamps in these conditions (Beard, 1990). The region supports trees of mainly 6-8m tall, with the main species being *Banksia attenuata, B. menziesii* and on wetter sites *B. ilicifolia,* along with *Eucalyptus todtiana* and *Nuytsia floribunda* (Beard, 1990).

The northern portion of the study area is described as having an overstorey of *Banksia attenuata, B. menziesii* and *Eucalyptus todtiana* over a shrub layer of *Adenanthos cygnorum, Allocasuarina humilis, Jacksonia furcellata, Xanthorrhoea preissii, Anigozanthos humilis, Conostylis aculeata* and *Eremaea fimbriata.* The southern portion of the study area has the same canopy layer as the northern portion, however the shrub layer is described as dominated by *Verticordia nitens* and *Conospermum incurvum* (Beard, 1990).

3.4 Climate

The climate experienced in the Drummond Botanical subdistrict is described as dry warm Mediterannean and typically experiences 5-6 dry months a year, with an annual rainfall of 600 – 1000mm (Beard, 1990). Representative data from the nearby Lancelin weather monitoring station is presented in **Graph 1** and is illustrative of rainfall trends experiences in the region. The average annual rainfall recorded at this station is 593.2mm. The average area had higher than average rains in December and January, followed by a drier than average autumn and higher than average rains during winter. The rainfall recorded for the past year is 539.7mm, higher than the average rainfall. Average monthly maximum temperatures at the Lancelin weather station range from 29.9°C in February to 19.2°C in July (BoM, 2018). The average minimum monthly temperatures at Lancelin range from 18.1°C in February to 9.9°C in July and August. Temperatures over the past year have been average for the area, with the past 12 months having been slightly below the yearly average maximum temperature.

Graph 1: Rainfall and temperature data at Lancelin Weather Station (BoM, 2018)



4 Desktop Review

4.1 Previous Studies

As part of the desktop assessment, the findings of previous surveys conducted within the study area and general surrounds were reviewed as listed in **Table 2**.

Table 2: Previous environmental surveys within or in close proximity to the study area

Author	Year	Reference
Rockwater Pty Ltd	2009	*Flora survey for Bidaminna North Exploration Drilling Programme (E70/2844)*
Brian Morgan Consultant Botanist	2014	*A Survey of Proposed Bidaminna Exploration Grid Lines*
Plantecology Consulting	2016	*Image Resources NL North Perth Basin – Bidaminna Threatened and Priority Flora Survey*

4.2 Desktop Assessment

Prior to the field assessment, a search of the Naturemap database was undertaken to identify flora of conservation significance previously recorded within the study area and surrounds. The following databases were consulted:

- DBCA Naturemap Search;
- The Commonwealth (EPBC Act) Protected Matters Search (for values of flora and vegetation of conservation significance).

The database searches were conducted using a 10km buffer around the centroid of the project area.

4.2.1 Threatened and Priority Flora Species

A database search of Naturemap identified 46 flora species of conservation significance, composed of eight Threatened, two Priority 1, seven Priority 2, eighteen Priority 3 and eleven Priority 4 species occurring within a 20km radius of the study area.

The Commonwealth (EPBC Act) Protected Matters Search Tool (DotE 2018) returned five additional Critically Endangered, Endangered and Vulnerable plant species from within a 10km radius of the above mentioned centroids.

Threatened and Priority flora identified from the DBCA and EPBC database search results are listed in **Appendix B**: Naturemap and Protected Matters Database Search Results of locally occurring Threatened and Priority Species.

5 Methods

The Targeted Flora and Vegetation survey was conducted during the peak flowering period between 29th of October and 2nd of November 2018, by Principal Ecologist Joseph Grehan and Graduate Ecologist Glenn Maslen of Terratree.

Flora and Vegetation

The flora and vegetation field assessment was conducted in accordance with the methods described in EPA *Technical Guide - Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA & DPaW, 2015). Specifically, the assessment included:

- a desktop study; and
- a Targeted survey for Threatened (Declared Rare) and Priority flora

After the initial desktop study, the study area was traversed by foot and vehicle to verify and further define vegetation communities within the study area, and to find Threatened or Priority flora which had appeared during desktop database searches. Botanists walked 5m either side of the proposed drill lines and searched for flora in areas 5m either side of them, covering 10m to either side of proposed drill lines. Relevés were conducted to delineate vegetation communities as they were encountered.

Where species could not be identified in the field, they were collected, labelled, pressed, dried and frozen in accordance with the requirements of the West Australian Herbarium. Subsequent to freezing the collected plant specimens were later identified by experienced taxonomist Dr. Chris Hancock using his personal knowledge, comparison with pressed specimens housed at the herbarium, taxonomic keys and other reference materials.

5.1 Relevés

A total of 4 relevés were sampled within the study area and these are presented spatially in **Figure 2** and **Figure 3**. Relevé locations were selected using aerial photography, topographic features and field observations to represent the diversity of vegetation present. Standardised data collection sheets were used to ensure consistent data records for the following features in each Relevé:

- Observer
- Date
- Location/site
- GPS Location (GDA 94)
- Species observed
- Soil type and colour
- Topography
- Degree and nature of disturbance
- Vegetation community and condition

Descriptions of communities were based on the nomenclature of the National Vegetation Information System (NVIS) (ESCAVI, 2003). Vegetation mapping was conducted by delineating plant communities based on distinctive characteristics such as vegetation structure, dominant species and species composition. A combination of aerial photography and ground-truthing was used to interpret the vegetation patterns present in the study area.

5.2 Threatened and Priority Flora

Prior to the survey descriptions and photographs of Threatened (Declared Rare) and Priority Flora identified in database searches or previously recorded in the area, were compiled from FloraBase and available literature to produce a 'field guide' to assist botanists with identification of target species during the survey.

Priority flora that were identified in the field were given a GPS location with the species name and the amount of plants within 3m of the GPS location. A specimen was taken for confirmation by an experienced taxonomist at the WA herbarium.

Individual plants or groups of plants were recorded using handheld GPS units. Where groups of plants were recorded, the location of the approximate centre of the group and number of individuals were recorded.

Specimens were recollected to confirm identification whenever a Priority species was encountered.

The locations of Priority flora were mapped in **Figure 4** and **Figure 5**.

5.3 Vegetation Condition

The level of classification of vegetation condition was determined based on the (perceived) ability of the bushland to maintain itself (**Table 3**). Disturbance and degree of alteration to the community in terms of structure and ecological function were also considered).

Table 3: Keighery Vegetation Condition Scale (Keighery, 1994)

Scale		Condition
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

5.4 Dieback Occurrence Categories

The Dieback Interpreters' guidelines: *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department* (DPaW 2015) categorises land that has been cleared of native vegetation (such as farmland) as 'excluded' from assessment. Non-vegetated areas that are 'excluded' from assessment include pasture, pits, easements, development, large roads (sealed and unsealed), permanent flooding and parkland tree stands.

Table 4 presents the *Assessability of vegetated and non-vegetated areas*, which includes the Excluded category (DPaW, 2015). The 'temporarily uninterpretable' category is allocated to areas of native vegetation which have been disturbed, but native vegetation will recover over time and may become interpretable and therefore mappable. Examples of temporarily uninterpretable areas include vegetation that has been impacted by fire, timber harvesting, flooding or mining with subsequent rehabilitation. The recovery time for

temporarily uninterpretable areas may take longer than 3 years (DPaW, 2015). Excluded areas are distinguished from 'temporarily uninterpretable' areas by the fact that excluded areas do not generally retain the ability to regenerate and eventually become mappable.

The Keighery vegetation disturbance scale (Keighery, 1993) presented in **Table 3** was used to determine the interpretability of the vegetation. Areas with a vegetation condition rating of 1-3 (Pristine - Very Good) are considered to be assessable. In addition, there must be enough disease indicator species present to enable a diagnosis of the disease status. An area with a vegetation condition rating of 4 (Good) is possibly assessable; however, it is up to the Interpreter's discretion. Temporarily uninterpretable and excluded areas are given a condition rating of 5 or 6 (Degraded or Completely Degraded).

Table 4: Assessability of vegetated and non-vegetated areas (DPaW, 2015)

	Phytophthora **occurrence category**	**Typically present**	**May be present**
Naturally vegetated areas Keighery disturbance rating of 3 or less. *Phytophthora* occurrence categorisation is possible. Small un-vegetated areas can exist and may be included in the assessment area considering total environmental context.	**INFESTED**	Dead and dying reliable indicator species	Healthy reliable indicator species. Indicator Species Deaths (ISDs) that have been killed by other agents
	UNINFESTED	Healthy reliable indicator species	ISDs that have been killed by other agents
	UNINTERPRETABLE	Very few reliable indicator species	Occasional reliable indicators, but too few for *Phytophthora* Dieback interpretation
	NOT YET RESOLVED	Usually reliable indicator species in an environment not favourable to disease development	Negative sample results for all *Phytophthora* species
Vegetation structure temporarily altered. *Phytophthora* occurrence assessment is will be possible when vegetation structure recovers. Recovery times will be variable depending on severity and type of disturbance.	**TEMPORARILY UNINTERPRETABLE**	Indicator species masked by disturbance typically from fire, harvesting, temporary flooding, poisoning.	Occasional reliable indicator species, but disturbance prevents accurate placement of *Phytophthora* occurrence
Road disturbance area	**DISEASE RISK ROAD (DRR)**	Unformed track with shoulders of interpretable vegetation	Shoulders and batters with regenerated vegetation. Incipient infestation
Vegetation structure severely altered. Keighery disturbance rating 5 or greater. Phytophthora occurrence assessment is not possible. Can be determined by desktop assessment (aerial photo). Small vegetated areas can exist and may be excluded from the assessment area considering total environmental context.	**EXCLUDED**	Pasture, pits, easements, infrastructure, large roads (sealed and unsealed) permanent flooding, plantations, parkland tree stands.	Sporadic reliable indicator species

5.5 Dieback Desktop Assessment

A desktop study was undertaken prior to the field assessment to gather background information about the assessment area and surrounding landscape. Maps of the area were accessed through the Dieback Information Data Management System (DIDMS). DIDMS maps use data from the Vegetation Health Services Laboratory to display Dieback sample results and occurrence mapping from previous surveys undertaken in the area. The desktop study also sought to:

- Examine topography and drainage of the study area and broader landscape;
- Identify possible disease vectors e.g. tracks, utility corridors and ground disturbance; and
- Determine the location of high risk areas (e.g. areas of high disturbance and water-gaining sites).

5.6 Dieback Field Assessment

The linear Dieback assessment was undertaken by Terratree Department of Biodiversity Conservation and Attraction (DBCA) registered Interpreter Joseph Grehan and training interpreter Glenn Maslen. The assessment was conducted in accordance with *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department* (DPaW 2015).

5.6.1 Disease Indicator Species

Disease Indicator species observed during the field survey are listed in **Table 5**.

Table 5: Disease Indicator Species

Family	Species	Indicator Status
Proteaceae	*Banksia attenuata*	Primary
	Banksia ilicifolia	Primary
	Banksia menziesii	Primary
	Petrophile linearis	Primary
	Stirlingia latifolia	Primary
Xanthorrhoeaceae	*Xanthorrhoea preissii*	Primary

5.6.2 Sampling

Soil and tissue samples of recently dead or dying disease indicator species were collected and lodged with the DPaW's Vegetation Health Services (VHS) laboratory, where diagnostic baiting was conducted. All sample point locations were recorded with a hand-held GPS, including geo-referenced photos. The following sampling strategy was applied when determining sample locations:

- Sampling to support infested diagnosis: Recently dead and dying indicator species are sampled to support an infested diagnosis; and
- Sampling to support an uninfested diagnosis: Recently dead and dying indicator species are sampled to support an uninfested diagnosis. Caution must be exercised when claiming that a negative result means that an area is uninfested, because false negative results can be recorded when inoculum levels are depleted from prolonged unfavourable environmental conditions for the pathogen.

All sampling adheres to strict hygiene procedures to ensure that samples are not contaminated. This involves sterilising all sampling tools with a 70:30 mixture of methylated spirits and water before samples are taken. Tools are then dried prior to re-sampling in order to ensure that results are not compromised. Once sampling

is complete, all tools are brushed off and sterilised in order to remove any excess soil and prevent contamination of the next sample site.

5.7 Mapping

5.7.1 Flora

Vegetation community areas were digitised using QGIS 3.2 software (QGIS Development Team, 2018), by digitising vector polygons over a high-resolution aerial photograph layer.

5.7.2 Dieback

Spatial data, in the form of field evidence and observations on disease status, are used to prepare the Dieback occurrence maps.

Areas of uninfested vegetation are characterised by the following features:

- No positive sample results for *P. cinnamomi;*
- An acceptable diversity of healthy disease indicator species;
- Vegetation condition in Pristine-Very Good (1-3) condition in accordance with the Keighery scale, which have good density of vegetation cover and no obvious reduction in biomass or masking by resistant species; and
- No evidence of disease pattern or chronology.

Areas of infested vegetation are identified based on the presence of the following characteristics:

- Positive results for *P. cinnamomi* either in the immediate area, upslope or upstream of the infested area;
- Multiple disease Indicator Species Deaths (ISDs);
- Disease pattern and chronology; and
- Vegetation structure and composition obviously altered.

6 Results

6.1 Flora

A total of 49 species, representing 38 genera from 18 families were recorded within the survey area. No introduced species were recorded. The full list of vascular flora species recorded is presented in **Appendix C**. Families with the highest representation were the Proteaceae (16 taxa), Myrtaceae (16 taxa), Fabaceae (4 taxa) and Ericaceae (4 taxa) families.

6.2 Threatened and Priority Flora

One Priority Flora species was recorded within the study area, *Banksia dallanneyi* subsp. ?*pollosta.* This species is Priority 3, a 'poorly-known' species. Explanation of the conservation codes can be found in **Appendix A**.

The locations of conservation significant flora recorded within the study area have been mapped spatially in **Figure 4** and **Figure 5**.

6.2.1 *Banksia dallanneyi* subsp. *pollosta* (P3)

Banksia dallanneyi subsp. *?pollosta* was found across the entire survey area. The species was not limited to a specific community, however, was prolific in Community Type 3 (**Figure 5**). 1378 plants were observed during the survey, with 231 plants found within 5m of the survey lines.

6.3 Introduced Flora (Weeds)

No introduced flora was discovered during the survey.

6.4 Vegetation Communities

In total, 3 plant communities were identified during the survey. Vegetation communities are detailed in **Table 6** below. Full descriptions of the vegetation communities can be found in **Appendix D**.

Table 6: Brief community descriptions from 2018 Survey by Terratree

Type	Vegetation Community Description
Type 1	Open woodland of *Banksia attenuata, B. menziesii* and *Eucalyptus todtiana* over shrubland of *Verticordia nitens, Adenanthos cygnorum* and *Stirlingia latifolia.*
Type 2	Open woodland of *Eucalyptus todtiana, Banksia menziesii* and *B. attenuata* over closed shrubland of *Allocasuarina humilis, Eremaea pauciflora* var. *pauciflora* and *Melaleuca clavifolia.*
Type 3	Open shrubland of *Adenanthos cygnorum, Pericalymma ellipticum* var. *ellipticum* and *Xanthorrhoea preissii* over closed low shrubland of *Patersonia occidentalis, Dasypogon bromeliifolius* and *Alexgeorgia nitens.*

6.5 Vegetation Condition

Vegetation condition throughout the area was rated as Pristine, in accordance with the Keighery Condition Scale (Keighery, 1994). Impacts to vegetation were largely restricted to the presence of exploration tracks and fire breaks.

6.6 Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESA's) can be applicable to a range of environmental, heritage and vegetation values. ESA's that are potentially applicable within the study area include:

- a Defined Wetland and the area within 50 metres of the wetland;
- the area covered by vegetation within 50 metres of Declared Rare Flora, to the extent to which the vegetation is continuous with the vegetation in which the rare flora is located; and
- the area covered by a threatened ecological community (TEC).

A search of the interactive WA Atlas on Landgate's Shared Land Information Platform (SLIP) website confirmed that there are no Defined Wetlands within the study area.

The project area lies within the area of the Endangered Banksia Woodlands TEC. Community types 1 and 2 meet the description of the TEC and would therefore classify as an ESA.

6.7 *Phytophthora* Dieback

In total, 4 samples were taken to test for the presence of *Phytophthora cinnamomi.* All samples recorded negative results for the disease. Sample BS2 was sent to Colin Crane for analysis and returned a result consistent with that of the fungus *Aplosporella* sp. Full results of the analysis can be found in **Appendix** F. Sample BS3 returned a result for another *Phytophthora* species. Images of samples taken can be found in **Plate 2**, **Plate 3** and **Plate 4**. The full table of sample results can be found in **Table 7**.

Table 7: Results from samples taken from Bidaminna survey area

Sample ID	Location	Plant Sampled	Diagnosis
BS1	E: 366024 N: 6560106	*Xanthorrhoea preissii*	Negative for *Phytophthora cinnamomi*
BS2	E: 365236 N: 6561760	*Banksia attenuata*	*Aplosporella* sp.
BS3	E: 363060 N: 6566089	*Banksia attenuata*	*Phytophthora* sp.(identification pending)
BS4	E: 367182 N: 6557140	*Banksia attenuata*	Negative for *Phytophthora cinnamomi*

7 Discussion

7.1 Threatened and Priority Flora

Priority Flora recorded within the study area are described in further detail below.

7.1.1 Banksia dallanneyi subsp. ?*pollosta* (P3)

Banksia dallanneyi subsp. *pollosta* is a prostrate, lignotuberous shrub that flowers yellow-brown from August to September, and commonly occurs in grey or yellow sand on predominantly flat topography.

Banksia dallanneyi subsp. *pollosta* differs from *Banksia dallanneyi* subsp. *dallanneyi* in it's narrower leaves, more lobes per leaf, fewer flowers per head and an upright habit. The taxonomic differences between the two species is discussed in **Table 8** below.

Table 8: Taxonomic descriptions of *Banksia dallanneyi* subsp. *pollosta* and *Banksia dallanneyi* subsp. *dallanneyi*, from Cavanagh and Pieroni (2006).

Description	*Banksia dallanneyi* subsp. *pollosta*	*Banksia dallanneyi* subsp. *dallanneyi*
Habit	More upright habit	Less upright habit
Leaf width	2-3mm	3-8mm
Lobes per leaf	60-80	30-60
Flowers per head	35-45	50-70

The collected specimens could not be definitively identified due to the leaves having on average 55-65 lobes, and the leaf width average approximately 3mm. *Banksia dallanneyi* subsp. *pollosta* is said to grade into *Banksia dallanneyi* subsp. *dallanneyi* to the south of its range (Cavanagh and Pieroni 2006). There is the potential for the specimens found during this survey to be transitional, similar to what was found in previous surveys of the area (Rockwater survey).

It was decided that the specimens are likely to be *Banksia dallanneyi* subsp. ?*pollosta* due to their habit, leaf width and the presence of leaves with up to 75 lobes per leaf. A precautionary approach was decided to be taken, due to one species being classified as a Priority 3 species, however there is potential for some specimens to be *Banksia dallanneyi* subsp. *dallanneyi.*

Banksia dallanneyi subsp. *?pollosta* was recorded in 4 main populations, in both the north and south project areas. This species is scattered throughout the habitat and is most associated with the Type 1 and 3 communities, however is still present within Type 2 vegetation (**Figure 5**: Priority Flora Locations - South Section).

A total of 1378 specimens of *Banksia dallanneyi* subsp. *?pollosta* were discovered during the survey, with 231 specimens occurring within a 5m buffer of the supplied survey lines by Image Resources. These plants are likely to be impacted by drilling activities. It is unlikely that drilling activities will have a significant impact on this population.

7.2 Vegetation Communities

Three separate vegetation communities were found during the survey. Vegetation Type 1 is characterised by a *Banksia* woodland tree canopy, over primarily *Verticordia nitens.* This community accounted for 65.9% of the survey lines (**Figure 2** and **Figure 3**). Vegetation Type 2 is a similar *Banksia* woodland community, however with an understorey of primarily *Eremaea pauciflora* var. *pauciflora* and *Melaleuca clavifolia.* This community was less profilic than Vegetation Type 1, accounting for 21.5% of the total assessed vegetation (**Figure 2** and **Figure 3**). Vegetation Type 3 accounted for a shrubland community characterised by primarily *Adenanthos*

cygnorum and *Pericalymma ellipticum* var. *ellipticum* over *Patersonia occidentalis* and *Dasypogon bromeliifolius.* This community is restricted to areas of lower topography, occurring only in the south portion of the project area (**Figure 2** and **Figure 3**). This was the smallest community, accounting for 12.59% of the total vegetation.

The overstorey of community Types 1 and 2 is consistent with that of the Endangered Banksia woodland TEC, and Image should consider a referral to the Department of Environment and Energy before any activities are undertaken, as they may be deemed significant impacts on the TEC.

7.3 *Phytophthora* Dieback

7.3.1 Phytophthora cinnamomi

No positive results for *Phytophthora cinnamomi* were retrieved during the survey, with no visual impacts noted during the survey. In accordance with the Dieback Interpreters' guidelines: *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department* (DPaW 2015)**,** the area was mapped to be 'uninfested' based on field evidence by an experience Dieback interpreter.

7.3.2 Other *Phytophthora* species

BS3 returned a negative result for *Phytophthora cinnamomi,* however returned a positive result for another *Phytophthora* species. This result is currently undergoing DNA analysis, and will be supplied by Terratree when the analysis is complete. There were limited observable effects of this *Phytophthora* species on the surrounding environment, and the area was still rated as 'Pristine' (Keighery, 1993).

7.4 Pathogenic Fungi

A fungus morphologically consistent with the genus *Aplosporella* (**Appendix F**) was isolated from the BS2 sample, in the southern part of the project area (**Figure 7**). This fungus is a genus within the order *Botryosphaeriales.* The following is a description from Crane (2018):

> 'Ecologically, they are sometimes parasitic, often exist as benign endophytes causing disease when the host is compromised in some way. Trees stress affected by drought, insect attack, defoliation by fungi, sunscald, herbicides or mechanical injury are predisposed to infection and disease development. Some species appear to have a pathogenic stage in their life cycle'.

Although this fungus was discovered during the survey, the impact to the surrounding vegetation was assessed to be low and does not appear to be significantly altering any ecosystem function in the surrounding area.

7.4.1 Drought

Impacts to vegetation because of prolonged drought are differentiated from impacts caused by *P. cinnamomi* by the following characteristics:

- No disease pattern or chronology in the surrounding vegetation;
- *Phytophthora* resistant species exhibiting evidence of stress and mortality;
- The plant had senesced gradually, rather than succumbing quickly as is usually the case with deaths attributed to *P. cinnamomi;*
- No visible lesions or mycelium on the roots of the dead or dying plant;
- Re-shooting or epicormic growth visible on dying plants; and
- The presence of single or multiple dead branches with the remainder of the plant appearing to be healthy.

Symptoms of drought on vegetation susceptible to *P. cinnamomi* were observed throughout uplands within the survey area.

7.5 Survey Limitations

The potential limitations of the survey, as outline in the EPA Guidance Statement No. 51 (EPA, 2004) are outlined in **Table 9**.

Table 9: Potential limitations and discussion of their relevance to the study area

Potential Limitation	Discussion
Sources of information and availability of contextual information (i.e. pre-existing background vs. new material)	**Not a limitation**. Existing information was available, including 3 earlier reports that focused on the same study area (Rockwater 2009, Morgan 2013, Plantecology 2016).
Scope (e.g. what life forms, etc., were sampled)	**Not a limitation**. There were no limitations on the scope. The survey assessed vegetation types and vascular plant species within the study area, including Priority species.
Proportion of flora collected and identified (based on sampling, timing and intensity)	**Not a limitation**. The study was undertaken in accordance with the description of Targeted Surveys in EPA Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment (EPA & DPaW, 2015). Relevés were undertaken in accordance with the guide, and plant specimens collected when botanists were not able to identify plants in the field. Opportunistic sampling was undertaken between relevés to ensure the survey area was aqequately sampled.
Completeness and further work which may be needed (e.g. was the relevant area fully surveyed)	**Not a limitation.** The survey area was adequately surveyed, with botanists covering the entire survey area. The priority species *Babingtonia delicata* was identified prior to the survey being undertaken, however the species was restricted to a creekline community which was adequately demarcated using aerial imagery.
Taxonomic certainty	**Not a limitation**. There were no significant limitations on taxonomic certainty. Species profiles, descriptions and photographs were compiled from specimens and information available on Florabase and resources in the WA Herbarium. These were used for field identification of any species with potential to be a threatened or priority species. Specimens were collected for all potential threatened and priority species and all unidentified plants (as encountered), for identification by a taxonomic expert in the WA Herbarium.
Mapping reliability	**Not a limitation**. The vegetation mapping was based on the requirements outlined in the EPA Technical Guide for a detailed Flora and Vegetation. For planning and mapping purposes, detailed aerial imagery was provided by the Client.
Timing, weather, season, cycle	**Not a limitation**. The targeted survey was completed during the peak flowering period, between 29th of October and the 2nd of November 2018. Annuals and Orchid species were observable at the time of the survey
Disturbances (fire, flood, accidental human intervention etc.)	**Not a limitation**. Disturbance within the study area was mainly limited to access tracks used for exploration activities.
Intensity (in retrospect, was the intensity adequate)	**Not a limitation**. The intensity of the survey was adequate. By the end of the survey no new vegetation types and few new plant species were being encountered.
Resources	**Not a limitation**. The field survey, plant identification and reporting were all adequately resourced.
Experience levels (e.g. degree of expertise in plant identification to taxon level).	**Not a limitation**. The field survey was carried out by suitably qualified and experienced personnel with extensive experience over a range of botanical districts with specific experience working in Banksia woodlands on the Swan Coastal Plain. Plant identification was primarily undertaken by Dr. Chris Hancock, whom has over ten years of experience in taxonomic identification and has extensive experience identifying flora from the Mallee region.

8 Conclusions and Recommendations

A total of 49 species, representing 38 genera from 18 families were recorded within the survey area. No introduced species were recorded.
Families with the highest representation were the Proteaceae (16 taxa), Myrtaceae (16 taxa), Fabaceae (4 taxa) and Ericaceae (4 taxa) families.

One Priority Three species, *Banksia dallanneyi* subsp. *?pollosta* was recorded within the study area. This species could not be fully identified, due to the species also having similar characteristics to *Banksia dallanneyi* subsp. *dallanneyi.* This was found during prior surveys. *Banksia dallanneyi* subsp. *pollosta* is said to integrade with *Banksia dallanneyi* subsp. *dallanneyi* to the south of its range, where the study area is located. Based on the characteristics of the collected specimens, the species was decided to be *Banksia dallanneyi* subsp. *?pollosta* based on the upright habit, small leaf width and number of leaf lobes.

The study area lies within the Endangered Banksia Woodland Threatened Ecological Community. Three vegetation communities were identified during the survey, with the main two vegetation types meeting the description for Banksia woodlands, possessing a main canopy of *Banksia attenuata* and *B. menziesii.* Areas within these communities are Environmentally Sensitive Areas.

The condition of the vegetation throughout the study area was determined to be 'Pristine' according to the Keighery Vegetation Condition Scale (Keighery, 1994). Disturbance was limited to tracks and firebreaks.

The entire study area was classified as 'uninfested' for *Phytophthora cinnamomi* Dieback. Four samples were taken for diagnosis of potential symptoms of *Phytophthora cinnamomi*. Two samples returned negative resuts. One sample, BS3 returned a positive result for another *Phytophthora* species. This *Phytophthora* species was a low impact on the surrounding environment and was not causing any major ecological changes in the local area. One sample returned a positive result for *Aplosporella,* a pathogenic fungi species. This species was not having a major impact on the surrounding environment, and the impact was deemed 'low'.

Terratree makes the following recommendations:

- Consider a referral to the Department of Environment and Energy as the proposed activities may constitute a significant impact on the Endangered Banksia Woodlands TEC.
- Is is strongly recommended that exploration activities should be conducted in accordance with Image's Bidaminna Project: Strategic Conservation Management Plan (Terratree, 2017). Specifically, exploration activities should adhere to the following management actions:
  - Avoid unnecessary disturbance to vegetation, clearing of large mature trees and shrubs;
  - Use a 'blade up' approach to track creation, rolling rather than clearing the vegetation;
  - If significant populations of Priority flora are to be impacted during exploration then every effort should be made to minimise impacts by demarcating populations prior to ground disturbance activities,
  - Ensure machinery entering site, especially earth-moving equipment, is 'clean on entry' to the project area i.e. free of soil and vegetative materials to prevent the introduction of weeds and pathogens.
  - Restrict driving to established tracks.
  - If exploration efforts intensify in the future, Image Resources should develop an Exploration Environmental Management Plan.

Terratree will to continue to work closely with Image Resources to implement best-practise environmental management procedures during exploration and can inform and train staff with regard to environmental matters within the study area in order to minimise disturbance to vegetation (disturbance footprint).

9 References

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10 Plates

Plate 1: *Banksia dallanneyi* subsp. *pollosta* at Bidaminna Survey Area

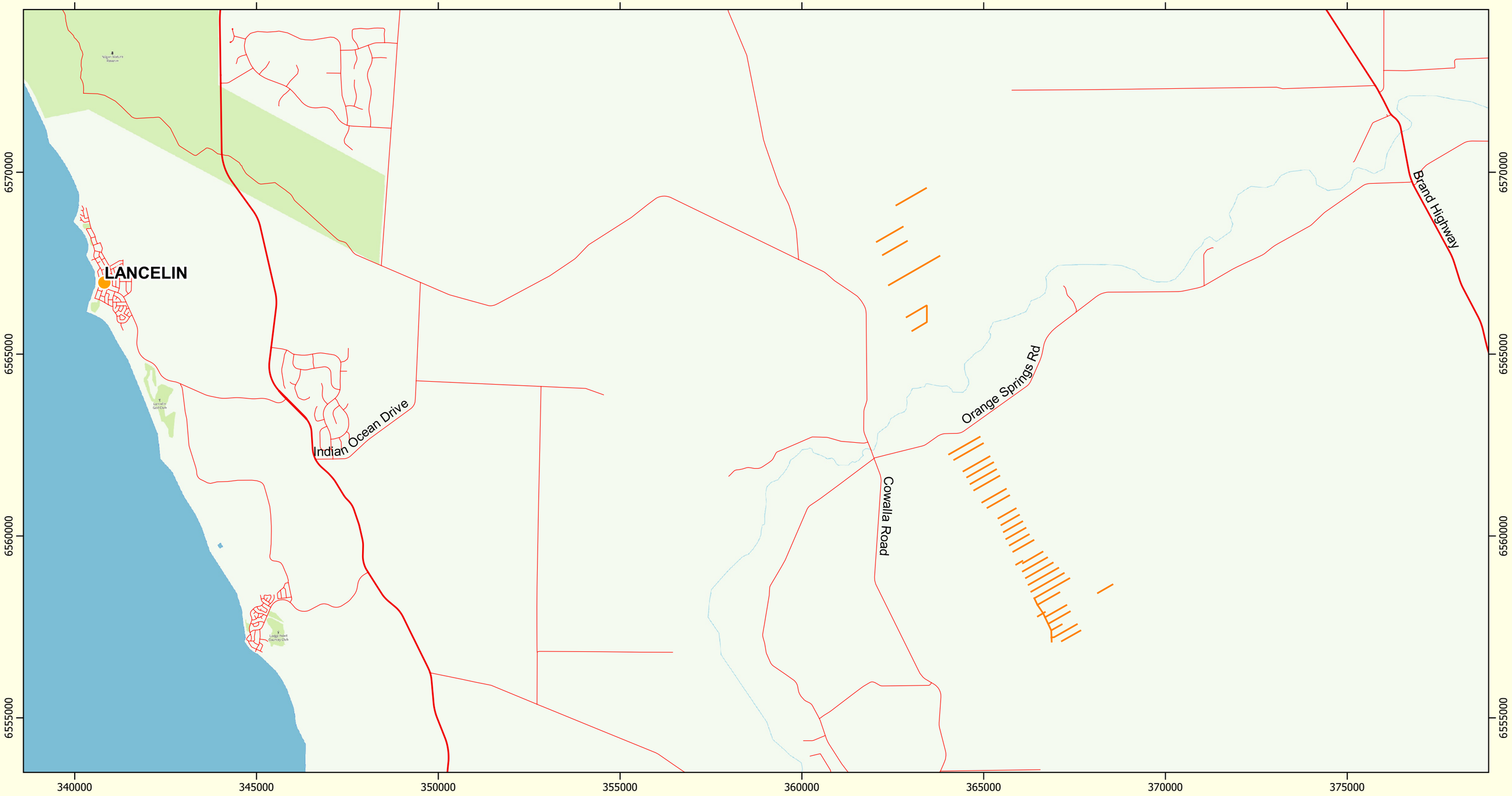
Plate 2: Sample BS1, a *Xanthorrhoea preissii* which returned a negative result for *Phytophthora* sp.

Plate 3: Sample BS3, a *Banksia attenuata* which returned a postive result for a *Phytophthora sp.*

Plate 4: Sample BS4, a *Banksia attenuata* which returned a negative result for *Phytophthora.*

11 Figures

Figure 1: Study Area Location



Legend

Place Locations

- Town

Road Network

- Local Road
- State Road
- Bidaminna Proposed Drill Lines

Project Location

Bidaminna Project Location

2018 Terratree Flora and Dieback Survey for Image Resources

1 0 1 2 3 4 5 km

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:100,000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 1	Review: J. Grehan	Terratree
	Revision:	

Figure 2: Vegetation types within survey area - North Section

Legend

Bidaminna Proposed Drill Lines

Vegetation Community Types

Type 1

Type 2

Project Location

Bidaminna North Vegetation Communities

2018 Terratree Flora and Dieback Survey for Image Resources

0 250 500 750 1000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:20000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 2	Review: J. Grehan	Terratree
	Revision:	

Figure 3: Vegetation Types within Survey – South Section

Legend

- Bidaminna Proposed Drill Lines

Vegetation Community Types

- Type 1
- Type 2
- Type 3
- Releve Locations

Project Location

Bidaminna South Vegetation Communities

2018 Terratree Flora and Dieback Survey for Image Resources

0 500 1000 1500 2000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:30000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 3	Review: J. Grehan	Terratree
	Revision:	

Figure 4: Priority Flora Locations – North Section

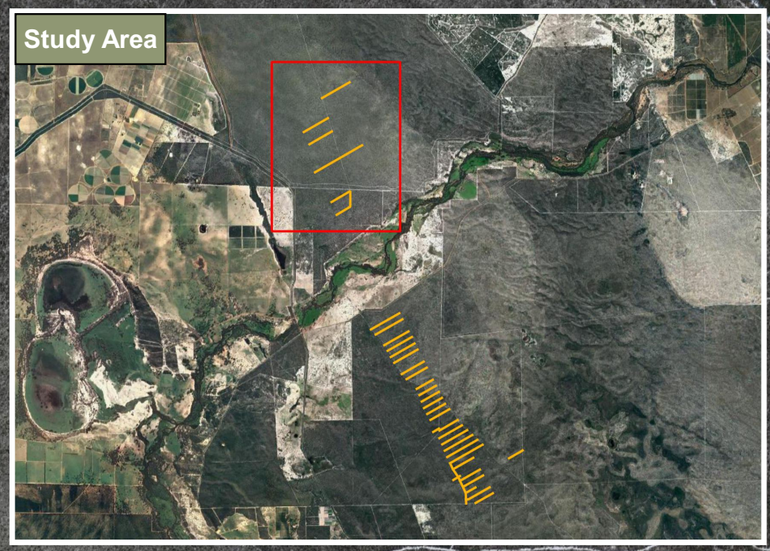
360000 361000 362000 363000 364000 365000 366000 367000

6569000

6568000

6567000

6566000



Legend

Bidaminna Proposed Drill Lines

Number of Banksia dallanneyi subsp. ?pollosta plants

- 1 - 6
- 6 - 12
- 12 - 20
- 20 - 35
- 35.0 - 50.0

Project Location

Bidaminna North Priority Species Location

2018 Terratree Flora and Dieback Survey for Image Resources

0 250 500 750 1000 m

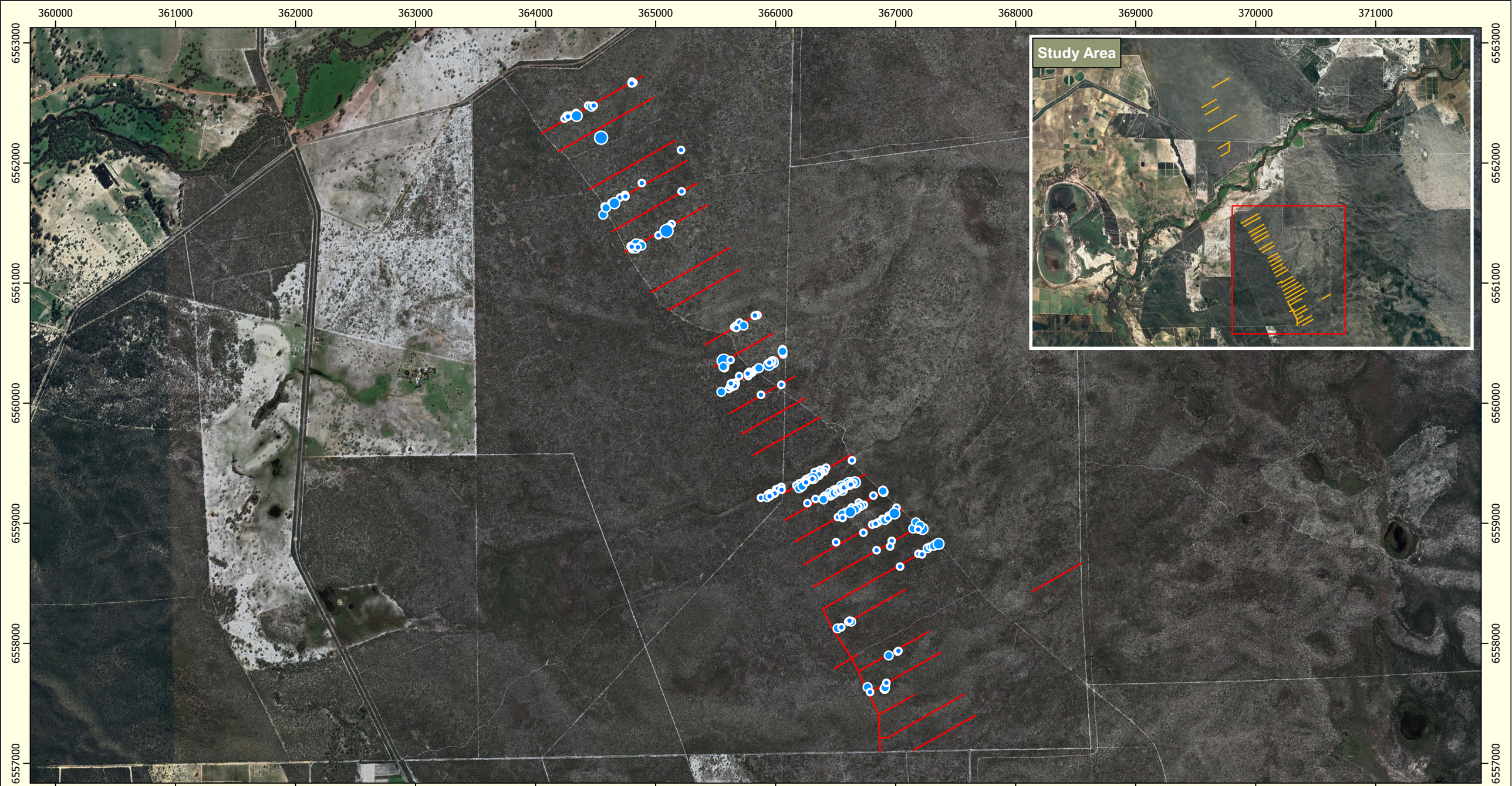
N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:20000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 4	Review: J. Grehan	Terratree
	Revision:	

Figure 5: Priority Flora Locations - South Section



Legend

Bidaminna Proposed Drill Lines

Number of Banksia dallanneyi subsp. ?pollosta plants

- 1 - 6
- 6 - 12
- 12 - 20
- 20 - 35
- 35 - 50

Project Location

Bidaminna South Priority Species Locations

2018 Terratree Flora and Dieback Survey for Image Resources

0 500 1000 1500 2000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:30000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 5	Review: J. Grehan	Terratree
	Revision:	

Figure 6: Dieback Occurrence Map– North Section

Legend

- Bidaminna Proposed Drill Lines
- Image Dieback Occurrence Category - Uninfested

Dieback Sample Locations

- Result positive for *Phytophthora* sp.

Project Location

Bidaminna North Dieback Occurrence Map

2018 Terratree Flora and Dieback Survey for Image Resources

0 250 500 750 1000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:20000 at A3

Date: 05/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 05/12/2018	Checked: G. Maslen	
Figure 6	Review: J. Grehan	Terratree
	Revision:	

Figure 7: Dieback Occurrence Map – South Section

Legend

- BidaminnaLines

Road Network

- Local Road

Phytophthora Sample Locations

- Phytophthora sp.
- Negative Sample Result
- Dieback Occurrence Category - Uninfested

Project Location

Bidaminna South Dieback Occurrence Map

2018 Terratree Flora and Dieback Survey for Image Resources

0 250 500 750 1000 m

N

Datum: GDA 1994
Projection: MGA Zone 50

Scale: 1:30000 at A3

Date: 13/12/2018	Prepared: G. Maslen	Project #: T18015
Expiry: 13/12/2019	Checked: J. Grehan	
Figure 7	Review:	Terratree
	Revision:	

12 Appendices

Appendix A: Conservation Codes for Threatened and Priority Flora and Ecological Communities

Table A.1 – Definition of codes for Threatened and Priority Flora (DPaW)

Code	Definition
T	**Threatened Flora – (Declared Rare Flora – Extant)** Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such (Schedule 1 under the *Wildlife Conservation Act 1950*).
X	**Presumed Extinct Flora (Declared Rare Flora - Extinct)** Taxa which have been adequately searched for and there is no reasonable doubt that the last individual has died, and have been gazetted as such Schedule 2 under the *Wildlife Conservation Act 1950*).
P1	**Priority One – Poorly Known Species** Species that are known from one or a few collections or sight records (generally less than five), all on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, Shire, Westrail and Main Roads WA road, gravel and soil reserves, and active mineral leases and under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two – Poorly Known Species** Species that are known from one or a few collections or sight records, some of which are on lands not under imminent threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. Species may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three – Poorly Known Species** Species that are known from collections or sight records from several localities not under imminent threat, or from few but widespread localities with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	**Priority Four – Rare, Near Threatened and other species in need of monitoring** (a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands. (b) Near Threatened. Species that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.
P5	**Priority Five - Conservation Dependent species** Species that are not threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years.

Table A.2 – Definition of codes for Commonwealth Listed Threatened Flora

Code	Definition
Ex	**Extinct** Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time, the species is the focus of a specific conservation programme, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

Table A.3 – Definition of codes for Threatened Ecological Communities

Code	Definition
PD: Presumed Totally Destroyed	An ecological community that has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrence of it is likely to recover its species composition and/or structure in the foreseeable future. An ecological community will be listed as presumed totally destroyed if there are no recent records of the community being extant
CR: Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range in the immediate future, or is already severely degraded throughout its range but capable of being substantially restored or rehabilitated. An ecological community will be listed as Critically Endangered when it has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
EN: Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future. An ecological community will be listed as Endangered when it has been adequately surveyed and is not Critically Endangered but is facing a very high risk of total destruction in the near future.
VU: Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range. An ecological community will be listed as Vulnerable when it has been adequately surveyed and is not Critically Endangered or Endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

Table A.4 – Definition of codes for Priority Ecological Communities

Code	Definition
P1: Priority One	Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or Pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2: Priority Two	Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3: Priority Three	(i) Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (ii) Communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (iii) Communities made up of large, and/or widespread occurrences that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4: Priority Four	Ecological communities that are adequately known, Rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. (a) Rare. Ecological communities known from few occurrences that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These communities are usually represented on conservation lands. (b) Near Threatened. Ecological communities that are considered to have been adequately surveyed and that do not qualify for Conservation Dependent, but that are close to qualifying for Vulnerable. (c) Ecological communities that have been removed from the list of threatened communities during the past five years. P5: Priority Five Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.
P5: Priority Five	Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Appendix B: Naturemap and Protected Matters Database Search Results of locally occurring Threatened and Priority Species.

THREATENED SPECIES
Andersonia gracilis
Anigozanthos viridis subsp. *terraspectans*
Darwinia acerosa
Darwinia carnea
Drakea elastica
Eleocharis keigheryi
Eucalyptus argutifolia
Grevillea curviloba subsp. *incurva*
Lepidosperma rostratum
Macarthuria keigheryi
Paracaleana dixonii
Ptychosema pusillum
Thelymitra dedmaniarum
PRIORITY ONE SPECIES
Grevillea evanescens
Gyrostemon sp. Mogumber (T.J. Hawkeswood 250)
PRIORITY TWO SPECIES
Dampiera tephrea
Goodenia xanthotricha
Hypocalymma sp. Cataby (G.J. Keighery 5151)
Isotropis cuneifolia subsp. *glabra*
Lepyrodia curvescens
Leucopogon squarrosus subsp. *trigynus*
Stylidium sp. Moora (J.A. Wege 713)
PRIORITY THREE SPECIES
Acacia drummondii subsp. *affinis*
Allocasuarina grevilleoides
Babingtonia urbana
Banksia dallanneyi subsp. *pollosta*
Banksia kippistiana var. *paenepeccata*
Conostylis bracteata
Desmocladus biformis
Dillwynia dillwynioides
Eryngium sp. Subdecumbens (G.J. Keighery 5390)
Haemodorum loratum
Hensmania stionella
Isopogon drummondii
Leucopogon sp. Yanchep (M. Hislop 1986)
Persoonia rudis
Petrophile biternata
Phlebocarya pilosissima subsp. *pilosissima*
Stylidium nonscandens
Thryptomene sp. Lancelin (M.E. Trudgen 14000)
PRIORITY FOUR SPECIES
Anigozanthus humilis subsp. *chrysanthus*
Calothamnus accedens
Calothamnus pachystachyus
Conostylis pauciflora subsp. *euryrhipis*
Dodonaea hackettiana
Eucalyptus macrocarpa subsp. *elachantha*
Rumex drummondii
Schoenus griffinianus
Tripterococcus sp. Brachylobus (A.S. George 14234)
Verticordia lindleyi subsp. *lindleyi*
Verticordia paludosa

Appendix C: All species collected during Targeted Flora Survey for Image Resources

Family	Species	Conservation Code
Asparagaceae	*Thysanotus sp.*	
Casuarinaceae	*Allocasuarina humilis*	
Cyperaceae	*Mesomelaena pseudostygia*	
Dasypogonaceae	*Dasypogon bromeliifolius*	
Dilleniaceae	*Hibbertia huegellii*	
	Hibbertia subvaginata	
Ericaceae	*Astroloma pallidum*	
	Conostephium pendulum	
	Leucopogon polymorphus	
	Styphelia ciliosa	
Fabaceae	*Acacia brumalis*	
	Bossiaea eriocarpa	
	Gompholobium tomentosum	
	Jacksonia floribunda	
Goodeniaceae	*Dampiera linearis*	
Haloragaceae	*Gonocarpus pithyoides*	
Haemodoraceae	*Anigozanthos humilis* subsp. *humilis*	
Iridaceae	*Patersonia occidentalis*	
Lauraceae	*Cassytha sp.*	
Loranthaceae	*Nuytsia floribunda*	
Myrtaceae	*Beaufortia elegans*	
	Calothamnus sanguineus	
	Calytrix sapphirina	
	Darwinia pinifolia	
	Eremaea asterocarpa subsp. *asterocarpa*	
	Eremaea pauciflora	
	Eremaea pauciflora var. *pauciflora*	
	Eucalyptus todtiana	
	Hypocalymma angustifoluum	
	Melaleuca clavifolia	
	Pericalymma ellipticum var. *ellipticum*	
	Verticordia nitens	
	Verticordia nobilis	
	Verticordia ovalifolia	
Proteaceae	*Adenanthos cygnorum*	
	Banksia attenuata	
	Banksia dallaneyi subsp. *pollosta*	P3
	Banksia ilicifolia	
	Banksia laricina	
	Banksia menziesii	
	Conospermum crassinervium	
	Hakea psilorrhyncha	

	Petrophile linearis	
	Stirlingia latifolia	
Restionaceae	*Alexgeorgea nitens*	
Thymelaeaceae	*Pimelea sulphurea*	
Xanthorrhoeaceae	*Xanthorrhoea preissii*	

Appendix D: Detailed Relevé Descriptions

<table>
<tr><th>Vegetation Type</th><th>% of total survey area</th><th>Relevé</th></tr>
<tr><td rowspan="3">1</td><td>65.9%</td><td>C1R1</td></tr>
<tr><td colspan="2">Open woodland of Banksia attenuata, Banksia menziesii and Eucalyptus todtiana over shrubland of Verticordia nitens, Adenanthos cygnorum and Stirlingia latifolia.</td></tr>
<tr><td colspan="2"> 
Type 1 vegetation in the study area</td></tr>
</table>

Vegetation Type	% of total survey area	Relevé
2	21.53%	C2R1, C2R2
	Open woodland of *Eucalyptus todtiana, Banksia menziesii* and *Banksia attenuata* over closed shrubland of *Allocasuarina humilis, Eremaea pauciflora* var. *pauciflora* and *Melaleuca clavifolia.*	
	 Type 2 vegetation in the study area	

<table>
<tr><th>Vegetation Type</th><th>% of total survey area</th><th>Relevé</th></tr>
<tr><td rowspan="3">3</td><td>12.59%</td><td>C3R1</td></tr>
<tr><td colspan="2">Open shrubland of Adenanthos cygnorum, Pericalymma ellipticum var. ellipticum and Xanthorrhoea preissii over closed low shrubland of Patersonia occidentalis, Dasypogon bromeliifolius and Alexgeorgia nitens.</td></tr>
<tr><td colspan="2"> 
Type 3 vegetation in the study area</td></tr>
</table>

Appendix E: VHS Dieback Report

VEGETATION HEALTH SERVICE - PHYTOPHTHORA SAMPLE INFORMATION SHEET

SEND TO: VHS Lab, Forest and Ecosystem Management Div - DPaW, 17 Dick Perry Ave KENSINGTON 6151 **Phone**:(08) 9334 0317 **Fax:** (08) 9334 0114

CONTACT DETAILS of sender
Name Glenn Maslen_____
Fax No. _____ Phone No. 0408406410_____
DPaW Office or Company Name Terratree Pty Ltd_____

GDA (1)
GDA 94 __✓__

Job Type (Please indicate)
DPaW (C) Alcoa (A)
Recoup (R) FPC
Private (P) Other_____

VHS USE ONLY
Date received 5.11.18
Date faxed 19.11.18

NOTIFY DFWA? _____

VHS Identification Number (VHS USE ONLY)	Sample Date	Sample label (Give location, eg. Forest Block or Shire, etc. and sample number)	Plant species sampled	Site Impact (2)	Zone 50 or 51	Map Reference (3)	Land Tenure (4)	RESULT s/s root (5)	RESULT bait (5)
VHS 38757	31/10	BS1	*Xanthorrhoea preissii*	L	50	E 366024 N 6560106	P		NEG
VHS 38758	31/10	BS3	*Banksia attenuata*	L	50	E 363059 N 6556089	P		SUB?
VHS 38759	02/01	BS4	*Banksia attenuata*	L	50	E 367183 N 6557141	P		NEG
						E _ _ _ _ _ _ N _ _ _ _ _ _ _			
						E _ _ _ _ _ _ N _ _ _ _ _ _ _			
						E _ _ _ _ _ _ N _ _ _ _ _ _ _			
						E _ _ _ _ _ _ N _ _ _ _ _ _ _			
						E _ _ _ _ _ _ N _ _ _ _ _ _ _			

NOTES:
1. Please tick this box if your map references are supplied in the **GDA 94** standard. If not, please specify the datum used.
2. Site impact - Low, Moderate, or High (as in the Dieback Interpreter's Manual).
3. An MGA map reference with prefixes **must** be supplied for all samples.
4. Land Tenure - State Forest (SF), National Park (NP), Reserve (R), Westrail (W), Private (P), Gravel Pit (GP), or other. (Other - describe in comments below).
5. Result codes used – CIN = *Phytophthora cinnamomi*, MUL = *P. multivora*, CRY = *P. cryptogea*, PI = *P. inundata*, ARE = *P. arenaria*, ELO = *P. elongata*, THE = *P. thermophila*, PM = *P. megasperma*, PN = *P. nicotianae*, CON = *P. constricta*, ALT = *P. alticola*, NEG = negative, SUB = subcultured for further tests

Please Note: a). NEG results cannot be used to represent a total absence of *Phytophthora* in the sampled area. b). Information from your samples will be incorporated into the VHS database.

COMMENTS:

Appendix F: Report by Colin Crane

PLANT DISEASE SAMPLE INFORMATION SHEET

CLIENT NAME Joe Grehan, Terratree consulting

SAMPLE *Banksia attenuata* excised stem pieces (fig.1) Lancelin, BS 2, CC 1923, Result CC 006 Received 8/11/18.

DIAGNOSIS* A fungus within the order *Botryosphaeriales*, family *Aplosporellaceae* and morphologically consistent with the genus *Aplosporella* (fig.2) was isolated from nearly all the excised stem pieces (fig.3 asexual conidia and condiophores).
See https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3825231/

Fig. 1


Fig. 2


Fig. 3

THE PATHOGEN In South Western Australia, *Botryosphaeriales* are commonly isolated from stem and twig cankers of *Eucalyptus, Hakea* and *Banksia spp*. (Shearer 1994). *Botryosphaeriales* is a large diverse group of pathogenic/latent endophytic or benign endophytic (present in host tissues asymptomatically) fungi that has a pan global distribution. For comparison, other genera within the *Botryosphaeriales* such as *Neofusiccocum* are also commonly isolated from dying trees in South Western Australia. Ecologically, they are sometimes parasitic, often exist as benign endophytes causing disease when the host is compromised in some way. Trees stress affected by drought, insect attack, defoliation by fungi, sunscald, herbicides or mechanical injury are predisposed to infection and disease development. Some species appear to have a pathogenic stage in their life cycle.

SYMPTOMS *Botryosphaeriales* beginning with small sunken cankers on twigs then coalescing to cause the death of twigs and stems.

HOST RANGE Many *Botryosphaeriales* are known to infect a wide range of hosts as wound pathogens and in some environments killing trees. The majority are generalists and affect a wide variety of woody plants including *Eucalyptus, Banksia,* grapes and walnuts to name a few.

DISTRIBUTION Cosmopolitan and probably widespread across the South West.

CONTROL While chemical control with benomyl and other fungicides is practiced in some commercial grape and forestry situations to reduce canker incidence it is unclear whether this would be beneficial in this situation.

LABORATORY SAMPLES CC1923. Mean spore size for this isolate was 87x51micron and larger than that reported though remaining morphology was consistent with *Aplosporella*. Spore size is known to vary with cultural environment. Isolation culture plates will be stored for 1 year from isolation.

LAT/LONG ? Lancelin area.

25/11/18
Colin Crane
Plant Diseases in Natural Ecosystems
Mob 0423088826
Email colinc57265@gmail.com

Shearer BL (1994) The major plant pathogens occurring in native ecosystems of south-western Australia, Journal of the Royal Society of Western Australia **77**, 113-122.

* Names of fungi are allocated on morphological basis and are subject to review. While much effort is spent ensuring accuracy and currency of names phylogenetic knowledge is advancing rapidly and mycological morphological identification can be beset with inaccuracies. DNA sequence analysis should be used to confirm identification of fungi.