JANDAKOT AIRPORT
DIEBACK MANAGEMENT PLAN

CONSERVATION MANAGEMENT PLAN
APPENDIX C

Jandakot Airport Holdings Pty Ltd
16 Eagle Drive
Jandakot WA 6164

Amendment History

Version	Issue Date	Description	Prepared By	Approved By (JAH)	Approved by (DOEE)
8	22/01/2014	Major revision	Joanne Wann (JAH EM)	J. Fraser	S.Gaddes 8/4/14
9	26/06/2015	Minor amendments to reflect updated dieback mapping.	Joanne Wann (JAH EM)	J. Fraser	S.Gaddes 8/9/15
10	03/05/2019	Minor amendments to reflect updated dieback mapping.	Joanne Wann (JAH EM)	J. Fraser	TBC

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

1 Background

Jandakot Airport is managed by Jandakot Airport Holdings Pty Ltd (JAH) under a lease agreement with the Commonwealth Government. The airport site contains 119 ha of conservation precinct. JAH is regulated by the Commonwealth *Airports Act 1996* (Airports Act) and the associated *Airports (Environment Protection) Regulations 1997*.

The Airports Act requires JAH to prepare and implement a Master Plan every five years, which includes an Environment Strategy that outlines environmental management of the airport. Master Plan 2014 was approved in February 2015 and includes a commitment to implement this Dieback Management Plan.

Dieback is caused by an introduced soil and water borne pathogen known as *Phytophthora cinnamomi* which infects the roots of plants causing roots and foliage to die off. This often leads to the eventual death of the infected plant. Many local native plants are susceptible to dieback and its spread can have devastating effects on the ecology of remnant bushland areas. Death of susceptible species in large numbers can encourage weed infestation and impact on fauna habitat and feeding sources. Areas identified as containing dieback cannot be cured once infested, however appropriate management can minimise the spread of the disease (Dieback Working Group, 2005). Jandakot Airport is adjacent to two other conservation bushland areas, Ken Hurst Park and the Jandakot Regional Park Acourt Road Reserve. Whilst these neighbouring properties are also affected by dieback, it is important that the spread of dieback is minimised.

Four *P. cinnamomi* dieback infestations comprising a total of 22.7 ha have been identified and mapped at Jandakot Airport (Glevan Consulting, 2018), and these are mostly associated with *Melaleuca preissiana*/dampland areas (see Figures 1, 2 and 3). Jandakot Airport contains regionally significant bushland, which includes at least one declared rare flora species (*Caladenia huegelii*), and provides habitat for one rare fauna species (Carnaby's Black-Cockatoo) and other priority species (Western Brush Wallaby and Quenda). JAH is committed to protecting these areas by implementing the actions described in this Dieback Management Plan.

Armillaria luteobubalina (Honey Fungus) has also previously been identified at Jandakot Airport. Honey Fungus is a mushroom producing fungus which is probably native to Western Australia, but which also infects the roots of many native plants leading to plant death. Honey Fungus can be spread by soil, water and air which makes it more difficult to manage than *P. cinnamomi* (Glevan Consulting, 2000).

There are also a number of other *Phytophthora* species which can lead to dieback, however *P. cinnamomi* is the most common and virulent species in Western Australia (Dieback Working Group, 2005). These other *Phytophthora* species are detected through the same process (field interpretation and laboratory analysis of soil and plant tissue) used to confirm the presence of *P. cinnamomi*.

The impact of *Phytophthora* species other than *P. cinnamomi* can vary considerably from site to site, but is typically much lower than that of *P. cinnamomi*. Management of other *Phytophthora* species is normally considered on a case by case basis and is largely dependent on the impact/threat level present in each case. If they are to be managed, then in general, they are managed in the same way as *P. cinnamomi*.

P. nicotianae was identified within a section of highly disturbed remnant vegetation (maintained as an amenity landscaped garden bed) near the JAH Administration building during the 2011 assessment, however given the already degraded state of the vegetation, the threat posed by the pathogen is thought to be minimal. In 2018, *P. elongata* and *P. palmivora* were detected in a drainage basin adjacent to Mustang Road.

2 Management

As previously stated, dieback infested areas cannot be cured and so the main management focus is to minimise its spread. The proposed management measures to be implemented at Jandakot Airport are detailed in the following sections.

Effective management of dieback spread is assisted by identifying areas of high conservation or those which are vulnerable to spread. JAH has identified the following as its priority areas for dieback management;

1. Conservation Precincts 1A and 1B - Areas containing the Endangered / Declared Rare Flora species *Caladenia huegelii*
2. Conservation precincts 2A and 2B
3. Dieback infested areas within bushland scheduled for clearing and development.

2.1 Dieback Treatment

2.1.1 <u>Phosphite Application</u>

Phosphite (phosphonate) treatment has been identified as successful in boosting the defence mechanisms of dieback susceptible plants and minimising the spread of dieback (Dieback Working Group, 2005). Phosphite can be applied by injection directly into susceptible tree species, or by aerial or ground based spraying. Phosphite is taken up by the leaves or roots of the plant and accumulated in the plant's tissue (Dieback Working Group, 2005).

JAH has previously undertaken aerial phosphite spraying, and this treatment method was last performed in 2008. However, aerial spraying of large areas is no longer considered to be an appropriate method given the urbanisation of the Jandakot region (i.e. due to contamination/nuisance potential for neighbours). Given the low probability of new infestations appearing, the low rates of disease spread associated with the existing infestations, and the small size of the dieback infested areas, aerial spraying is not a cost effective method.

Instead, JAH will use a combination of ground-based spraying (for small understorey species) and trunk injection (for plants with a stem diameter of 10cm or greater). The exact methodology and concentrations used will be determined by the expert contractor engaged to undertake the treatment in-line with the most up-to-date advice issued by relevant dieback organisations, such as the Dieback Working Group or the Department of Biodiversity, Conservation and Attractions (DBCA).

Treatment will take place during dry weather (preferably autumn) at three year intervals.

JAH has undertaken phosphite treatment of the mapped disease edges in 2012/13, 2015 and 2018 following completion of triennial dieback assessment and mapping.

2.2 Dieback Prevention and Containment

2.2.1 <u>Access</u>

Restricting access to dieback areas, and particularly across dieback category boundaries, is the most effective method to minimise dieback spread. Much of Jandakot Airport is surrounded by a chain mesh security fence which minimises unauthorised access to bushland areas by trail bikes and the like. In addition, there are numerous internal and airside security fences.

- Precinct 1A (boundaries as detailed within Figure 1 and Master Plan 2009) is fully fenced.

- Precinct 1B (boundaries as detailed within Figure 1 and Master Plan 2009) is fenced along all boundaries and isolated from operational airside areas.
- Precinct 2A is fences along all boundaries and includes 'wallaby gates' to facilitate fauna corridors.
- Precinct 2B is located within the secured 'Airside' area.

Airside security fences and fences adjoining airside areas are inspected daily. Other fences are inspected, at a minimum, weekly.

Limestone and other suitable track hardening materials have been laid over parts of the airport perimeter road to ensure tracks are traversable and provide a barrier across dieback category boundaries. This enables emergency response access and fence inspections to occur without fear of spreading dieback. Access to other sand tracks and firebreaks is restricted to JAH personnel and approved contractors (e.g. weed sprayers and wildlife consultants).

Should dieback monitoring indicate that the dieback front is advancing significantly greater than expected (as defined by the consultant within the triennial assessment report), JAH will consider hardening existing access tracks to act as a barrier across dieback category boundaries. However, as the 2014 and 2017 dieback assessments concluded that the disease distribution was almost identical to the 2011 survey, it is unlikely that track hardening for dieback containment will be required in the near future. The only exception is the small new infestation within Precinct 1B, an area of approximately 1.8 ha. The track along which the infestation occurs has been is rarely utilised, so JAH is unsure how or when the infestation could have been introduced (or spread from the infestation 150m to the north). Given that access along the track is not essential (there are alternative routes) JAH has taken the approach to restrict access except when it is essential (and only in fine weather when soils are dry). Should there be a demand to access the track on a regular basis (including in wet weather), JAH will install a limestone 'bridge' to traverse the location.

Dieback infested areas are signposted as a reminder to vehicles and pedestrians to keep away, unless access into these areas is necessary and undertaken in an approved manner. All vehicle entry and exits points to dieback infested areas as well as tracks adjacent to infested areas are appropriately signposted. JAH will inspect signs annually. Apart from the new infestation in Precinct 1B, the 2017 assessment found no evidence of the pathogen being spread by vehicles.

Pedestrian access into Conservation Precincts and dieback infested areas is restricted to management activities such as fauna surveys, weed control, etc. This allows for controls to be specified, such as restricting access during wet weather, when there is the greatest risk of dieback spread from footwear.

JAH will continue to implement these access restriction measures.

Access across dieback category boundaries by wallabies and other animals is not currently restricted at Jandakot Airport. While macropods are believed to be responsible for spreading the disease in other locations, it is thought that macropods do not represent a significant risk in relation to disease spread within Jandakot Airport. The 2014 assessment found no evidence of the pathogen being spread by wildlife.

2.2.2 Construction/Earthmoving

If not managed correctly, construction or earthmoving activities which necessitate crossing dieback category boundaries can spread dieback through the movement of infested soil or plant material or via infested soil attached to vehicles and machinery.

A Construction Environmental Management Plan (CEMP) is developed for all construction and earthmoving activities. Where dieback management activities are identified as a high risk and not adequately addressed within the CEMP, the JAH EM will require the contractor to develop a project-specific Dieback Management Plan as part of the Works Permit conditions.

CEMPs and/or project-specific DMPs will be consistent with the JAH Contractor Dieback Hygiene Policy and Guidelines (Attachment 1).

2.2.3 Drainage

Water can easily spread dieback via surface or groundwater flows. There is no standing water at Jandakot Airport, although there are a number of areas which have been identified as damplands (see Figure 3). Stormwater flows are minimal due to the highly free-draining and sandy soils present.

Drainage from developed areas is described in detail within Maser Plan 2014 and the Jandakot Airport Local Water Management Strategy (Essential Environmental 2015). The majority of stormwater drainage basins on the airport are located within cleared and developed areas well away from Conservation Precincts. There is one artificial infiltration basin in Conservation Precinct 1B which receives stormwater from areas within the older airside developments of the airport. Stormwater previously infiltrated across a wide area until the drainage was redesigned in 2005/06, resulting in stormwater being confined to the Precinct 1B Mustang Road verge. Despite the previous basin area being identified as "completely degraded" (as per the Bush Forever scale) in a 2005 vegetation survey (Cardno BSD, 2005), more recent surveys (Ecoscape, 2016) have defined this area as "good" to "very good". This is due to a significant increase in vegetation biomass within the basin since 2005. The basin has been mapped as dieback uninfested (Glevan Consulting 2018), but it is at high risk of becoming infested in the future as it is directly adjacent to a dieback infested area.

Most of the dieback infested sites at Jandakot Airport are associated with damplands or low points across the airport. This means that stormwater runoff would tend to run towards these areas, thereby minimising dieback spread away from these areas. JAH will ensure that there is no managed stormwater discharge from dieback infested or uninterpretable areas into uninfested areas.

The groundwater at Jandakot Airport flows in an approximately north to north-westerly direction. This means that areas north to north-west of dieback infested areas are high risk areas which may be subject to natural dieback spread via the groundwater. These dieback 'fronts' are routinely targeted during triennial phosphite treatments.

2.2.4 Landscaping and Revegetation

JAH regularly undertakes landscaping in development areas and occasionally undertakes revegetation projects in Conservation Precincts. These need to be managed carefully to minimise dieback spread and ensure successful growth of plants.

The need to undertake rehabilitation or revegetation within the Conservation Precincts of Jandakot Airport can be triggered by:

- Bushfires
- Impacts of weeds on vegetation condition not successfully managed by weed control
- Impacts of dieback on vegetation condition not successfully managed by phosphite and other dieback management measures
- The closure of surplus or non-essential firebreaks and access tracks and
- Verge impacts from the construction of new roads as detailed in Master Plan 2014.

No areas within the Jandakot Airport Conservation Precincts are currently identified as requiring rehabilitation or revegetation. However, in the event that revegetation is required to be undertaken at some future point, the Rehabilitation and Revegetation Guidelines (CMP Appendix D) have been developed to assist in planning.

Sourcing Seed and Plants

It is JAH policy that all revegetation in Conservation Area utilise only provenance seeds where possible and plant species indigenous to the site.

All landscaping in developed areas should be consistent with the Jandakot Airport Landscape Design Guidelines. Landscaping works should consist primarily of species indigenous to the area, with other water efficient native species allowed to supplement.

JAH has limited capacity to propagate plants from seed or cuttings onsite, and the majority of the plants using in landscaping and revegetation will be propagated offsite. Plants grown offsite are to be purchased from NIASA (Nursery Industry Accreditation Scheme Australia) or other appropriately accredited nurseries, to ensure that appropriate dieback hygiene measures have been implemented and minimise the risk of introducing further dieback infections onto Jandakot Airport.

Transplants should not be collected from dieback infested areas as the risk of spreading dieback into uninfested areas is too great. Seed can be collected from dieback infested areas as long as appropriate dieback clean-down procedures are implemented for all shoes, vehicles and tools.

Revegetation in Dieback and High Risk Areas

In dieback areas, only dieback resistant species (See Attachment 2) should be planted. In areas adjacent to dieback infestations or high risk areas for dieback spread (e.g. areas subject to significant earthmoving), dieback resistant species should be planted.

When the condition of dieback infested areas has declined to the point of requiring revegetation, it can be difficult to maintain the area's original vegetation type. Shearer and Hill (1989) observed that in Banksia woodlands of the Bassendean Dune system of the Swan Coastal Plain, most of the dominants and many understorey species are susceptible to *P. cinnamomi. Banksia attenuata*, *B. ilicifolia* and *B. menziesii* are commonly lost from communities, leaving scattered trees of *Eucalyptus todtiana* (Prickly bark) and *Nuytsia floribunda* (W.A Christmas tree), both of which are largely resistant to infection. These species, along with strains of dieback-resistant jarrah identified from areas in the state's south-west, will be considered where there has been significant overstorey decline.

Seedlings are known to be particularly susceptible to death from dieback, even if they are not of a dieback susceptible species. In dieback infested areas, it may be appropriate to revegetate using direct seeding instead of planting seedlings.

Topsoil and Mulch

Topsoil and mulch may be collected from cleared areas for reuse in landscaping as long as materials from dieback infested areas are kept within the infestation boundaries.

2.2.5 Bushfire Management

JAH has in place a Bushfire Management Plan which outlines the planning for and response to fire incidents at Jandakot Airport. Fire access is provided as described in Section 2.2.1. Current dieback mapping is included in the Bushfire Management Plan, along with the following guidelines to address dieback spread during fire response and recovery:

- Try to keep all machinery operations in one area, either in dieback infested or uninfested areas
- Minimise the entry of machinery or vehicles into bushland areas, or keep to marked access tracks
- During earthworks take care not to push dieback infested soil into uninfested areas
- Avoid areas where soil can be picked up e.g. muddy or wet areas, or clean soil off vehicles.

3 Research and Industry Consultation

JAH recognises that research is an important part in improving dieback identification and management measures. In previous years JAH has supported a number of dieback related projects undertaken by Murdoch University students and has been involved with the Dieback Working Group (DWG). JAH will, wherever practicably possible, support future dieback research proposals by facilitating access to dieback infested areas on Jandakot Airport.

There are a number of Phytophthora dieback organisations in Western Australia, including the DWG, the Dieback Consultative Council (DCC), Dieback Response Group (DRG) and the Centre for Phytophthora Science & Management (CPSM). JAH will generally seek expert advice direct from dieback consultants. However, where necessary, JAH will consult with these organisations and dieback professionals to ensure that the most appropriate prevention and treatment methods are being applied at Jandakot Airport.

4 Identification & Monitoring

Dieback infestation is usually identified via two methods – interpretation and laboratory testing. During dieback surveys, all bushland areas are assigned one of the following categories:

- Dieback infested – dieback is present
- Dieback uninfested – dieback does not appear to be present at the time of the survey
- Dieback uninterpretable – the presence or absence of dieback cannot be determined as the bushland is too degraded or does not contain plant species which are susceptible to dieback.

These categories are used to determine appropriate management measures in each area.

4.1 Interpretation

Dieback interpretation is undertaken by an appropriately qualified dieback interpreter who is accredited by DBCA. Reassessment is recommended every three years.

Dieback interpretation involves a visual assessment of the plant species present in a given area. Deaths of susceptible species and their approximate age are noted as well as the general health of non-susceptible species. Deaths of a number of different aged susceptible species may indicate the presence of dieback. Deaths of non-susceptible species may indicate an alternative cause of death such as drought, fire or other disturbance (Glevan Consulting 2005, 2012, 2015, 2018).

A combination of interpretation and laboratory testing methods give the most reliable method of dieback identification.

The first dieback interpretation undertaken at Jandakot Airport was in completed in November 2000 (Glevan Consulting 2000). Reassessments were undertaken in November 2005 (Glevan Consulting 2005), November 2011 (Glevan Consulting 2012), spring 2014 (Glevan Consulting 2015) and most recently spring 2017 (Glevan Consulting 2018). The results of the 2017 assessment (which was amended in 2018 to include additional testing relating to the Mustang Road basin) are shown in Figure 1. Areas shown in red are dieback infested, and all other bushland areas are considered to be dieback 'uninfested'.

With the exception of an small additional infestation discussed in Section 2.2.1, the 2017 assessment showed that dieback spread was minimal over the three year period from 2014 to 2017. This is likely due to the sandy soils present at the airport which allow free drainage, and also the management measures which were initially implemented after the

2000 survey. JAH propose to undertake dieback reassessment at Jandakot Airport every three years. The next dieback survey will be conducted in 2020.

4.2 Laboratory Testing

Laboratory testing is usually undertaken in conjunction with dieback interpretation and can consist of soil and/or plant tissue samples collected from areas interpreted as dieback infested. There are two main methods of laboratory testing in use – baiting and DNA analysis.

Baiting involves placing the soil or tissue sample and a germinated seed under laboratory conditions which promote the growth of *P. cinnamomi*. The samples are left for a period of up to two weeks and the seedling assessed for *P. cinnamomi* infection (Glevan Consulting, 2005).

DNA analysis is a relatively new technique which is quicker and more accurate, however it is also more expensive. Medical technology is used to detect the DNA of *P. cinnamomi* in soil or plant tissue samples. This method detects *P. cinnamomi* even if it is in a dormant state, which the baiting method may not detect (Murdoch University, 2006).

In both testing methods it should be noted that a negative result does not mean that an area is free of dieback. This is because relatively small amounts of soil and tissue are collected for samples and *P. cinnamomi* is not evenly spread within infested soil. Anecdotal evidence suggests that tissue samples collected from suspected dieback infected plants have a higher rate of positive *P. cinnamomi* detection.

Soil and tissue samples were collected in both the 2000 and 2005 surveys and sampled using the baiting method. Five of twelve samples collected in 2000 were confirmed to contain *P. cinnamomi*, while only one of thirteen samples collected in 2005 tested positive for the presence of *P. cinnamomi*.

During the 2011 assessment, 22 samples were taken. Twenty one of the samples were taken outside of the known infestations, and all tested negative for the presence of *P. cinnamomi.* The other sample was taken purely as a 'control' from a known infestation where the presence of *P. cinnamomi* was confirmed during the 2005 assessment. Sampling of known infestations is not common practice, but in areas where pathogen dormancy may be a factor, it assists in confirming that the pathogen is being detected by the laboratory process, and that 'false negative' results are not being recorded. *P. cinnamomi* was recovered from the control sample, providing evidence that the pathogen will be recovered if present, and that false negative sample results are not being recorded.

During the 2014 assessment, 18 samples were taken outside of the 2011 dieback boundaries and one control sample was taken from a dieback area. No new Phytophthora Dieback infestations were identified and only minor adjustments were made to the boundaries of the five existing infestations. Minimal disease expression was evident during the assessment, and the lack of expression is most likely the result of ongoing phosphite treatment.

During the 2017 assessment 8 samples were initially taken, with only one sample, associated with the new Precinct 1B infestation, testing positive for *P. cinnamomi*. An additional two samples taken after the initial assessment, in response to suspicious tree deaths in the Mustang Road drainage basin reported by JAH staff, tested positive for *P. elongata* and *P. palmivora*.

In addition to the scheduled site-wide dieback assessments, specific investigations have been conducted as required in response to dieback concerns. In December 2006 Murdoch University's Centre for Phytophthora Science and Management conducted DNA analysis on ten soil and one plant tissue samples collected from an uninterpretable area within the Stage 1 commercial area. The plant tissue sample tested positive but all the soil samples tested negative for *P. cinnamomi*. In 2008, 5 soil and tissue samples were taken from the Compass Road development area by Glevan Consulting. *P. cinnamomi* was not recovered from the vegetation assessed.

4.3 Bushland Condition

There appears to be a relatively strong correlation between bushland condition ratings (Ecoscape 2011, 2017) and the presence of *P. cinnamomi.* While the bushland condition within some of the infested sites is not markedly different from the uninfested areas, the vegetation associated with the infestations in Precincts 2A exhibited slightly higher levels of disturbance than the surrounding uninfested areas (see Figure 4). Bushland Condition thresholds for triggering further management intervention (including rehabilitation and revegetation) are addressed in the Weed Management Plan (Appendix B).

4.4 Ongoing Monitoring

JAH will monitor the effectiveness of this Dieback Management Plan in minimising the spread of dieback via the proposed triennial surveys utilising interpretation and/or laboratory assessment. The methods used (including laboratory testing) will be based on the advice of the expert consultant contracted to undertake the dieback interpretation.

Ongoing bushland condition monitoring results will also be compared with dieback mapping as part of triennial dieback interpretation to determine any correlation between the two.

In addition, opportunistic observations throughout the conservation precincts can be made on a regular basis by the JAH Environment Manager and by other staff whilst undertaking works within or adjacent to Conservation Precincts. Suspected new infestations or suspected rapid spread of existing infestations will be entered into the JAH Safety Management System database as an Environment Incident and actioned accordingly. It is via this method that the *P. elongata* and *P. palmivora* in the Mustang Road drainage basin were identified in 2018.

5 Communication

JAH communicates the contents of this Dieback Management Plan to its stakeholders via the following methods:

- Dieback infested areas are identified via signage (see Table 1, DMP4)
- Publication of the DMP on the JAH website where it is accessible to all staff, tenants, contractors and members of the public
- Inclusion of relevant dieback management information within CEMP templates and Operational Environmental Management Plan (OEMP) templates
- Inclusion of dieback management information in relevant site inductions.

6 Reporting Requirements

Reporting against actions described in this plan will be included within the Jandakot Airport Annual Environment Report (AER). In line with the *Airports (Environment Protection) Regulations 1997*, the AER will be submitted to the Department of Infrastructure, Regional Development and Cities (DIRDC) by 28th October each year. A copy of the report will be provided to the Department of Environment and Energy (DOEE) by 28th October each year.

Reporting relevant to the DMP will also be included in an annual compliance report, as required under Condition 16 of EPBC 2009/4796, and published on the JAH website by 28th October each year.

7 Review and Amendment of Dieback Management Plan

As with the overarching Conservation Management Plan, the Dieback Management Plan will require regular review and amendment in order to meet practical requirements on site as changing circumstances demand.

Once amended, the Dieback Management Plan will be submitted to DoEE for the Minister's approval (ref Conditions 6 and 12 of EPBC 2009/4796 approval). The approved management plan will be implemented.

The JAH Environment Manager will review this Dieback Management Plan every three years to ensure that it is up to date and its control measures are effective. This review is planned to occur following the triennial dieback assessment, which will determine whether existing management measures have been effective in halting, or at least slowing, the spread of the disease. If required, new or amended management measures will be identified and included within the Dieback Management Plan.

However, if new relevant information comes to light before the three-yearly review is undertaken (e.g. a new infestation is identified, new or improved treatment methods are discovered etc.), a review of the Dieback Management Plan will occur before the scheduled action.

8 Summary of Actions

The Table below contains a list of summary actions relating to the Jandakot Airport Dieback Management Plan.

Table 1. Dieback Management Plan Summary of Actions.			
Action		**Responsibility**	**Timing**
Dieback Treatment			
DMP1	Undertake phosphite (or other appropriate) treatment of dieback infested areas utilising methods recommended by dieback experts (refer to DMP14).	JAH EM	Triennially (next due 2021).
Dieback Management – Prevention and Containment			
Access			
DMP2	Inspect airside security fencing daily (other fences weekly) and repair immediately if necessary.	JAH ASOs (airside) and JAH Senior Groundsman (landside).	Daily/weekly (dependent on location).
DMP3	Investigate the feasibility of hardening existing access tracks to act as a barrier across the relevant dieback category boundaries, where the dieback front is advancing significantly* and additional control actions are required (as determined via triennial assessments). *Significantly, as defined by the dieback consultant undertaking assessment.	JAH EM in consultation with JAH Operations Manager and JAH Facilities Manager.	Feasibility investigation to be completed within 6 months of the triennial assessment that initially identified the issue.
DMP4	Plan and implement works recommended within the feasibility investigation (DMP3).	JAH EM in consultation with JAH Operations Manager and JAH Facilities Manager.	Timing as recommended within feasibility investigation.
DMP5	Install (or if appropriate, relocate) dieback awareness/warning signs at all entry/exit tracks to infested areas and along adjacent tracks when a new dieback infestation is detected or an existing dieback infestation boundary has increased beyond the existing signage.	JAH EM.	Within 3 months of a new infestation being detected or an existing dieback front assessed as having increased beyond the existing signage.
DMP6	Inspect dieback signage and replaced/update if required.	JAH EM.	Annually (July each year).
Construction and Earthmoving			
DMP7	Prepare a JAH-approved CEMP or project-specific DMP for all construction and earthmoving activities. CEMPs and project-specific DMPs will be consistent with the JAH Contractor Dieback Hygiene Policy and Guidelines (Attachment 1).	JAH EM in liaison with contractors.	Prior to works commencing.
DMP8	Implement the JAH-approved CEMP or project-specific DMP for all construction and earthmoving activities prepared under DMP7.	Construction and earthmoving contractors	During construction and earthmoving works.
Drainage			

Table 1. Dieback Management Plan Summary of Actions.			
Action		**Responsibility**	**Timing**
DMP9	Design new developments/drainage works to avoid stormwater discharge from dieback infested or uninterpretable areas into uninfested bushland areas.	JAH EM in consultation with contractors and JAH staff.	Where relevant, to be included in CEMP prior to works commencing.
Landscaping and Revegetation			
DMP10	Revegetation shall be consistent with CMP Appendix D Bushland Rehabilitation and Revegetation Guidelines.	JAH EM	At all times
DMP11	Landscaping in developed areas shall be consistent with the Jandakot Airport Landscape Design Guidelines.	JAH EM	At all times
Research and Industry Consultation			
DMP12	Assess research proposals requesting access to Jandakot Airport dieback infestations in regards to feasibility, safety, relevance, impost on JAH resources, etc.	JAH EM	Timing of assessment to be agreed upon between JAH and relevant research institution requesting the access.
DMP13	Facilitate access by researchers to Jandakot Airport dieback infestations (subject to assessment and approval as described in DMP12).	JAH EM	Following receipt of request from a research institution or government agency.
DMP14	Consult with dieback organisations and/or professionals to ensure that the most appropriate prevention and treatment methods are being applied at Jandakot Airport.	JAH EM	Prior to undertaking phosphite (or other appropriate) treatment and during triennial review of the DMP.
Monitoring and Contingency Requirements			
DMP15	Undertake dieback reassessment.	JAH EM.	Triennially (next due 2020).
DMP16	Enter suspected new infestations or suspected rapid spread of existing infestations observed in between triennial dieback assessments into the JAH Safety Management System database as an Environment Incident.	JAH EM	Within 7 days of a suspected new infestation or rapid spread of an existing infestation being reported.
DMP17	Implement actions identified from the Environment Incident investigation process commenced under DMP16	JAH EM	In accordance with timing identified under Environment Incident investigation process.
Communication			
DMP18	Publish the amended DMP on the JAH website.	JAH EM	Within 4 weeks of DMP review completion (or, if applicable, within

Table 1. Dieback Management Plan Summary of Actions.			
Action		**Responsibility**	**Timing**
			one month of endorsement by relevant government regulator).
DMP19	Update the JAH CEMP and tenant OEMP templates with relevant dieback management information (only required if information within current CEMP and OEMP templates is not consistent with the current DMP).	JAH EM	Within 3 months of DMP review completion (or, if applicable, within one month of endorsement by relevant government regulator).
DMP20	Ensure all CEMPs and OEMPs submitted to JAH for review and endorsement adequately addresses dieback management, relevant to the activities proposed to be undertaken.	JAH EM	Prior to endorsing CEMP or OEMP.
DMP21	Include relevant dieback management information within inductions or written instructions for contractors working across dieback boundaries (e.g. weed spraying contractors).	JAH EM	Ongoing – Inductions to be completed before works commence.
Reporting Requirements			
DMP22	Report against actions of the DMP within the Jandakot Airport Annual Environment Report (AER) and provide copies to DIRDC and DOEE.	JAH EM	28 October Annually.
DMP23	Report against actions of the DMP within an Annual Compliance Report (ref Condition 16 of EPBC 2009/4796) and publish on the JAH website.	JAH EM	28 October Annually.
Review and Amendment of DMP			
DMP24	Review and update (if required) DMP following triennial dieback survey.	JAH EM	June 2021, then Triennially.

9 Glossary

AER	Annual Environment Report
ASO	Airport Services Officer
CEMP	Construction Environmental Management Plan
CMP	Conservation Management Plan
DBCA	Department of Biodiversity, Conservation and Attractions (Formerly DPAW, DEC and CALM).
DEC	Department of Environment and Conservation. On 1 July 2013 the Department of Environment and Conservation separated into two agencies, the Department of Parks and Wildlife (DPAW – now DBCA) and the Department of Environment Regulation (DER – now DWER).
DEWHA	Department of Environment, Water, Heritage and the Arts (now DOEE)
DIRDC	Department of Infrastructure, Regional Development and Cities (previously DIRD and DIT)
DIT	Department of Infrastructure and Transport (now DIRDC)
DMP	Dieback Management Plan
DOEE	Department of the Environment and Energy (previously DOE, DEWHA and DSEWPaC)
DPAW	Department of Parks and Wildlife (formerly DEC). On 1 July 2017 DPAW was merged with three other Departments to become DBCA.
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Previously DEWHA and now DOEE)
EPBC	Environmental Protection and Biodiversity Conservation Act 1999
JAH	Jandakot Airport Holdings
JAH EM	Jandakot Airport Holdings Environment Manager
OEMP	Operational Environmental Management Plan
OM	Operations Manager
SMS	Safety Management System (an access database used by JAH to record all Incidents).

10 References

Cardno BSD (2005), *Jandakot Airport Land Caladenia huegelii (Declared Rare Flora) Search*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

DEC (1999) *Phytophthora cinnamomi and the disease caused by it. Volume III – Phosphite Operations Guidelines.* Department of Environment and Conservation.

Dieback Working Group (2005), *Managing Phytophthora Dieback in Bushland*, published by WWF Australia.

Ecoscape (2011). *Jandakot Airport Weed Assessment and Bushland Condition,* unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Ecoscape (2017), *Jandakot Airport Weed Survey and Bushland Condition Assessment.* Unpublished report Prepared for Jandakot Airport Holdings Pty Ltd.

Essential Environmental (2015), *Jandakot Airport Local Water Management Strategy*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Glevan Consulting (2000), *Jandakot Airport Interpretation for Phytophthora (Dieback) Species*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Glevan Consulting (2005), *Jandakot Airport Dieback Assessment*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Glevan Consulting (2012), *Jandakot Airport Dieback Assessment*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Glevan Consulting (2015), *Jandakot Airport Triennial Phytophthora Dieback occurrence assessment*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Glevan Consulting (2018), *Jandakot Airport Triennial Phytophthora Dieback occurrence assessment*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Groves, E., Hardy, G. & McComb, J. (date unknown), *Western Australian Natives Resistant to Phytophthora cinnamomi*, unpublished report prepared by for Murdoch University.

Groves, E., Hardy, G. & McComb, J. (date unknown), *Western Australian Natives Susceptible to Phytophthora cinnamomi*, unpublished report prepared by for Murdoch University.

Murdoch University Centre for Phytophthora Science and Management Diagnostic Facility (Murdoch University) (2006), *Development of a Soil Sampling Regime for Jandakot Airport Holdings Pty Ltd*, unpublished report prepared for Jandakot Airport Holdings Pty Ltd.

Shearer BL, Hill TC (1989) Diseases of *Banksia* woodlands on the Bassendean and Spearwood Dune systems. *Journal of the Royal Society of Western Australia* **71**, 113–114.

FIGURE 1. JANDAKOT AIRPORT PHYTOPHTHORA CINNAMOMI OCCURRENCE 2017

Note: Precinct boundaries utilised in the 2014 assessment were consistent with the previous assessment and Master Plan 2009, noting Master Plan 2014 (detailing the revised boundary between Precinct 1A and 1B).

FIGURE 2. VEGETATION COMMUNITIES MAPPING 2016

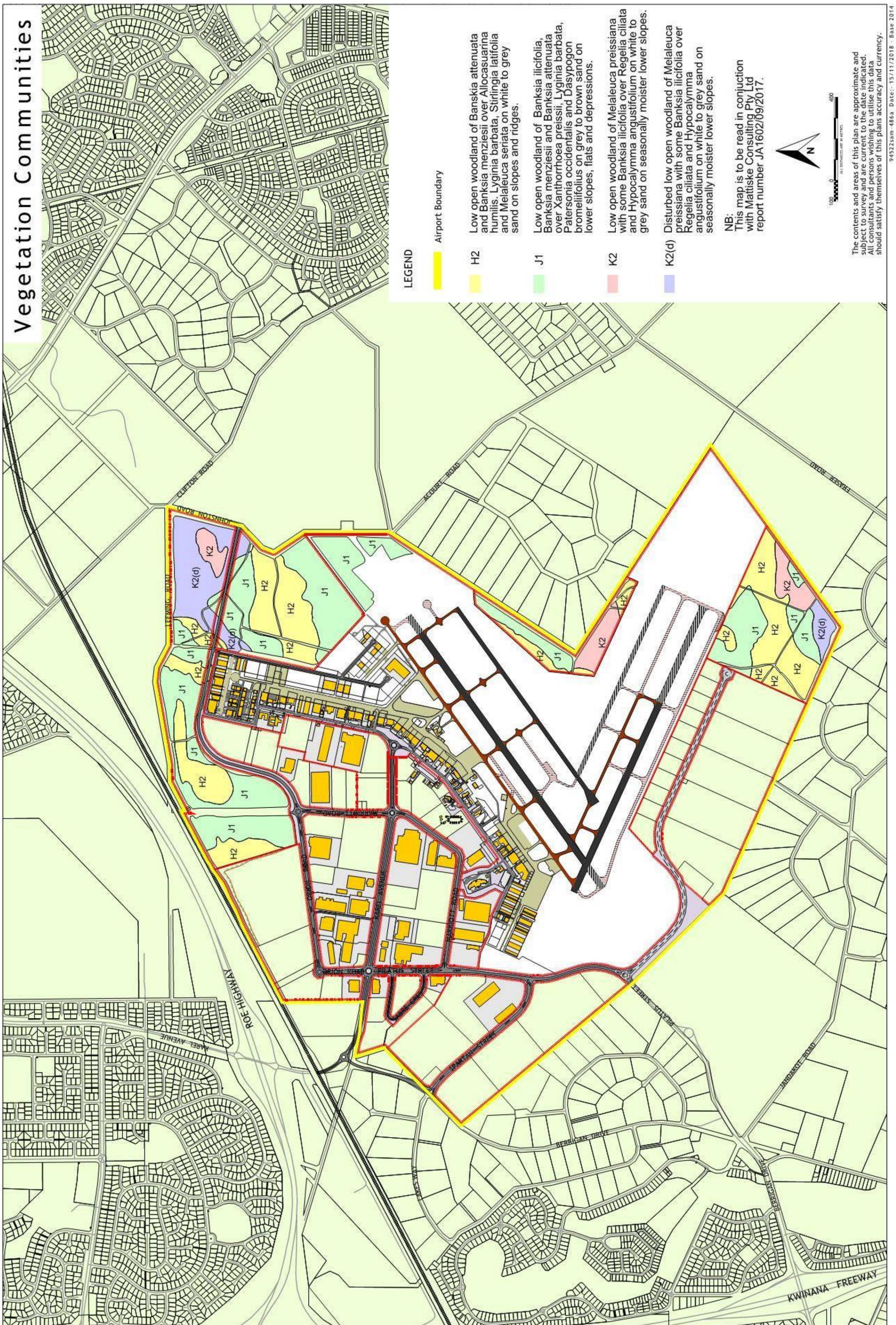
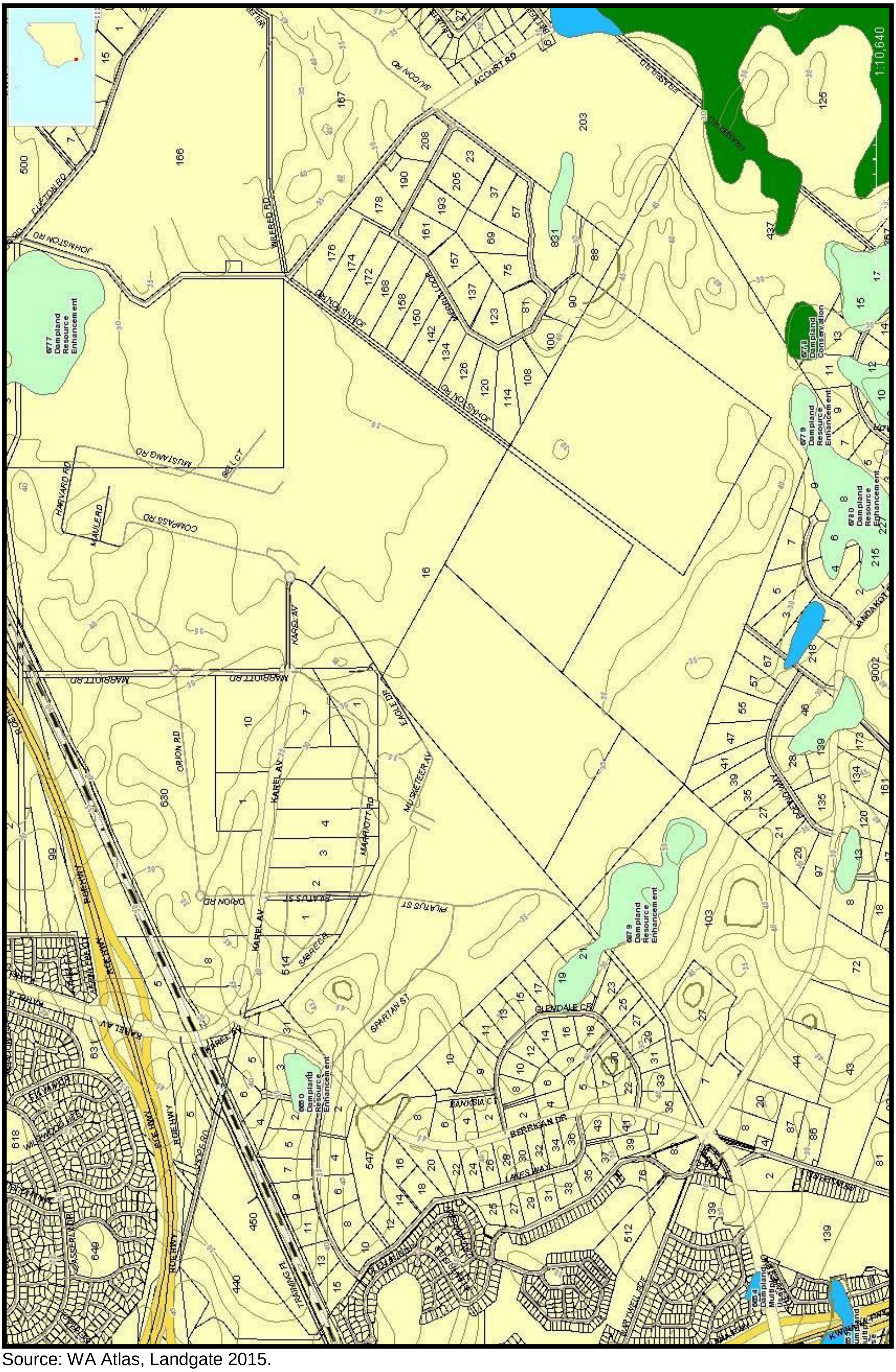
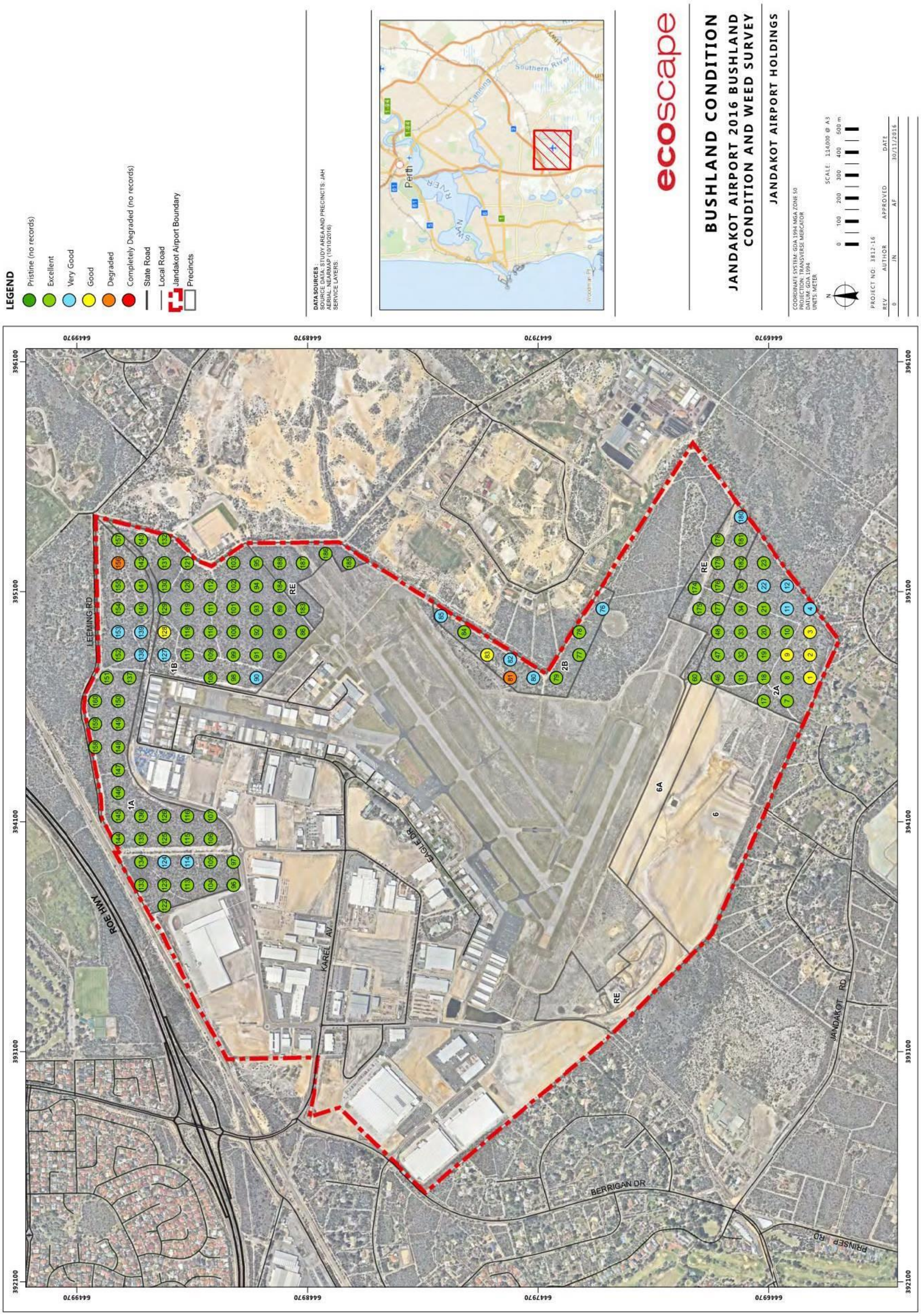


FIGURE 3. DAMPLANDS



Source: WA Atlas, Landgate 2015.

FIGURE 4. BUSHLAND CONDITION MAPPING 2016



Attachment 1. JAH Contractor Dieback Hygiene Policy and Guidelines

DIEBACK HYGIENE POLICY

The objective of dieback management is to protect all vegetation within Jandakot Airport by minimizing the risk of introducing and spreading *Phytopthora cinnamomi.*

BACKGROUND

Phytophthora cinnamomi, also known as 'dieback' or 'jarrah dieback', is a soil-borne pathogen that kills a wide range of plant species in the southwest of WA by destroying their root systems. *P. cinnamomi* causes disease in a range of vegetation communities and affects a diverse range of plants. Native plant communities particularly at risk from *P. cinnamomi* include those dominated with Banksia species – such as the vegetation at Jandakot Airport.

A number of known dieback infested areas exist at Jandakot Airport. These areas have been mapped and Jandakot Airport Holdings aims to ensure that dieback is not spread via unhygienic practices from these areas into uninfested areas either elsewhere on the Airport estate or offsite.

Similarly, Jandakot Airport Holdings aims to ensure that unhygienic practices do not result in new dieback infestations being introduced to the airport from off-site sources.

SPREAD

Dieback can spread:

- by water (drainage, irrigation or groundwater flow)
- in soil (transported by bulk soil deliveries, containers, shoes, tools, vehicles and other equipment)
- by the movement of infected plants and plant materials.

Natural spread dieback is generally slow and is achieved through movement of the pathogen along plant root systems or, on a faster scale, through the movement of microscopic spores in surface and sub-surface water flows, and by animals.

Human-related vectors can disperse the pathogen much more quickly and are believed to be the primary reason for the widespread distribution of dieback in WA. <u>Any activity that transfers soil and plant material (either intentionally on non-intentionally) from one location to another is a potential vector.</u> Examples of activities that can contribute to the spread of the pathogen include:

- road construction and civil works
- earth moving
- vegetation clearing
- revegetation activities
- off-road/four-wheel driving.

CONTRACTOR CONSTRUCTION/DIEBACK MANAGEMENT PLANS

In order to ensure that appropriate hygiene controls are in place to prevent dieback spread, contractors undertaking activities that can contribute to the spread of dieback will need to address dieback management within a project-specific Construction Environment Management Plan (CEMP) or Dieback Management Plan (DMP).

BASIC DIEBACK HYGIENE MANAGEMENT MEASURES AND GUIDLEINES

- Where possible, schedule activities that involve soil disturbance for dry summer months (November – March) or dry conditions.
- Minimise soil disturbance – consider mowing, slashing or use herbicide, rather than ploughing and grading, whenever possible.
- When undertaking works across dieback category boundaries (i.e. in areas that include both infested and uninfested), where possible complete activities in the uninfested part of the bushland, before moving to the infested part of the bushland.
- In the uninfested parts of the estate/bushland:
  - Do not bring in soil/sand/gravel. If it is required, it should be obtained from certified phytophthora-free sources.
  - Landscape supplies should be sourced from either certified phytophthora-free sources or accredited Nursery Industry Association suppliers.
  - Prevent vehicles and machinery entering bushland. If they must enter, they must be free of soil and mud, and restricted to a hard, dry surface wherever possible.
  - Vehicles are to be cleaned off-site prior to initially accessing the airport for works. If vehicles temporarily leave site, they must be re-cleaned before returning unless they have remained on sealed roads in low-risk areas (e.g. trucks that make multiple daily journeys to cart sand from Jandakot airport development areas to off-site storage facilities).
  - Footwear to be free of mud and soil when entering bushland.
  - Any water used in earthworks etc. must be from approved sources (e.g. mains supply, approved bores etc.)
- In the infested parts of the estate/bushland
  - Prevent vehicles and machinery entering. If they must enter, restrict them to hard, dry surfaces and vehicles are to be free of soil and mud when exiting the infested bushland.
  - Do not remove soil/sand/gravel from the infested part of the bushland. If it must be removed, it must be placed at a site that is also infested with *P. cinnamomi* or managed in accordance with the approved CEMP or project-specific DMP.
  - Footwear must be free of mud and soil when exiting the bushland.

GUIDELINES FOR CLEANING EQUIPMENT AND VEHICLES

Cleaning will be easier and more effective if completed at a depot or designated cleaning area prior to accessing the airport. In instances where on-site cleaning must occur (e.g. prior to exiting dieback infested areas), the below guidelines are provided to assist in the development of a CEMP or project-specific DMP.

Field-based cleaning requires:

- A hard, well-drained surface (e.g. road or ramp) that is well away from native vegetation. Any wash-down effluent (water, mud and slurry) must be collected on-site and must not be allowed to drain into uninfested bushland.
- Minimise water use to remove soil and mud from equipment/vehicles. This can be achieved by preferentially dry cleaning techniques e.g. stiff brushes.

- Pay particular attention to mudflaps and tyres.
- Do not drive through effluent generated from cleaning when exiting the washdown facility.

Guidelines for cleaning footwear

- Try to remove mud and soil when it is dry. Remove as much mud and soil as possible with a stiff brush or stick and minimise the amount of water used.
- Collect all mud and soil removed and dispose of at a site that is infested with *P. cinnamomi*.

Guidelines for sterilising

Sterilisation of equipment, footwear and vehicle tyres can be used as an extra precaution. Sterilisation of nursery equipment using steam is common practice; however the use of steam is not practical in the field. The following sterilisation methods can be used in the field.

- Spray methylated spirits on small hand tools and footwear covering all surfaces and allowing a few minutes for it to soak into all soil material.
- Spray diluted bleach (sodium hypochlorite) onto equipment and footwear allowing a few minutes before rinsing the bleach off using water. Dilute bleach so that solution contains 1% active ingredient sodium hypochlorite. Be sure to follow any of the manufacturer's safety instructions provided on the bleach container.
- Phytoclean® or other effective disinfectants can be used in footbaths, washdown facilities and during the cleaning of equipment. See the manufacturer's details for directions.

Attachment 2 - Jandakot Airport Flora Species Dieback Susceptibility

S = Dieback Susceptible; R = Dieback Resistant

Acacia applanata		*Caladenia discoidea*		*Desmocladus asciculatus*	
Acacia huegelii	R	*Caladenia flava*		*Desmocladus fasciculatus*	R
Acacia pulchella	R	*Caladenia huegelii*		*Desmocladus flexuosus*	R
Acacia saligna	R	*Caladenia longicauda*		*Dianella revoluta*	S
Acacia stenoptera	S	*Caladenia paludosa*		*Dielsia stenostachya*	
Acacia willdenowiana		*Calectasia narragara*		*Diuris corymbosa*	
Actinotus glomeratus		*Calytrix angulata*		*Diuris emarginata*	
Adenanthos cygnorum	S	*Calytrix flavescens*	R	*Diuris laxiflora*	
Adenanthos obovatus	S	*Calytrix fraseri*	S	*Diuris longifolia*	
Allocasuarina fraseriana	S	*Calytrix strigosa*		*Drosera erythrorhiza*	R
Allocasuarina humilis	S	*Cassytha flava*	R	*Drosera glanduligera*	
Amphipogon laguroides		*Cassytha glabella*	R	*Drosera macrantha*	R
Amphipogon turbinates		*Cassytha racemosa*		*Drosera menziesii*	
Anigozanthos humilis		*Centrolepis aristata*		*Drosera paleacea*	
Anigozanthos manglesii	R	*Centrolepis drummondiana*		*Drosera pulchella*	
Aotus sp. procumbent		*Centrolepis humillima*		*Eremaea asterocarpa*	
Arnocrinum preissii		*Chamaescilla corymbosa*	R	*Eremaea pauciflora*	
Astartea fascicularis	R	*Chordifex microcodon*		*Eriachne sp.*	
Astartea scoparia		*Comesperma calymega*	R	*Eucalyptus gomphocephala*	R
Asteraceae sp.		*Conospermum stoechadis*	S	*Eucalyptus marginata*	S
Astroloma pallidum		*Conospermum triplinervium*	S	*Eucalyptus rudis*	R
Astroloma xerophyllum	S	*Conostephium minus*		*Eucalyptus todtiana*	S
Austrodanthonia occidentalis		*Conostephium pendulum*	S	*Euchilopsis linearis*	
Austrodanthonia pilosa		*Conostephium preisii*		*Euchiton sphaericus*	
Austrostipa compressa		*Conostylis aculeata*	R	*Eutaxia virgata*	
Austrostipa elegantissima	?	*Conostylis aurea*		*Gastrolobium capitatum*	
Baeckea camphorosmae	R	*Conostylis caricina*		*Gompholobium capitatum*	R
Banksia attenuata	S	*Conostylis juncea*		*Gompholobium confertum*	
Banksia dallanneyi	S	*Conostylis serrulata*	?	*Gompholobium scabrum*	
Banksia grandis	S	*Conostylis setigera*	R	*Gompholobium tomentosum*	R
Banksia ilicifolia	S	*Crassula colorata*		*Gonocarpus pithyoides*	
Banksia littoralis	S	*Croninia kingiana*		*Goodenia pulchella*	
Banksia menziesii	S	*Cryptostylis ovata*	R	*Haemodorum paniculatum*	R
Banksia nivea	S	*Cyanicula gemmata*		*Haemodorum spicatum*	
Baumea articulata		*Cyanicula sericea*		*Hardenbergia comptoniana*	R
Beaufortia elegans		*Cyathochaeta avenacea*	R	*Helichrysum leucopsideum*	
Beaufortia squarrosa		*Dampiera linearis*	R	*Hemiandra pungens*	R
Boronia busselliana		*Danthonia pilosa*		*Hensmania turbinata*	
Boronia crenulata	R	*Dasypogon bromeliifolius*	S	*Hibbertia aurea*	
Boronia fastigiata		*Daviesia gracilis*		*Hibbertia huegelii*	S
Boronia ramosa		*Daviesia incrassata*	S	*Hibbertia hypericoides*	S
Bossiaea eriocarpa	S	*Daviesia juncea*		*Hibbertia racemosa*	R
Brachyloma preissii		*Daviesia nudiflora*		*Hibbertia sericosepala*	
Burchardia congesta	R	*Daviesia physodes*	S	*Hibbertia subvaginata*	
Burchardia umbellata		*Daviesia triflora*		*Homalosciadium homalocarpum*	
Hovea trisperma	R	*Lomandra micrantha*		*Podotheca chrysantha*	

Hyalosperma cotula		*Lomandra nigricans*	R	*Poranthera microphylla*	
Hypocalymma angustifolium	R	*Lomandra odora*	S	*Prasophyllum parvifolium*	
Hypocalymma robustum	S	*Lomandra preissii*	R	*Prasophyllum sp.*	
Hypolaena exsulca		*Lomandra purpurea*		*Pterostylis pyramidalis*	
Hypolaena pubescens		*Lomandra suaveolans*		*Pterostylis recurva*	
Isolepis marginata		*Lomandra sp.*		*Pterostylis vittata*	
Jacksonia furcellata	S	*Lotus sp.*		*Pterostylis sp.*	
Jacksonia sternbergiana	S	*Loxocarya cinerea*	S	*Pultenaea reticulata*	
Juncus kraussii		*Lyginia barbata*		*Pyrorchis nigricans*	
Kennedia prostrata	R	*Lyginia imberbis*		*Quinetia urvillei*	
Kunzea ericifolia	S	*Lysinema ciliatum*	S	*Regelia ciliata*	
Kunzea glabrescens		*Lysinema elegans*		*Regleia inops*	
Lagenophora huegelii	R	*Macrozamia fraseri*		*Restio microcodon*	
Laxmannia ramosa		*Macrozamia riedlei*	S	*Rhodanthe sp*	
Laxmannia squarrosa		*Medicago sp.*		*Ricinocarpus glaucus*	
Lechenaultia biloba	R	*Melaleuca incana*		*Scaevola paludosa*	
Lechenaultia expansa		*Melaleuca preissiana*	R	*Scaevola repens*	
Lechenaultia floribunda		*Melaleuca scabra*	S	*Schoenus brevisetis*	
Lepidosperma angustatum		*Melaleuca seriata*		*Schoenus caespititius*	
Lepidosperma effusum		*Melaleuca systena*		*Schoenus curvifolius*	R
Lepidosperma longitudinale		*Melaleuca thymoides*	S	*Schoenus efoliatus*	
Lepidosperma pubisquameum		*Melaleuca viminea*		*Schoenus globifer*	
Lepidosperma scabrum	R	*Mesomelaena pseudostygia*		*Schoenus sp.*	
Lepidosperma squamatum	R	*Mesomelaena stygia*	R	*Scholtzia involucrata*	S
Lepidosperma tenue	R	*Mesomelaena tetragona*	R	*Senecio pinnatifolius*	
Leporella fimbriata	R	*Microtis media*		*Siloxerus humifusus*	
Leptocarpus canus		*Microtis sp.*		*Sowerbaea laxiflora*	
Leptocarpus tenax	R	*Millotia tenuifolia*	R	*Stackhousia monogyna*	
Leptomeria empetriformis		*Monotaxis grandiflora*		*Stirlingia latifolia*	S
Leptospermum erubescens	R	*Neurachne alopecuroidea*		*Stylidium brunonianum*	R
Lepyrodia muirii		*Nuytsia floribunda*	R	*Stylidium carnosum*	
Leucopogon australis	S	*Opercularia vaginata*	S	*Stylidium guttatum*	
Leucopogon conostephioides	S	*Patersonia occidentalis*	S	*Stylidium junceum*	S
Leucopogon insularis		*Pericalymma ellipticum*	S	*Stylidium piliferum*	R
Leucopogon nutans	S	*Persoonia saccata*	R	*Stylidium repens*	
Leucopogon oxycedrus	S	*Petrophile linearis*	S	*Stylidium schoenoides*	S
Leucopogon pendulus	R	*Philotheca spicata*		*Stylidium sp.*	
Leucopogon polymorphus	S	*Phlebocarya ciliata*	R	*Synaphea spinulosa*	
Leucopogon propinquus	S	*Phlebocarya filifolia*		*Synaphea sp.*	
Leucopogon pulchellus	S	*Phyllangium divergens*		*Tetratheca setigera*	S
Leucopogon racemulosus		*Phyllangium paradoxum*		*Thelymitra campanulata*	
Leucopogon sprengelioides		*Pimelea angustifolia*		*Thelymitra crinita*	
Leucopogon strictus		*Pimelea imbricata*		*Thelymitra fuscolutea*	
Levenhookia pusilla		*Pimelea rosea*		*Thelymitra sp.*	
Levenhookia stipitata		*Pimelea sulphurea*		*Thysanotus arbuscula*	
Lobelia tenuior		*Pithocarpa pulchella*		*Thysanotus manglesianus*	
Lomandra caespitosa		*Platysace compressa*	S	*Thysanotus multiflorus*	
Lomandra endlicheri		*Platytheca galioides*		*Thysanotus patersonii*	
Lomandra hermaphrodita		*Podotheca angustifolia*		*Thysanotus sparteus*	
Thysanotus thyrsoideus	S	*Tricoryne tenalla*		*Xanthorrhoea gracilis*	S

Thysanotus triandrus		*Tripterococcus brunonis*		*Xanthorrhoea preissii*	S
Thysanotus sp.		*Verticordia drummondii*		*Xanthosia huegelii*	R
Trachymene pilosa		*Wahlenbergia preissii*			
Tricoryne elatior	R	*Waitzia suaveolens*			

Taken from information compiled by E.Groves, G.Hardy and J.McComb, Murdoch University. Species list reviewed by Mark Brundrett, 2011 and the Jandakot Airport floristic surveys 2001-2017 (Mattiske).

Attachment 3. 2017 *Phytophthora cinnamomi* Occurrence Assessment

Jandakot Airport

Triennial Phytophthora Dieback occurrence assessment – Version 2.0

GLEVAN CONSULTING

Disclaimer

This report has been prepared in accordance with the scope of work agreed between the Client and Glevan Consulting and contains results and recommendations specific to the agreement. Results and recommendations in this report should not be referenced for other projects without the written consent of Glevan Consulting.

Procedures and guidelines stipulated in various Department of Environment and Conservation and Dieback Working Group manuals are applied as the base methodology used by Glevan Consulting in the delivery of the services and products required by this scope of work. These guidelines, along with overarching peer review and quality standards ensure that all results are presented to the highest standard.

Glevan Consulting has assessed areas based on existing evidence presented at the time of assessment. The Phytophthora pathogen may exist in the soil as incipient disease. Methods have been devised and utilised that compensate for this phenomenon; however, very new centres of infestation, that do not present any visible evidence, may remain undetected during the assessment.

Author Simon Robinson

Note on version numbering:

0.1 – 0.∞	*Internal documents*
1.0 – 1.∞	*First draft and iterations to Client.*
2.0	*Final document.*

Table of Contents

List of Figures

List of Tables

1 Summary

Glevan Consulting conducted an assessment of the remnant vegetation within the Jandakot Airport Study Area for the presence of Phytophthora Dieback. The assessment was conducted from 13-11-2017 to 20-12-2017 by Simon Robinson.

The study area has been assessed previously by Glevan Consulting on several occasions, and most recently in 2014, as part of Jandakot Airport Holdings' (JAH) commitment to undertaking Phytophthora Dieback assessments on a triennial basis. The study area has been reduced in size since the 2014 assessment, due to the clearing of three significant sections in the south east of the study area, and now comprises a total of 119.7 hectares. The study area was assessed in its entirety, with no areas were excluded from the assessment.

A previously unmapped Phytophthora Dieback infestation was identified during the assessment. The infestation is small and appears to be associated with an access track. The disease appears to be recently established and was most likely introduced to the site in the last 5 years. Only minor adjustments were made to the boundaries of the five existing infestations. A section of vegetation associated with the infestation located in the northeast corner of the study area was reclaimed as uninfested. Several negative sample results have now been recorded in this area and the previous decline that resulted in it being included in the infested area is no longer apparent.

Minimal disease expression was evident during the assessment, and the lack of expression is most likely the result of periodic phosphite treatment which has occurred several times during the last 10 years. A significant amount of vegetation decline not related to Phytophthora Dieback was observed during the assessment, and several soil and tissue samples were taken to assist with the diagnosis of these areas. A total of 10 soil and tissue samples were taken, seven of which produced negative results. One sample produced a positive result for *P. cinnamomi*, while another two samples contained other *Phytophthora* pathogens, namely *P. elongata* and *P. palmivora.*

The Dieback mapping performed during this assessment is valid for 3 years and will expire in December 2020. It is recommended however, where clearing and development works are still occurring beyond 12 months that any Dieback boundaries associated with the works be reassessed.

2 Introduction

2.1 Background

Glevan Consulting was commissioned by JAH to conduct an assessment of the remnant vegetation within the Jandakot Airport Study Area for the presence of Phytophthora Dieback. Under the EPBC Conditions of Approval and JAH's Dieback Management Plan, it is a requirement that Phytophthora Dieback occurrence mapping is conducted at Jandakot Airport every three years. The updated occurrence mapping will also provide boundaries for the upcoming phosphite treatment program, and proposed clearing activities that may occur in the next three years.

2.2 Location of Study Area.

Jandakot Airport is located on Eagle Drive, within the suburb of Jandakot, approximately 15 km south of Perth CBD. The study area for the assessment is comprised of the 119.7 ha of remnant vegetation surrounding the airport facilities (Figure 1).

Figure 1 - Study Area

2.3 Study team

The assessment was conducted by Simon Robinson of Glevan Consulting in November and December of 2017. Mr Robinson is accredited by the Department of Biodiversity, Conservation and Attractions' (DBCA) in the detection, diagnosis and mapping of the Dieback disease. This accreditation recognises the skills and experience of Mr Robinson.

3 Phytophthora Dieback

The pathogen *Phytophthora cinnamomi* is an agent of environmental disease found in vulnerable areas of Western Australia. Phytophthora Dieback is the common name for the observable disease result of interaction between the pathogen (*P. cinnamomi*) and the vegetation hosts (susceptible plant species within vulnerable areas).

The environment conditions of the site significantly affect the pathogens ability to survive or flourish and spread over time. All land with an annual average rainfall of more than 400 millimetres and suitable soil composition is considered vulnerable to Phytophthora Dieback. This large area stretches approximately from Perth, Bunbury and Augusta in the west to Narrogin, Ravensthorpe and Esperance in the east, and as far north as Kalbarri.

This vulnerable area has many different bioregions, having specific characteristics formed by climate and geology. These two factors are highly significant in determining the pathogen's effectiveness and resulting disease impact levels.

3.1 The Pathogen

Phytophthora cinnamomi is a microscopic water mould. It belongs to the class Oomycetes and belongs in the Kingdom Stramenopila. It is more closely related to brown algae than to true fungi. Oomycetes organisms occupy both saprophytic and pathogenic lifestyles however *P. cinnamomi* is considered parasitic. It behaves largely as a necrotrophic pathogen causing damage to the host plant's root tissues because of infection and invasion.

The life cycle of *Phytophthora cinnamomi* is a continuous circle of infection, sporulation and further infection and is readily vectored by animals and human activity allowing for rapid invasion into new areas.

3.2 Host

A population of hosts is made up of susceptible, infected and immune or resistant individuals. The infection of host plants is an unseen activity happening constantly beneath the soil at an infested site. The environmental conditions favouring or disfavouring the pathogen may change at a critical point during disease development, temporarily changing the rates of infection and invasion. This can be observed symptomatically after soil temperature change through winter months.

The plant host is a highly variable component of the disease development. Sites may range from having no susceptible host, to containing plant communities with almost 100% susceptibility. Within vulnerable areas, three main family groups are regarded as highly susceptible to Phytophthora Dieback disease, being:

- Proteaceae
- Ericaceae
- Xanthorrhoeaceae.

3.3 Environment

Two fundamental environmental characteristics influencing Phytophthora Dieback disease are rainfall and soil. Areas vulnerable to Phytophthora Dieback are defined as native vegetation which occur west of the 400 millimetre rainfall isohyet. The correlation of increased Phytophthora Dieback impact with increased annual rainfall is generally applicable. Certain soil properties influence Phytophthora Dieback disease development within the vulnerable areas:

1. Moisture is critical for *Phytophthora cinnamomi* to survive in the soil and for sporangia production.
2. Soil pH affects the growth and reproduction of the pathogen. The calcareous sands closest to the coast are alkaline and hostile to *Phytophthora cinnamomi,* but are favourable to *P. multivora.*
3. Fertile soils are less favourable to Phytophthora Dieback because the richness of nutrients aids strong host resistance, good soil structure allows water movement and drainage, and high organic matter provides antagonistic microflora.
4. Coarse-textured soils have larger pore spaces which favour dispersal of spores.
5. The optimum temperature for *Phytophthora cinnamomi* sporulation is 21 to 30°C, peaking at 25°C., but some sporangia can still be produced at temperatures as low as 12°C. The optimum growth range is 15 to 30°C and temperatures lower than 5°C or greater than 35°C are unfavourable for the persistence of survival of spores and the vegetative mycelia of *P. cinnamomi.*

4 Methods

4.1 Pre survey desktop study

Known databases of *Phytophthora* locations retained by Glevan Consulting and Vegetation Health Services (DBCA) were searched to determine previous recoveries of *Phytophthora* within the project area. Previous Phytophthora Dieback Occurrence reports and maps pertaining to the study area were also studied prior to undertaking the field work.

4.2 Interpretation

Based on the considerations of Section 3 'Phytophthora Dieback', the personnel involved in the field work determined the presence of Phytophthora Dieback based on symptoms and disease signatures displayed in susceptible vegetation. These symptoms are supported through the strategic sampling and subsequent recovery of Phytophthora from soil and tissue samples taken during the assessment.

The detection of the plant pathogen Phytophthora Dieback involves the observation and interpretation of plant deaths (or reduction of biomass or perceived temporal change in vegetation structure) using a logical assessment of factors that imply pathogen presence above other possible causes of plant deaths or vegetation change. A combination of the following factors may indicate the presence of disease caused by *Phytophthora* Dieback or other *Phytophthora* species.

<u>Deaths of disease indicating species:</u>

An indicator species is a plant species, which is reliably susceptible to Phytophthora Dieback (i.e. will die). Common indicators include several species of *Banksia, Patersonia*, *Persoonia*, and *Xanthorrhoea*. The distribution and composition of indicator species will vary from place to place according to vegetation types.

<u>Chronology of deaths:</u>

As the pathogen spreads through an area, some or all susceptible plants become infected and die. Consequently there will be an age range from more recent deaths with yellowing or brown leaves through to older leafless stags to remnant stumps in the ground.

Pattern of deaths:

The topography, soil type, vegetation type and drainage characteristics of an area together with the influence of climatic patterns and disturbances will influence the shape or pattern of an infested area over time. A typical recent infestation may show a small cluster of dead indicator species which, in time, will spread to become a small circular shape 'the ulcer effect' and then begin lengthening towards natural drainage channels. A fringe of recent deaths is often seen around the edge of the infested area. Patterns may be further highlighted by a paucity of ground cover within the infested area.

Other causes of indicator species death:

Phytophthora cinnamomi is not the only agent to cause death of native vegetation. Other agents include, but are not limited to:

- other *Phytophthora* spp, *Armillaria luteobubalina*, various cankers, insects;
- drought, wind scorch, frost, salinity, water logging, fire and lightning;
- senescence, competition, physical damage;
- herbicides, chemical spills (for example fuel).

Based on the field assessment, the Project Area can be distributed to the following occurrence categories.

Table 1 - Phytophthora Dieback occurrence categories

Vegetated area	Infested	Areas that have plant disease symptoms consistent with the presence of Phytophthora Dieback
	Uninfested	Areas free of plant disease symptoms that indicate the presence of Phytophthora Dieback.
	Uninterpretable	Areas where indicator plants are absent or too few to determine the presence or absence of Phytophthora Dieback.
	Unmappable	Areas that are sufficiently disturbed so that Phytophthora Dieback occurrence mapping is not possible at the time of inspection.
	Not yet resolved	Areas where the interpretation process has not confidently determined the status of the vegetation.
Non-vegetated area	Excluded	Areas devoid of vegetation are excluded from the assessment area.

4.3 Demarcation of hygiene boundaries

Phytophthora Dieback infestations were demarcated with fluoro pink flagging tape. A single band of tape was tied to a suitable tree with the knot facing towards the infestation. The taped boundaries were positioned on, or within 3 metres of the perceived disease front, and placed approximately 10 -15m apart.

4.4 Soil and tissue sampling

Suspicious sites can have a representative soil and tissue sample taken to assist with the interpretation process. The laboratory result can confirm the presence of the *P. cinnamomi* pathogen. A negative result does not necessarily prove that the pathogen isn't present at the site, and should be supported by the field interpretation.

Samples were processed at the Department of Biodiversity, Conservation and Attractions' Vegetation Health Service (VHS) laboratory in Kensington using the *Eucalyptus sieberi* cotyledon baiting method. The laboratory provides a dedicated, specialist scientific service for the detection and identification of Phytophthora species from samples associated with Western Australia's forest and conservation estate, timber harvesting and mining activities, private industry and research.

Sampling was conducted using the following procedure:

- All digging implements used were thoroughly sterilised prior to use with methylated spirits. The implements were then allowed to dry so that the integrity of the sample was not compromised.
- The area around the base of the plant/s to be sampled was cleared of vegetative matter to aid the digging process.
- The plant was dug to a satisfactory depth so that the tissue with the highest moisture content was obtained.
- Sections of the roots and stem base from all sides of the plant were taken and placed in a plastic bag. If any lesion was noticed on the tissue, it was also placed in the bag. A few handfuls of sand from various depths were also deposited in the plastic bag.
- The sample bags were irrigated with distilled water to try and simulate the optimum conditions for the *Phytophthora* to survive.

- Details, such as the date, sample number and interpreters were written on an aluminium tag, which was left at the site. The tag was demarcated with a strip of day-glow orange flagging tape.
- All digging implements used were again sterilised after each sample was taken to ensure that infected soil was not transported to the next sample site.

4.5 Mapping

Subsequent to hygiene boundary demarcation, the boundaries were again walked and recorded utilising a handheld GPS. The recorded data was then transferred to a desktop computer and used to produce the relevant maps.

4.6 Limitations of disease mapping

The assessment for the disease caused by Phytophthora Dieback is based on interpreting the vegetation for symptoms which can be ascribed to the disease presence. These observable factors must be present during the assessment period. Management recommendations may be included if it is considered that the disease may be cryptic, or the project area displays evidence of activities that are considered a high risk of introducing the disease.

The validity of the boundaries mapped for this project is three years from the completion of this project (12/2020). However, for areas in which operations are occurring i.e. clearing, it is recommended that the boundaries be rechecked after 12 months.

5 Project area environmental data

5.1 Rainfall

The average annual rainfall recorded for Jandakot Airport since 1972 is 824 mm (Bureau of Meteorology, 2018) which, combined with several months of average soil temperatures above 21 degrees Celsius, provides favourable conditions for sporulation and increased disease activity.

5.2 Soil types

The soil within the study area appeared to be consistent with that normally observed on the Bassendean dune system. The soils are old, free draining, heavily leached, nutrient deficient and acidic, with very little clay and silt content. The interdunal depressions are subject to seasonal waterlogging, and have poor drainage, providing high moisture conditions for extended periods, which are very favourable to the pathogen.

5.3 Vegetation structure

The vegetation is typical Swan Coastal Plain Banksia woodland featuring *Banksia menziesii* and *Banksia attenuata* over a species rich understorey of Proteaceous and Myrtaceous shrubs and grass trees. Such vegetation has relatively high susceptibility to Phytophthora Dieback and generally provides good levels of disease expression, assisting in the detection and mapping of infested areas.

The combination of the above environmental factors suggests that if Phytophthora Dieback was present within the study area, it would be readily detected and mapped.

6 Results

6.1 Phytophthora Dieback occurrence distribution

Four infestations, including a previously unmapped spot infestation (associated with sample 2), comprising a total of 22.7 ha were observed during the assessment, and the remaining 97 ha of the study area was found to be uninfested. Only minor changes were made to the boundaries of the existing infestations.

The vast majority of the infested vegetation within the study area correlates directly with water-gaining sites, and the disease has not spread significantly beyond these water-gaining areas.

Table 2 - Area Summary

Category	Area (ha)	% of total area
Infested (with *P. cinnamomi*)	22.7	19
Uninterpretable	0.0	
Uninfested	97.0	81
TOTAL AREA	119.7	

6.2 Disease expression

Disease expression was variable across the study area, but was generally found to be subtle or non-perceptible. It appears likely that disease expression has been supressed by the application of phosphite on and around the disease front in recent years. A freshly deceased *Banksia menziesii* was associated with the previously unmapped infestation and without this expression it is unlikely that the infestation would have been detected.

6.3 Soil and tissue samples

A total of 10 soil and tissue samples were taken during the assessment. Sample 2 returned a positive result for the presence of *P. cinnamomi*, assisting in the identification of a previously unmapped infestation. The remaining nine samples tested negative for the presence of *P. cinnamomi* (Table 3). Samples 9 and 10 contained other *Phytophthora* species, namely *P. elongata* and *P. palmivora.*

Table 3 – Project Area Sample Summary

Sample	Plant sampled	Easting	Northing	Result
1	***Xanthorrhoea preissii***	**395010**	**6449575**	***Negative***
2	***Banksia menziesii***	**395164**	**6449378**	***Positive***
3	***Banksia attenuata***	**395015**	**6448410**	***Negative***
4	***Callistemon spp.***	**394035**	**6448510**	***Negative***
5	***Eucalyptus maculata***	**393173**	**6448801**	***Negative***
6	***Banksia attenuata***	**395158**	**6449290**	***Negative***
7	***Stirlingia latifolia***	**395183**	**6449400**	***Negative***
8	***Banksia attenuata***	**395030**	**6449375**	***Negative***
9	***Banksia menziesii***	**394660**	**6449240**	***P. elongata***
10	***Banksia menziesii***	**394680**	**6449335**	***P. palmivora***

7 Discussion

7.1 Phytophthora Dieback occurrence distribution

A total of four infestations comprising a total of 22.7 ha were observed and mapped during the assessment. One of the infestations (associated with sample 2) had not previously been mapped. It is not clear whether the infestation would have been present during previous assessments, however its size and the pattern of vegetation decline suggest that it has been recently introduced (within the last 5 years) and that the source of introduction was vehicle movement along the access track with which it is associated. Non-native plants growing around rubble and building materials indicates that illegal dumping has also previously occurred at the site, however as access to the area has been restricted for several decades, it is likely that this activity significantly pre-dates the introduction of the pathogen, which appears to have occurred in the last 5 years.

The disease boundaries of the existing infestations were almost identical to the 2014 survey, with only minor changes made to the existing boundaries. A section of vegetation (near sample 1) approximately 0.6 ha in size, associated with the infestation located in the northeast corner of the study area, was reclaimed as uninfested. Several negative sample results have now been recorded in this area and the previous decline that resulted in it being included in the infested area is no longer apparent.

The vast majority of the infested vegetation within the study area correlates directly with water-gaining sites, and the disease has not spread significantly beyond these water-gaining areas. Water-gaining sites are usually subject to seasonal waterlogging or inundation, providing ideal conditions for the survival and sporulation of the pathogen. Spread of the disease is generally faster within high moisture sites, where the disease is transported by water and does not rely on root to root contact to be transmitted.

The spread of the disease from these infested water-gaining sites now appears to be relatively slow, as it is likely that the pathogen has already spread throughout the areas that are subject to seasonal waterlogging/inundation, and is now slowly spreading autonomously (root to root contact) away from the immediate water-gaining areas. This is a favourable situation in terms of management. Not only should natural rates of spread continue to be low, but the movement of the disease front should be predictable and easily monitored.

The small infestation adjacent to the main access road exhibited relatively good disease expression, with several fresh indicator species deaths observed, and a perceptible disease front. Disease front movement of up to 1.5m was observed.

The drainage basin adjacent to Mustang Road was found to contain the *Phytophthora* pathogens *P. elongata* and *P. palmivora.* The introduction of these pathogens is believed to be associated with illegal dumping of garden waste.

7.2 Disease expression

Disease expression was variable across the study area, but was generally found to be subtle or non-perceptible. It appears likely that disease expression has been supressed by the periodic application of phosphite on and around the disease front. This treatment has meant that many susceptible plants on the disease front, that would otherwise have perished, have survived, greatly reducing the number of ISD's present.

Phosphite (also known as phosphonate) is a biodegradable fungicide that can increase a plant's own natural defences, and help susceptible species survive in infested areas. CALM trials in Swan Coastal Plain *Banksia* Woodland have found that aerial applications of 30-60 l/ha of 40% phosphite can give effective protection for up to 3 years (DEC 1999).

While less notable than during the 2014 assessment, a still significant amount of vegetation decline not related to Phytophthora Dieback was observed throughout the study area. The characteristic pattern normally associated with the presence of *P. cinnamomi* was not observed at these sites, and the plant deaths appeared to be largely scattered, random and 'staged'. This is consistent with observations made during the 2011 and 2014 surveys, in which drought was considered to be the most likely cause of the vegetation decline observed.

The expression associated with sites containing *P. elongata* and *P. palmivora* was limited to one or two deceased *Banksia* trees. While the impact is currently low, the introduction of the pathogens is likely to have only recently occurred. In addition, vegetation in this area is relatively sparse, so it is difficult to predict the potential pathogenicity of these species should they be spread into more densely vegetated areas.

P*hytophthora elongata* has been isolated from both natural forest and heath-land stands in Western Australia and has demonstrated pathogenicity towards several native plant genera including *Eucalyptus, Corymbia, Banksia, Leucopogon, Xanthorrhoea, Andersonia* and *Patersonia*. It is however far less virulent and destructive than P. cinnamomi. *Phytophthora palmivora* is found worldwide and has a wide host range, however it's effects on native vegetation in Western Australia are not well documented.

7.3 Soil and tissue sampling strategies

As per the 2011 and 2014 surveys, a significant number of samples were taken to eliminate *P. cinnamomi* as the cause of the unexplained decline present throughout the study area, and all except sample 2 tested negative for the presence of *P. cinnamomi*. The positive result recorded at sample site 2 is not surprising however, as it is associated with a high-risk vector (access track). Samples 9 and 10 were taken in a drain basin adjacent to Mustang Road where there was clear evidence of vehicle access and dumping of garden waste. Sampling of these sites recovered the *Phytophthora* pathogens *P. elongata* and *P. palmivora*.

An additional three samples were taken in areas surrounding the new infestation to assist in determining whether any of the nearby vegetation decline was also related to Phytophthora Dieback. The samples produced negative results.

Samples 4 and 5 were taken in amenity gardens to assist in determining whether the tree decline present was related to Phytophthora Dieback. The samples both returned negative results and the cause of the decline remains unknown.

8 Recommendations

- Consider blocking access to, or imposing dry soil only restrictions on, the section of track associated with the newly mapped infestation. Alternatively, consider creating a small bypass section that skirts around the infested area, or the use of a limestone ‘bridge’ where the existing track intersects the infested area.

- Infested soil can be used beneath the pavements of new runways and taxiways where there is no natural vegetation in the immediate vicinity (i.e. areas that are currently the cleared runway offshoot areas).

- Amend the Jandakot Airport Dieback Management Plan to include the above recommendations and identify the updated dieback infested areas identified in this report. Continue to implement the Dieback Management Plan.

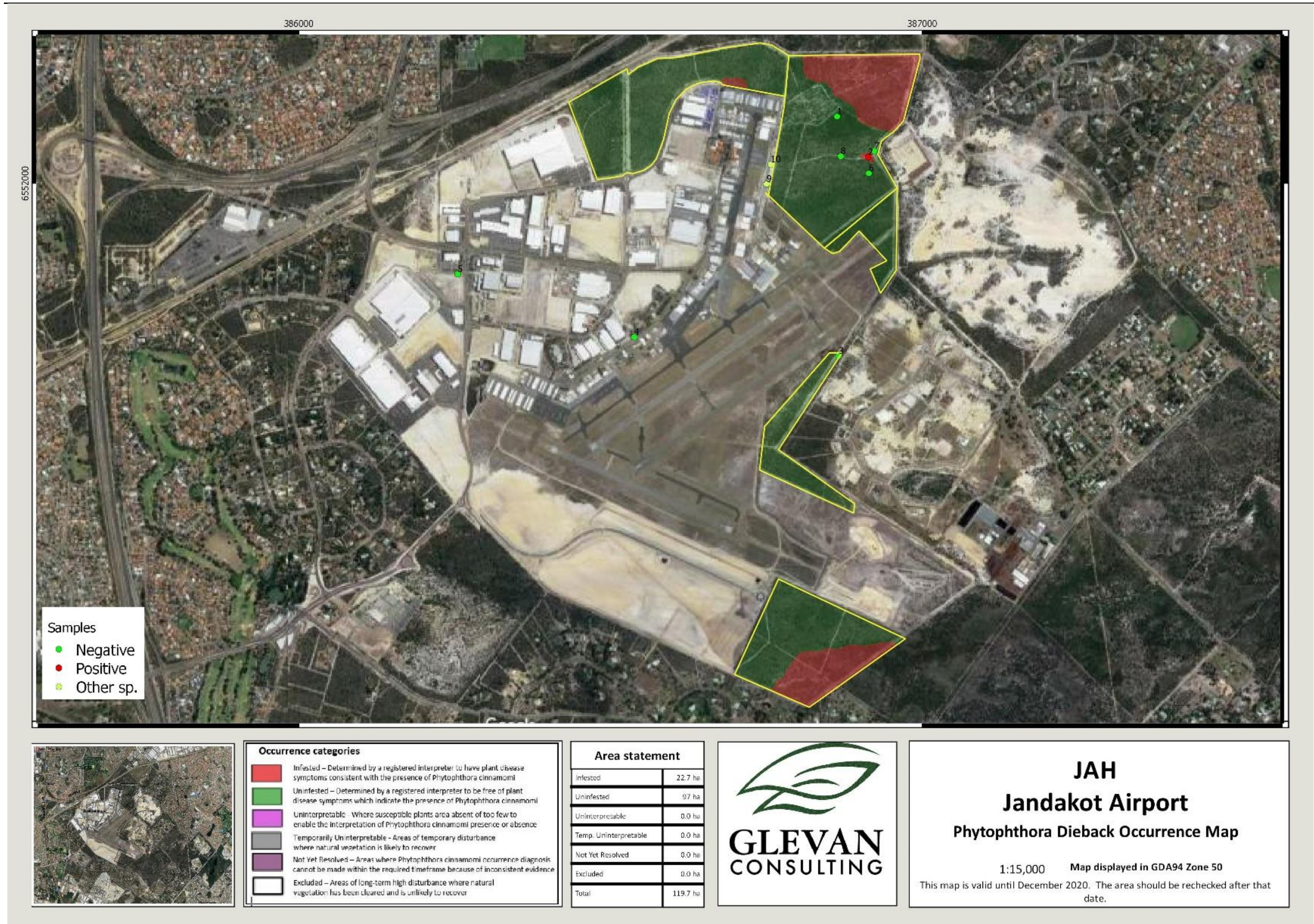
9 Bibliography

Bureau of Meteorology, *Climate Statistics for Australian Locations*. Available from: http://www.bom.gov.au/climate/averages/tables/cw_009172.shtml [02 February 2018].

Glevan Consulting (2011). *Jandakot Airport P.c Assessment 2011.* Unpublished report for Jandakot Airport Holdings.

Glevan Consulting (2014). *Jandakot Airport Phytophthora Dieback Assessment 2014.* Unpublished report for Jandakot Airport Holdings.

10 Appendix – Phytophthora occurrence map



END OF DOCUMENT