

Appendix E

Aboriginal Heritage Inquiry

Report



Search Criteria

6 Registered Aboriginal Sites in Custom search area; 401117.97mE, 6472679.51mN z50 (MGA94) : 402848.40mE, 6483908.17mN z50 (MGA94)

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Aboriginal Affairs by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at heritageenquiries@daa.wa.gov.au and we will make every effort to rectify it as soon as possible.

South West Settlement ILUA Disclaimer

Your heritage enquiry is on land within the following Indigenous Land Use Agreement(s): Whadjuk People ILUA

On 8 June 2015, six identical Indigenous Land Use Agreements (ILUAs) were executed across the South West by the Western Australian Government and, respectively, the Yued, Whadjuk People, Gnaala Karla Booja, Ballardong People, South West Boojarah #2 and Wagyl Kaip & Southern Noongar groups, and the South West Aboriginal Land and Sea Council (SWALSC).

The ILUAs bind the parties (including 'the State', which encompasses all State Government Departments and certain State Government agencies) to enter into a Noongar Standard Heritage Agreement (NSHA) when conducting Aboriginal Heritage Surveys in the ILUA areas, unless they have an existing heritage agreement. It is also intended that other State agencies and instrumentalities enter into the NSHA when conducting Aboriginal Heritage Surveys in the ILUA areas. It is recommended a NSHA is entered into, and an 'Activity Notice' issued under the NSHA, if there is a risk that an activity will 'impact' (i.e. by excavating, damaging, destroying or altering in any way) an Aboriginal heritage site. The Aboriginal Heritage Due Diligence Guidelines, which are referenced by the NSHA, provide guidance on how to assess the potential risk to Aboriginal heritage.

Likewise, from 8 June 2015 the Department of Mines and Petroleum (DMP) in granting Mineral, Petroleum and related Access Authority tenures within the South West Settlement ILUA areas, will place a condition on these tenures requiring a heritage agreement or a NSHA before any rights can be exercised.

If you are a State Government Department, Agency or Instrumentality, or have a heritage condition placed on your mineral or petroleum title by DMP, you should seek advice as to the requirement to use the NSHA for your proposed activity. The full ILUA documents, maps of the ILUA areas and the NSHA template can be found at <https://www.dpc.wa.gov.au/lantu/Claims/Pages/SouthWestSettlement.aspx>.

Further advice can also be sought from the Department of Aboriginal Affairs (DAA) at heritageenquiries@daa.wa.gov.au.



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Coordinate Accuracy

Accuracy is shown as a code in brackets following the coordinates. Map coordinates (Latitude/Longitude and Easting/Northing) are based on the GDA 94 Datum. The Easting/Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '500000mE:Z50' means Easting=500000, Zone=50.

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Aboriginal Affairs to the place

Status:

- o **Registered Site:** The place has been assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972*
- o **Other Heritage Place which includes:**
 - **Stored Data / Not a Site:** The place has been assessed as not meeting Section 5 of the *Aboriginal Heritage Act 1972*
 - **Lodged:** Information has been received in relation to the place, but an assessment has not been completed at this stage to determine if it meets Section 5 of the *Aboriginal Heritage Act 1972*

Status Reason: e.g. Exclusion - Relates to a portion of an Aboriginal site or heritage place as assessed by the Aboriginal Cultural Material Committee (ACMC). e.g. such as the land subject to a section 18 notice.

Origin Place ID: Used in conjunction with Status Reason to indicate which Registered Site this Place originates from.

Access and Restrictions:

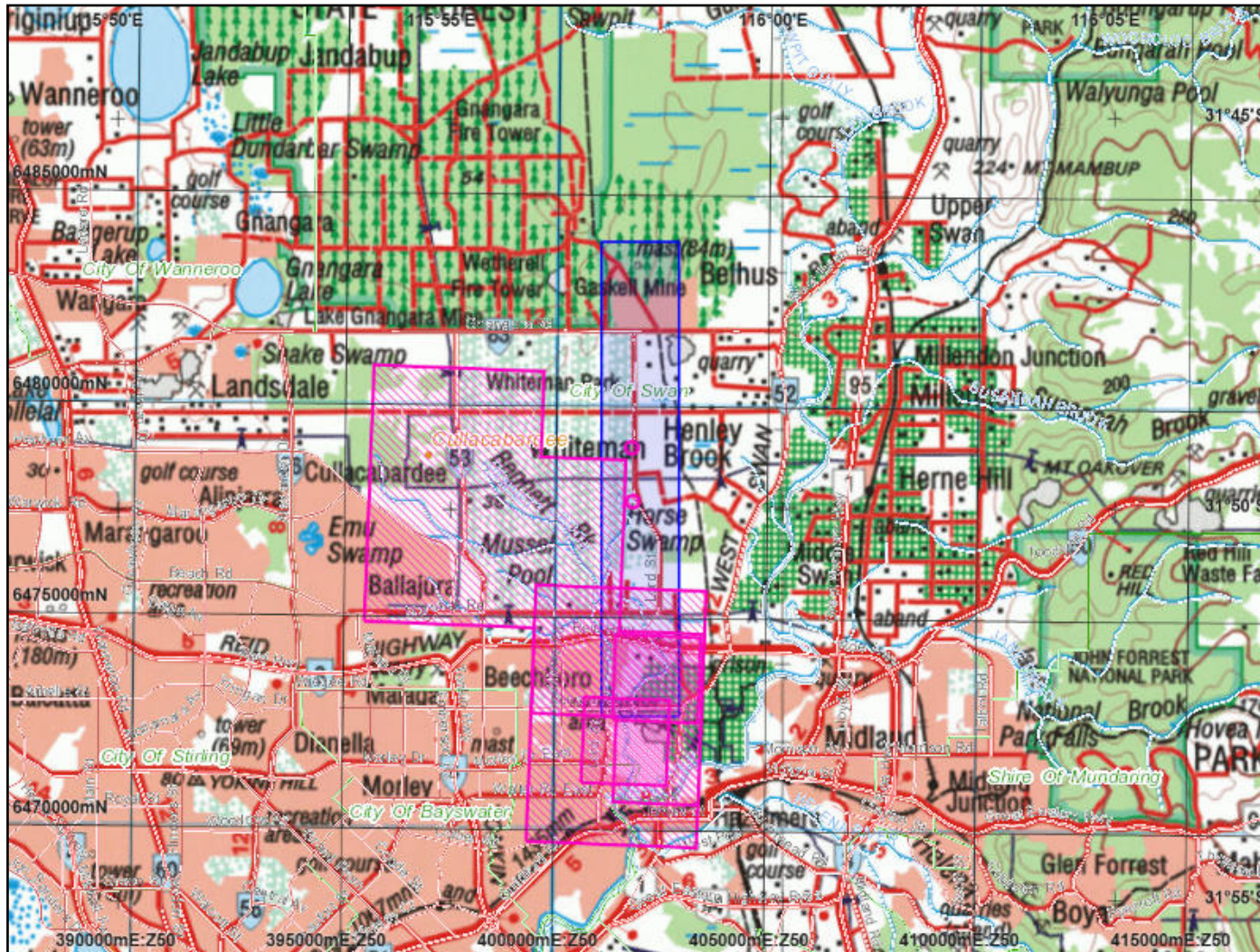
- o **File Restricted = No:** Availability of information (other than boundary) that the Department of Aboriginal Affairs holds in relation to the place is not restricted in any way.
- o **File Restricted = Yes:** Some of the information that the Department of Aboriginal Affairs holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Aboriginal Affairs receives written approval from the informants who provided the information. Download the [Request to Access Restricted Information](#) letter and form.
- o **Boundary Restricted = No:** place location is shown as accurately as the information lodged with the Registrar allows.
- o **Boundary Restricted = Yes:** To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact DAA.
- o **Restrictions:**
 - **No Restrictions:** Anyone can view the information.
 - **Male Access Only:** Only males can view restricted information.
 - **Female Access Only:** Only females can view restricted information

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.



List of Registered Aboriginal Sites with Map

Site ID	Site Name	File Restricted	Boundary Restricted	Restrictions	Status	Status Reason	Origin Place ID	Site Type	Knowledge Holders	Coordinates	Legacy ID
551	LORD STREET NORTH 1	No	No	No Gender Restrictions	Registered Site			Ceremonial		401793mE 6479040mN Zone 50 [Reliable]	S02916
552	LORD STREET NORTH 2.	No	No	No Gender Restrictions	Registered Site			Ceremonial, Mythological, Water Source	*Registered Knowledge Holder names available from DAA	401815mE 6477745mN Zone 50 [Reliable]	S02917
3489	BENNETT BROOK: LORD ST. 1	Yes	Yes	No Gender Restrictions	Registered Site			Ceremonial, Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	S02663
3692	BENNETT BROOK: in toto	Yes	Yes	No Gender Restrictions	Registered Site			Mythological	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	S02254
3744	MARSHALLS PADDOCK	Yes	Yes	No Gender Restrictions	Registered Site			Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	S02194
3840	BENNETT BROOK: CAMP AREA.	Yes	Yes	No Gender Restrictions	Registered Site			Artefacts / Scatter, Ceremonial, Fish Trap, Historical, Man-Made Structure, Mythological, Skeletal Material / Burial, Camp, Hunting Place, Plant Resource, Water Source	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	S01997



Legend

Selected Heritage Sites

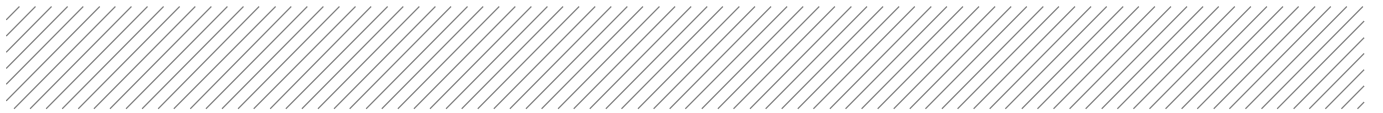
- Registered Sites
- Aboriginal Community Occupied
- Aboriginal Community Unoccupied
- Town
- Search Area

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Geothermal Application, Geothermal Title, Mining Tenement, Petroleum Application, Petroleum Title boundary data copyright © the State of Western Australia (DMP) (2016.5)

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Appendix F

Contaminated Sites Records



Contaminated Sites Act 2003
Basic Summary of Records Search Response

Report Generated at: 3:21:47PM, 30/05/2016

Search Results

This response relates to a search request received for:

91 Benara Rd
Caversham WA 6055

This parcel belongs to a site that contains 1 parcel(s).

According to Department of Environment Regulation records, this land has been reported as a known or suspected contaminated site.

Address	91 Benara Rd Caversham WA 6055
Lot on Plan Address	Lot 50 On Diagram 98581
Parcel Status	<p>Classification: 15/10/2013 - Remediated for restricted use</p> <p>Nature and Extent of Contamination:</p> <p>Asbestos contaminated fill remains on the site on the central portion of the western boundary. The fill is covered by a geotextile warning barrier and 500mm of clean fill.</p> <p>Restrictions on Use:</p> <p>Ongoing monitoring of the containment area should be undertaken in the form of an inspection program as detailed by the consultant in the document entitled 'Perth Vineyards - Ongoing Environmental Management Plan for Contaminated Areas' (Western Environmental, July 2013).</p> <p>Due to the presence of asbestos in soil, a site-specific health and safety plan is required to address the risks to the health of any workers undertaking intrusive works (below 500mm depth if necessary) until further notice.</p> <p>Reason for Classification:</p> <p>Lot 50 Benara Road, Caversham (the site) was reported to the Department of Environment Regulation (DER) as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003', which commenced on 1 December 2006. The site classification was based on information submitted to DER by July 2012. These reasons for classification have been updated to reflect information submitted to DER by August 2013.</p> <p>Uncontrolled fill material was deposited at the site over a period of approximately 8 years, from 1977 to 1985. This is a land use that has the potential to cause contamination, as</p>

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This Summary of Records has been prepared by Department of Environment Regulation (DER) as a requirement of the *Contaminated Sites Act 2003*. DER makes every effort to ensure the accuracy, currency and reliability of this information at the time it was prepared, however advises that due to the ability of contamination to potentially change in nature and extent over time, circumstances may have changed since the information was originally provided. Users must exercise their own skill and care when interpreting the information contained within this Summary of Records and, where applicable, obtain independent professional advice appropriate to their circumstances. In no event will DER, its agents or employees be held responsible for any loss or damage arising from any use of or reliance on this information. Additionally, the Summary of Records must not be reproduced or supplied to third parties except in full and unabridged form.



Contaminated Sites Act 2003

Basic Summary of Records Search Response

Report Generated at: 3:21:47PM, 30/05/2016

specified in the guideline 'Potentially Contaminating Activities, Industries and Landuses' (Department of Environment, 2004).

The eastern portion of the site is used as a caravan park with short term accommodation, the north-west portion of the site was historically used as a vineyard and the use of the south-west portion of the site is unknown. The proposed development involves the construction of chalets and roads over the historic vineyard area in the north-west portion of the site.

A contamination assessment was carried out in 2012 in order to comply with a condition that had been placed by the City of Swan on the site as part of the planning approval process.

Soil investigations were conducted between May 2012 and July 2013. The investigations were undertaken over the entire site, with targeted sampling within the western portion of the site.

The area proposed for development mainly occupies the north-west portion of the site but also stretches south along the western edge of the current on-site residential cabins. The northern portion of the development area is known as Area A and has historically been used as a vineyard. The soil in Area A was sampled in November 2012 and analysed for chemicals of potential concern. No potential contaminants were detected within the soils of Area A above Ecological Investigation Levels or Health-based Investigation Levels for residential land use, as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment and Conservation, 2010). For geotechnical reasons the top 200mm of soil was scraped from this area and was stockpiled as clean fill.

The southern portion of the development area is known as Area B. Area B was found to contain potential asbestos containing material (ACM) fragments within the soil. The area was excavated down to natural soil and the sides of the excavation progressively lined during the excavation. The ACM impacted soil was stockpiled on site for future onsite containment.

The area south and east of the proposed development area is known as Area Y. This area has been built over with roads and chalets. ACM was identified in this area but was left in situ, as it is covered by 200mm of clean fill.

The area south west of the development area is known as Area X and received uncontrolled fill between 1977 and 1985. Soil investigations conducted in May 2012 identified ACM, lead and dieldrin impacted soils. Lead was identified in soil at concentrations exceeding Health-based Investigation Levels for high-density residential and dieldrin in soil, at concentrations exceeding Ecological Investigation Levels, as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment and Conservation, 2010).

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Contaminated Sites Act 2003

Basic Summary of Records Search Response

Report Generated at: 3:21:47PM, 30/05/2016

The lead and dieldrin impacted soil was remediated between April and May 2013 through excavation and off-site disposal of the soils, and all identified lead and dieldrin impacted soils have been successfully remediated.

A trench excavation was undertaken between 14 and 15 May 2013 for the installation of services. The excavated fill was impacted by ACM. This was stockpiled for future disposal. The trench was excavated down to clean fill, lined with a geotechnical warning barrier, and then backfilled with clean fill on 16 May 2013.

As Area X is to be used as public open space, it was decided that ACM impacted soil from Area B, the trench ACM impacted soil and one of the subsequent 'clean fill' stockpiles created from the 200mm scraping of Area A which was found to contain ACM should be contained in Area X. The asbestos impacted soil from Area X, Area B, the trench excavated soil and the ACM impacted stockpile was then covered with a geotechnical warning barrier between 28 and 31 May 2013. The geotechnical warning barrier was progressively covered with a minimum of 500mm of clean fill between 29 May and 20 June 2013.

Groundwater investigations were undertaken between 20 November 2012 and 16 January 2013. Copper and zinc were present in groundwater at concentrations exceeding Aquatic Ecosystems - Freshwater guidelines, but below Australian Drinking Water Guidelines as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment and Conservation, 2010).

An intermediate risk assessment has indicated that the contamination present on the site does not currently pose an unacceptable risk to human health, the environment or environmental values under the proposed landuse. However, the contamination may present an unacceptable risk to human health under a more sensitive land use (such as residential with accessible soils, primary schools and childcare centres).

The investigations and risk assessment works were the subject of an independent review by an accredited contaminated sites auditor who provided a Mandatory Auditor's Report (MAR) dated 31 July 2013. The MAR recommended that the site is suitable for the proposed land use. The Department of Health (DoH) has reviewed the MAR and associated reports and provided advice to DER on 2 October 2013. DER and DoH accept the findings of the MAR.

As the site is contaminated and has been remediated such that it is suitable for the proposed landuse, but may not be suitable for a more sensitive landuse, the site is classified as 'remediated for restricted use'.

Due to the presence of asbestos-impacted fill below the geotextile warning barrier, the ongoing site management plan must be implemented and any disturbance of fill material beneath the warning barrier should be avoided. The ongoing site management will be undertaken by the site management company. A copy of the plan will be held by the site management company, or can be requested from DER for a fee via a detailed summary of

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**Contaminated Sites Act 2003
 Basic Summary of Records Search Response**

Report Generated at: 3:21:47PM, 30/05/2016

Certificate of Title Memorial
Current Regulatory Notice Issued
General

records request.

DER, in consultation with the Department of Health, has classified this site based on the information available to DER at the time of classification. It is acknowledged that the contamination status of the site may have changed since the information was collated and/or submitted to DER, and as such, the usefulness of this information may be limited.

In accordance with Department of Health advice, if groundwater is being, or is proposed to be abstracted, DER recommends that analytical testing should be carried out to determine whether the groundwater is suitable for its intended use.

Action Required

Ongoing monitoring of the containment area should be undertaken in the form of an inspection program as detailed by the consultant in the document entitled 'Perth Vineyards - Ongoing Environmental Management Plan for Contaminated Areas' (Western Environmental, July 2013).

Under the Contaminated Sites Act 2003, this site has been classified as "remediated for restricted use". For further information on the contamination status of this site, please contact the Contaminated Sites section of the Department of Environment Regulation.

Type of Regulatory Notice: Nil

Date Issued: Nil

No other information relating to this parcel.

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Contaminated Sites Act 2003 Detailed Summary of Records Search Response

Report generated at 11:22:45AM, 15/03/2016

Receipt No: DER48626

Search Results

This response relates to a search request received for:

State Forest 65
Lexia, WA, 6065
State Forest 65, Lexia WA 6065 (PIN 1149 8130)
This parcel belongs to a site that contains 3 parcel(s).

According to Department of Environment Regulation records, this land has been reported as a known or suspected contaminated site.

Address	State Forest 65 Lexia, WA, 6065 State Forest 65, Lexia WA 6065 (PIN 1149 8130)
Lot on Plan Address	State Forest 65
Parcel Status	<p>Classification: 06/07/2007 - <i>Possibly contaminated - investigation required</i></p> <p>Nature and Extent of Contamination:</p> <p>Groundwater beneath the Source Site is contaminated with ammonia and heavy metals.</p> <p>In 1994, the plume was 600m wide and 1000m long of which 500m was within Whiteman Park. The plume extended to the full extent of the superficial (shallow) aquifer below the Site.</p> <p>Restrictions on Use:</p> <p>Please refer to Reasons for Classification for further information on the contamination present at the Site.</p> <p>Reason for Classification:</p> <p>This Site was originally reported to the Department of Environment and Conservation (DEC) prior to the commencement of the "Contaminated Sites Act 2003". The Site was also reported to DEC as per reporting obligations under section 11 of the 'Contaminated Sites Act 2003', which commenced on 1 December 2006. The Site classification is based on information submitted to DEC by 21 May 2007.</p> <p>The Site to the north of Gngangara Road (the Source Site) was formerly used as a sewage effluent treatment facility and waste disposal site, a land use that has the potential to cause contamination, as specified in the guideline 'Potentially Contaminating Activities, Industries and Landuses' (Department of Environment, 2004). The site falls within the Priority 1 source protection area of the Gngangara Underground Water Pollution Control Area.</p> <p>DEC understands that the Source Site was used for the treatment and disposal of domestic sewage effluent from November 1971 until 1982. The Site was temporarily re-opened in 1987 and operated between August 1987 and November 1988. Although the Site was only authorized to accept domestic waste, various trade and industrial wastes are also suspected of having been deposited at the Site.</p> <p>The operational area of the Site comprised a number of unlined pits in which liquid waste underwent sedimentation/anaerobic digestion over a three to five month period, followed by oxidation and evaporation. Given that the pits were unlined, liquid wastes are likely to have leaked, leading to contamination of underlying soil and groundwater which lies between 3 and 10 meters below the base of the pits. Contamination of soils is also likely to have occurred as a result of the burial of digested sludges on-Site.</p> <p>Soil investigations have not been carried out and the quality of soil at the Site is unknown.</p> <p>DEC understands that a groundwater monitoring network of sixteen wells was installed in 1976 and monitored biannually between 1976 and 1982. However, the results of the monitoring programme were not available to DEC Land and Water Quality Branch at the time of classification. Further groundwater investigations were undertaken in 1993 and 1994 to determine if disposal practices at the Site were contaminating groundwater in the Gngangara Underground Water Pollution Control Area.</p> <p>The groundwater investigations carried out in 1994 identified a contaminant plume extending from the Source Site in a south to southeasterly direction and affecting land south of Gngangara Road. Ammonia and heavy metals were present in groundwater at concentrations exceeding Australian</p>

Disclaimer

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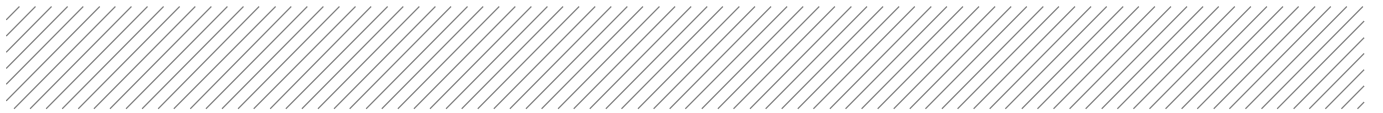
Contaminated Sites Act 2003 Detailed Summary of Records Search Response

Report generated at 11:22:46AM, 15/03/2016

	<p>Drinking Water Guidelines and Aquatic Ecosystems - Freshwater, as published in 'Assessment Levels for Soil, Sediment and Water' (Department of Environment, 2003).</p> <p>Concentrations of contaminants have been found to exceed adopted assessment levels for potable water for human consumption and ecological investigation levels. A Screening Risk Assessment has therefore indicated that further investigation is required to determine the risk to human health, the environment and environmental values.</p> <p>In January 1995, the then Department of Environmental Protection requested the continual assessment and monitoring of the plume and provision of reports on a regular basis. No further monitoring information has been received.</p> <p>Without further investigations into the current status of soil and groundwater contamination at the Site, DEC cannot comment on the suitability of the site for the current landuses (State Forest and public water supply).</p> <p>As there are grounds to indicate possible soil and groundwater contamination of the site, the site is classified as 'possibly contaminated - investigation required'.</p> <p>DEC has classified this site based on the information available at the time of classification. It is acknowledged that the contamination status may have changed since this time, and as such the usefulness of this information may be limited.</p>
Certificate of Title Memorial	Under the Contaminated Sites Act 2003, this site has been classified as "Possibly contaminated - investigation required". For further information on the contamination status of this site, please contact the Contaminated Sites section of the Department of Environment & Conservation.
Current Regulatory Notice Issued	<p>Type of Regulatory Notice: <i>Nil</i></p> <p>Date Issued: <i>Nil</i></p>
Certificate of Contamination Audit	Date Issued: <i>Nil</i>
Environmental Reports	<p>1. Preliminary Site Investigation, Former Liquid Waste Facility, Lexia (Golder, March 2015) Report Author: Golder Associates Pty Ltd. [Report Date: 01/03/2015, Receival Date: 19/08/2015]</p> <p>2. Investigation of Groundwater Contamination from the Gngara Liquid Waste Disposal Site (Water Authority, October 1994) Report Author: Water Corporation. [Report Date: 01/10/1994, Receival Date: 01/12/1994]</p>
Auditor Reports	No reports.
General	No other information relating to this parcel.

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Appendix G

Dieback Survey Report



***Phytophthora* Dieback Assessment of Ellenbrook Transit
Corridor**

Prepared for Eco Logical Australia Pty Ltd

Ref: T16005

**ecological assessment
& management**

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Document Control

Version	Date	Author	Reviewer(s)
Rev_0	01/04/2016	K. Jennings J. Grehan	K. Jennings K. Zeehandelaar-Adams
Rev_1	18/04/2016	K. Jennings J. Grehan	K. Zeehandelaar-Adams
Rev_2	20/04/2016	K. Jennings	K. Zeehandelaar-Adams
Rev_3	22/04/2016	K. Jennings J. Grehan	K. Zeehandelaar-Adams
Final			



Author: Kelby Jennings
Ecologist



Author: Joseph Grehan
Principal Ecologist

DISCLAIMER

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Terratree Pty Ltd

Executive Summary

Eco Logical Australia Pty Ltd, on behalf of Aurecon, engaged Terratree Pty Ltd (Terratree) to undertake a comprehensive linear *Phytophthora* Dieback (Dieback) assessment of native vegetation along Lords St and adjacent areas, (hereafter referred to as the 'assessment area'). The assessment was conducted by Department of Parks and Wildlife (DPaW) Registered Dieback Interpreter Joseph Grehan, in accordance with *FEM047: Phytophthora Dieback Interpreter's Manual for lands managed by the Department*, Forest and Ecosystems Management, Department of Parks and Wildlife, March 2015.

A total of three soil and tissue samples were taken from recently dead disease indicator species within the project area, with one sample ETRS01 returning a positive result for *Phytophthora cinnamomi*. This small infested area is the only assessable vegetation within the assessment area and represents only 0.34% of the overall assessment area.

The majority of the assessment area (97%) has been categorised as Excluded. Dieback is widespread within Whiteman Park which is immediately adjacent to the west of the assessment area.

Uninterpretable areas comprise 2.63% (6.55ha) of the assessment area. Vegetation in the Uninterpretable area is dominated by resistant wetland species including *Melaleuca preissiana* and *M. raphiophylla*, and contains or very few Disease Indicator Species.

The Uninterpretable areas do not meet the requirements set out in DPaW's Protocol for identifying Protectable Areas due to their size and shape (e.g. > 4 ha with axis >100 m) (DPaW, 2015). In addition these areas do not form any linkages to larger Protectable areas outside the assessment area. Conversely due to the widespread occurrence of Dieback within vegetation and surface water drainage in Whiteman Park, it is possible that the pathogen has been vectored into these areas but disease symptoms are not visible. The table below presents a Dieback mapping area statement showing area (ha) proportion of the overall assessment area for each dieback occurrence category.

Dieback Occurrence Category	Area (ha)	% Area
Infested	0.85	0.34
Uninterpretable (Unprotectable)	6.55	2.63
Excluded	241.19	97.02
Total	248.59	100

Although the majority of Lord Street between Reid Highway and Gngangara Road is categorised as Excluded, as a precautionary measure this section of the assessment area should be managed as Infested, due to the recovery of positive Dieback samples along Lord Street.

While access was limited to the assessment area, Terratree has not identified any Protectable areas through the desktop assessment in potential receiving environments adjacent to, down-gradient or downstream of the proposed Ellenbrook Transit Corridor project area.

Terratree makes the following recommendations for managing *Phytophthora* Dieback during the Ellenbrook Transit Corridor project:

- All vehicles and machinery should be inspected on arrival to site and be 'clean on entry' i.e. no soil or vegetative material adhering to the vehicle or machine when arriving on site;
- All vehicles and machinery should be inspected before leaving the site and be 'clean on exit' to prevent the spread of Dieback outside the assessment area;
- Personnel should ensure that footwear is 'clean on entry' and 'clean on exit' i.e. free of soil or vegetative material;

- All personnel should be informed about Dieback, in terms of why it poses a significant threat to biodiversity, how the pathogen is spread, and how to avoid spreading it. This information should be incorporated into an induction package for all personnel;
- Dieback management procedures should be developed and implemented, with actions and responsibilities clearly defined to ensure compliance with management recommendations. A recommended Vehicle Hygiene Inspection form is included in **Appendix 1**;
- All soil removed from the site should be disposed of in such a fashion so that the Dieback pathogen is not vectored into Protectable areas; and
- Any native plant species used in revegetation programs should be resistant to the Dieback pathogen to minimise risk to revegetation development and survival. All plants and seedlings should be sourced from Nursery Industry Accreditation Scheme (NIASA) accredited nurseries.

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1 Introduction

Eco Logical Australia Pty Ltd, engaged Terratree Pty Ltd (Terratree) on behalf of Aurecon to undertake a comprehensive linear *Phytophthora* Dieback (Dieback) assessment of native vegetation along Lords St and adjacent areas, (hereafter referred to as the 'assessment area') (Figure 1). The assessment was conducted by Department of Parks and Wildlife (DPaW) Registered Dieback Interpreter Joseph Grehan, in accordance with *FEM047: Phytophthora Dieback Interpreter's Manual for lands managed by the Department*, Forest and Ecosystems Management, Department of Parks and Wildlife, March 2015.

1.1 Project Location

The assessment area is located along Lord St within the City of Swan LGA, ranging from the intersection with Reid Highway to the south and extending along Montpellier Drive in Ellenbrook Estate to the north. This road forms the eastern boundary of Whiteman Park, which is known to contain significant areas of Dieback infestation (Figure 1).

1.2 Background

Phytophthora Dieback ('Dieback') is a soil borne pathogenic fungus with a range of hosts in the southwest of Western Australia. These predominantly come from the Proteaceae, Ericaceae, Myrtaceae, and Xanthorrhoeaceae plant families. While some plant species are resistant, others are susceptible to the disease caused by the pathogen resulting in chlorosis, dieback and usually death (Wills, R.T. and Keighery, G.J. 1994).

According to the most recent Western Australian (WA) State of the Environment Report (Environmental Protection Authority 2007), Dieback is listed as a Priority 1 threat, and is the third greatest threat to biodiversity after salinity and climate change. It is a more serious threat than weeds, clearing of native vegetation, acid sulphate soils and soil erosion. It is significant in WA is because:

- Over 40% (2,300) of the native plant species and half of the endangered plant species in the southwest of WA are susceptible to the pathogen;
- The changes in plant community composition and structure that Dieback causes has impact throughout the whole ecosystem, including on the indigenous fauna; and
- Dieback can lead to significant soil erosion as a result of the loss of susceptible vegetation.

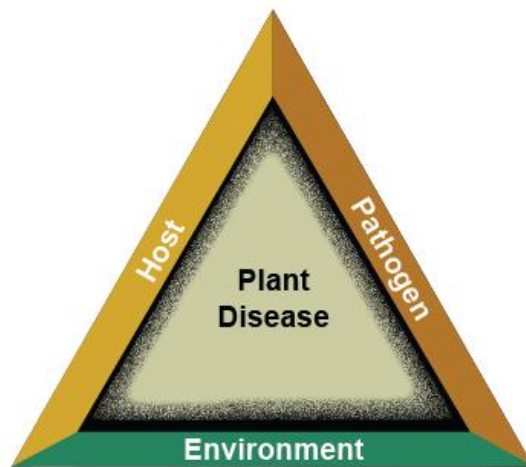
The Dieback pathogen is widespread in areas with greater than 900 mm of annual rainfall, less extensive in areas that receive between 600–900 mm, and mainly restricted to water-gaining sites in areas that receive 400–600 mm. The pathogen does not occur in areas that receive less than 400 mm of annual rainfall. In Western Australia, 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.

Dieback is spread through the movement of water and soil within the landscape. Major vectors of Dieback include wet soil adhering to vehicle tyres/tracks and earthmoving equipment, among others. 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:

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

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



1.3 Regulatory Context

Phytophthora Dieback management is required under several regulatory mechanisms including:

- *Environmental Protection Act* (1986) Part V S.50A “Serious Environmental Harm” provisions;
- Projects being assessed under the *Environmental Protection Act* (1986) and the *Mining Act* (1978), which require Department of Parks and Wildlife (DPaW) and/or Department of Mines and Petroleum (DMP) to comment on Dieback management and provide these agencies with the right to impose conditions to new approvals; and
- *Phytophthora* Dieback is listed as a Key Threatening Process with the Federal Government under the *Environmental Protection and Biodiversity Conservation Act* (1999).

2 Existing Environment

2.1 Biogeography

The project area is located within the Swan Coastal Plain 2 (SWA2) subregion, in accordance with the Interim Biogeographic Regionalisation for Australia (IBRA). The IBRA system identifies 89 bioregions and 419 subregions across Australia, based on climate, geology, landforms and characteristic vegetation and fauna.

Mitchell *et.al.* (2002) describe the SWA2 subregion as consisting of colluvial and aeolian sands, alluvial river flats, and coastal limestone deposits. The climate is described as Warm Mediterranean, with an average annual rainfall of 600 – 1000mm. The subregional extent is 1,303,911ha.

Vegetation is characterised by Jarrah - *Banksia* woodlands in Aeolian sand areas, with Marri woodland dominating in colluvial and alluvial areas. Coastal limestone outcrops are characterized by heathland and Tuart woodlands.

Dominant land uses include agriculture, urban development and conservation/UCL reserves.

2.2 Regional Vegetation

Vegetation complexes within the Swan Coastal Plain were mapped Hedde *et.al.* (1980). The assessment area contains three vegetation complexes, listed in order of occurrence from south to north:

- **Southern River Complex:** Open Woodland of *Corymbia calophylla*, *Eucalyptus marginata* and *Banksia* spp., with fringing woodlands of *Eucalyptus rudis* and *Melaleuca raphiophylla* along creeklines.
- **Bassendean Complex (Central and South):** Woodland of *Eucalyptus marginata*, *Allocasuarina fraseriana* and *Banksia* spp. to Low Woodlands of *Melaleuca* spp. and sedgeland on moist soils.
- **Bassendean Complex (North):** Low Open Forest/Low Woodland of *Eucalyptus todtiana* and *Banksia* spp. to Low Woodland of *Melaleuca* spp. and sedgeland on moist soils.

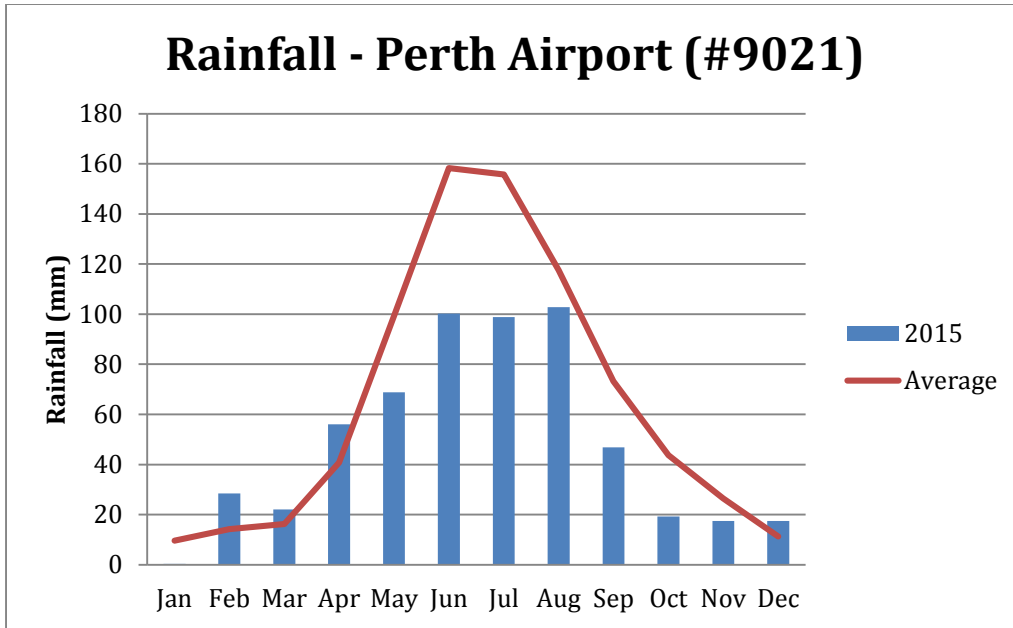
2.3 Climate

The South-west of Western Australia experiences an Interior Mediterranean (Csa) climate under the Köppen climate classification system, characterised as mild, with dry, hot summers and cool, wet winters (Pidwirny, 2011).

Weather Station Perth Airport (#9021) receives an average annual rainfall of 767.4mm. In areas receiving between 600-900mm rainfall per annum, Dieback can be present throughout the landscape, although upland infestations are rare in such circumstances.

The south-west has been experiencing lower than average rainfall over the past decade. Reduced rainfall is likely to negatively affect disease spread, as a less saturated soil profile and reduced surface water flow will restrict pathogen mobility within the soil profile. Therefore, indicators of disease activity and expression, including disease Indicator Species Deaths (ISDs), are likely to be less evident. Additionally, low rainfall can induce drought-stress mortality within vegetation complexes during warmer months, which can imitate and/or mask Dieback disease expression.

In 2015, Perth Airport (#9021) recorded significantly reduced rainfall when compared against the long-term average (**Graph 1**). Total rainfall for 2015 was 578.2mm, which represents 75.3% of the annual average. Rainfall was significantly below average for months May-October, which are the main contributors to overall rainfall, and therefore have significant effects of disease activity and expression.



Graph 1: Rainfall Data – Perth Airport (BoM, 2016)

3 Desktop Review

A desktop assessment was undertaken prior to the field assessment in order to:

- Examine topography and drainage of the assessment area and broader landscape;
- Review sample history or Dieback occurrence mapping from within the assessment area and surrounding 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).

Data from the vegetation Health Services (VHS) database provide numerous sample locations within Whiteman Park which tested positive for *P. cinnamomi*. Due to their proximity to the project area, these results have a significant bearing on assumptions, extrapolations and assessment of disease risk within the assessment area.

Possible vectors for disease include:

- Drainage lines;
- Uncontrolled vehicular access in areas of native vegetation; and
- Earthworks associated with roadworks and construction.

High risk areas within the assessment area include:

- Tracks and roads;
- Creeks and gullies;
- Water-gaining sites such as culverts and drains; and
- Areas of high soil disturbance, including roadworks and vehicle activity.

4 Method

The linear Dieback assessment was undertaken on January 19th & 20th, 2016, by DPaW registered Dieback Interpreter Joseph Grehan of Terratree. The assessment area was traversed by vehicle, with areas of native vegetation subject to intensive assessment on foot. Observations of vegetation health and disease expression were captured with hand-held GPS units, including georeferenced photographs.

The objectives of the Dieback assessment were to:

- Collect field evidence in the form of visual observations as well as soil and tissue samples from recently dead indicator species to test for the pathogen's presence;
- Identify and accurately map *Phytophthora* Dieback infestations within the assessment area; and
- Identify and accurately map Protectable areas within the assessment area.

4.1 Recent Changes to Dieback Occurrence Categories

The Dieback Interpreters Guidelines (DPaW 2015) were recently updated and now categorise land that has been cleared of native vegetation as 'Excluded' from assessment. Non-vegetated areas that are Excluded from assessment include pasture, pits, easements, development, large roads (sealed and unsealed), permanently flooded areas and parkland tree stands. Excluded areas are distinguished from 'Temporarily Uninterpretable' areas by the fact that they cannot regenerate naturally and eventually become Mappable. The Keighery vegetation disturbance scale presented in **Table 1** was used to determine the assessability of disturbed areas (DPaW 2015).

Table 2 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 will recover over time and become Interpretable and therefore Mappable. Examples of Temporarily Uninterpretable areas include vegetation that has been impacted by fire, grazing, timber harvesting, flooding or mining and rehabilitation. Recovery in Temporarily Uninterpretable areas may take longer than 3 years (DPaW, 2015).

The vegetation of Uninterpretable areas can range from Pristine to Very Good; however, whether the pathogen is present in resistant hosts or as Zoospores in permanent water bodies is indeterminable. Uninterpretable areas that meet the protocols for identifying Protectable Areas (DPaW, 2015) are managed as being both Infested and Uninfested so that the pathogen is neither imported into, nor exported from, these areas.

Table 1: Keighery Vegetation Disturbance Scale and Assessability (Keighery 1994, as referenced in DPaW, 2015)

Assessability	Scale	Condition
Assessable	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.
Possibly Assessable, discretion required	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.

Assessability	Scale		Condition
Not Assessable, Excluded from assessment	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.

Table 2: Assessability of vegetated and non-vegetated areas (DPaW, 2015)

	Phytophthora occurrence category	Typically present	May be present
Naturally vegetated areas (Phytophthora occurrence categorisation is or will be 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. ISDs that have been killed by other agents
	UNINFESTED	Healthy reliable indicator species	ISDs that have been killed by other agents
	UNINTERPETABLE	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
	TEMPORARILY UNINTERPRETABLE	Indicator species masked by disturbance. Keighery disturbance rating of 4 or greater Disturbance typically from; fire, harvesting, temporary flooding. Should recover (become interpretable) in 3 years or less	Occasional reliable indicator species, but disturbance prevents accurate placement of Phytophthora occurrence boundaries. Recovery time may be longer than 3 years
Non-vegetated areas (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	DISEASE RISK ROAD	Unformed track with shoulders of interpretable vegetation	Shoulders and batters with regenerated vegetation. Incipient infestation
	EXCLUDED	Pasture, pits, easements, infrastructure, large roads (sealed and unsealed) permanent flooding, plantations, parkland tree stands	Sporadic reliable indicator species

4.2 Protocols for Identifying Protectable Areas

According to Dieback Interpreters Guidelines (DPaW, 2015), the following primary criteria are used to define 'Protectable Areas' as those that:

- Have been determined to be free of the pathogen *Phytophthora* spp. by a registered Dieback Interpreter (all susceptible indicator plant species are healthy and no plant disease symptoms normally attributed to *Phytophthora* Dieback are evident);
- Consists of areas where human vectors are controllable (e.g. not an open road, private property) (DPaW 2013, pp 101 - 102); and
- Are positioned in the landscape and are of sufficient size (e.g. > 4 ha with axis >100 m) such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term (a period of a few decades); or
- Includes areas of high conservation and/or socio-economic value (for example, a small Uninfested area with a known population of a susceptible species of Threatened flora).

4.3 Disease Indicator Species

Disease indicator species observed within the assessment area include representatives of the Proteaceae, Myrtaceae and Xanthorrhoeaceae families. *Xanthorrhoea preissii* was the most reliable indicator of disease expression, due to their relative abundance within the project area. *Banksia* spp. were also used to inform disease interpretation where present. Indicator species observed during the field survey are listed in Table 3.

Table 3: Disease Indicator Species

Family	Species
Myrtaceae	<i>Eucalyptus marginata</i>
Proteaceae	<i>Banksia attenuata</i>
	<i>Banksia menziesii</i>
	<i>Banksia ilicifolia</i>
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>
Zamiaceae	<i>Macrozamia riedlei</i>

4.4 Sampling

Soil and tissue samples were taken from recently dead or dying indicator species to confirm the presence or indicate the possible absence of Dieback and inform interpretation of the area. While a positive sample result for *P. cinnamomi* is irrevocable, negative results are revocable. False negative results are common in areas receiving <600mm of annual rainfall are common. Negative sample results do not necessarily mean that the pathogen is absent, as low levels of inoculum activity can lead to false negative results.

Sampling strategies for the assessment of Dieback include the following:

Initial standards sampling: Initial samples were taken to determine disease behaviour. The results inform the sampling strategy and enable the testing of early hypotheses (e.g. are other factors causing the deaths of susceptible species such as *Armillaria luteobubalina* or drought).

Sampling to support infested diagnosis: Recently dead and dying indicator species were sampled to support an infested diagnosis.

Sampling to supporting an uninfested diagnosis: Recently dead and dying indicator species were sampled to support an uninfested diagnosis. A cautious approach must be adopted when claiming that a negative result means that an area is Uninfested, as false negative results can be recorded when inoculum levels are depleted due to prolonged unfavourable environmental conditions for the pathogen.

All sampling strictly adhered to the following procedures:

- All tools used in sampling were thoroughly sterilised with a 70:30 mixture of methylated spirits and water before samples were taken. Tools were dry prior to sampling so that the results were not compromised;
- The area around the base of the plant being sampled was cleared of leaf litter and debris so that this material was not included in the sample;
- The plant sampled was excavated to a suitable depth to ensure that adequate plant tissue material can be obtained from the roots and cambium layer around the collar of the plant being sampled;
- Material from all around the plant was taken in addition to any obvious lesions to avoid missing any infected material. All the plant tissue material and a few handfuls of soil from around the roots and other places in the soil profile were placed in a polythene bag;

- All relevant information pertaining to the plant sampled and sample location was recorded on the Sample Information Sheet;
- Two aluminium tags which provide the date, project name, sample number, species sampled and the name of the interpreter were written. One tag was placed in the sample bag and the other was tied near the sample site, which was also flagged with a day-glo orange flagging banner;
- The sample hole was backfilled to prevent fauna becoming trapped; and
- All tools were brushed off (to remove excess soil) and sterilised to prevent contamination of the next sample site and sample.

4.5 Buffers

The following buffers are normally applied when demarcating disease boundaries from Protectable areas, in accordance with the Dieback Interpreter Guidelines (DPaW 2015):

- Minimum upslope buffers 15 m (depending on complexity of disease expression); and
- Minimum downslope buffer of 25 m (depending on degree of slope, drainage patterns, soil type and geology).

No disease boundaries were not demarcated because no Protectable areas were identified within or adjacent to the assessment area.

4.6 Limitations

The following limitations were encountered during the assessment:

1. Access- significant areas, including areas within Whiteman Park, were not accessible; therefore, comprehensive assessment of all potential receiving environments was not possible
2. Pathogen inactivity due to reduced rainfall makes Dieback Interpretation more difficult, with disease expression becoming more cryptic, due to an absence of Indicator Species Deaths (ISDs) and the complicating effects of drought-induced mortality;
3. The timing of the survey (February) means that the potential for 'false negative' results from soil and tissue samples are significantly increased, due to a lack of viable inoculum within the soil profile; and
4. Disturbance as a result of extensive vegetation clearing and agricultural activity, resulting in large areas being categorized as 'Excluded' from assessment due to vegetation condition being Degraded- Completely Degraded.

5 Results

A total of three soil and tissue samples were taken from recently dead disease indicator species within the project area. One sample returned a positive result for *Phytophthora cinnamomi* (Table 4).

Table 4: Sample Results

Sample No.	Species	Easting (GDA 94, Zone 50)	Northing (GDA 94, Zone 50)	VHS Laboratory Results
ETC-S01	<i>Banksia menziesii</i>	401796	6478305	<i>P. cinnamomi</i>
ETC-S02	<i>Xanthorrhoea preissii</i>	401779	6479076	Negative
ETC-S03	<i>Xanthorrhoea preissii</i>	401789	6479501	Negative

In total, 248.58 ha were assessed, with only 7.4 ha being assessable and 241.2 ha being Excluded. Table 5 provides an area statement of the size and proportion of each Dieback mapping category. Figure 2 and Figure 3 show Dieback occurrence mapping and the sample locations within the assessment area.

Table 5: Dieback Mapping Area Statement

Dieback Occurrence Category	Area (ha)	% Area
Infested	0.85	0.34
Uninterpretable (Unprotectable)	6.55	2.63
Excluded	241.19	97.02
Total	248.59	100

6 Discussion

6.1 Excluded Areas

The majority of the assessment area, 97% (241.2ha), has been categorised as Excluded (**Figure 2** and **Figure 3**). These areas are predominately comprised of agricultural land, but also included areas of native vegetation in Degraded or Completely Degraded condition (**Plate 1**).

Although two samples returned negative results, the areas from which the samples were taken were Degraded and are therefore categorised as Excluded (**Plate 2**). Due to a lack of susceptible species, poor vegetation condition and the presence of numerous disturbance impacts, a determination on disease status is not possible for these areas.

6.2 Infested Area

Only a very small proportion of the assessment area was assessable for Dieback. Sample ETRS01 returned a positive result for *P. cinnamomi*, and this small infested area represents the only assessable vegetation within the assessment area (**Plate 3** and **Figure 3**). The Infested area represents 0.34% (0.85ha) of the overall assessment area.

False negative results are common in areas receiving <600mm of annual rainfall are common. Although the mean annual rainfall for the assessment area is 764mm, 2015 has seen a significant reduction in rainfall, with only 578mm being received. Low rainfall can lead to reduced levels of inoculum in the soils therefore potentially compromising sample results.

Dieback is widespread within Whiteman Park, which is immediately adjacent to the west of the assessment area (**Figure 1**). Although the majority of Lord Street between Reid Highway and Gngangara Road is categorised as Excluded, as a precautionary measure this section of the assessment area should be managed as Infested, due to the recovery of positive Dieback samples along Lord Street (**Figure 1**).

6.3 Uninterpretable Areas

Uninterpretable areas comprise 2.63% (6.55ha) of the assessment area (**Figure 2** and **Figure 3**). Vegetation in the Uninterpretable area is dominated by resistant wetland species including *Melaleuca preissiana* and *M. raphiophylla*, (**Plate 4**) and contains or very few Disease Indicator Species.

The Uninterpretable areas do not meet the requirements for Protectable, as defined in DPaW's Protocol for identifying Protectable Areas, due to their size and shape (e.g. > 4 ha with axis >100 m) (DPaW, 2015). In addition these areas do not form any linkages to larger Protectable areas outside the assessment area. Conversely due to the widespread occurrence of Dieback within vegetation and surface water drainage in Whiteman Park, it is possible that the pathogen has been vectored into these areas but disease symptoms are not visible.

6.4 Other Impacts

6.4.1 Drought

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

- No disease pattern or chronology in the surrounding vegetation;
- 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 (**Plate 5**); and
- The presence of single or multiple dead branches with the remainder of the plant appearing to be healthy may be attributed to drought or pathogenic fungi.

Drought impacts were observed throughout the assessment area, especially in areas with a shallow soil profile. However due to the high rate of *P. cinnamomi* recovery from samples taken, the dry conditions did not affect recovery of the pathogen or lead to false negative results.

6.4.2 *Armillaria luteobubalina*

Armillaria luteobubalina (Armillaria) or Australian Honey Fungus is a species of mushroom which causes *Armillaria* root-rot in affected plants. The fungus is widespread in Jarrah (*Eucalyptus marginata*) and Karri (*E. diversicolor*) forests of the southwest of Western Australia, and has also been recorded on the south coast region in Fitzgerald River National Park (Shearer *et al.* 1994a, 1997). *Armillaria* is dispersed by spores produced by the mushroom and also reproduces vegetatively through the roots of affected plants. It affects many of the same plant genera as *Phytophthora*, in particular members of the Myrtaceae and Proteaceae plant families such as *Eucalyptus* and *Banksia* species. *Armillaria* forms quite visible white or yellow leathery mycelial sheath which can be seen beneath the bark in the roots or lower stem. Other observable factors that can be applied in the diagnosis of *Armillaria* infection include:

- Clusters of fruiting bodies around or near the base of the plant
- A pungent mushroom smell
- An inverted V shaped scar at the base of the plant
- Yellow-white stringy rot under the bark in the roots and base of affected plants (DPaW 2015)

No evidence of *Armillaria* was observed within the assessment area.

6.4.3 Other Pathogenic fungi

In addition to the impact of drought the possibility also exists that cankers caused by aerial fungi are having an impact on *Banksia* species in particular (**Plate 6**). The impact of cankers caused by pathogenic fungus on Proteaceous species was examined by Crane and Burgess (2012) in coastal vegetation between Esperance and Cervantes. The study demonstrated pathogenicity in seven *Banksia* spp. over a wide geographic range. The pathogenic fungus was identified as a new genus and species within the *Cryphonectriaceae* (*Diaporthales*) and is described as *Luteocirrhus shearii* gen. sp. nov. The fungus causes the death of single branches. However, it can lead to multiple branch deaths or cause complete crown Dieback as occurred with some of the *Banksia baxteri* and *B. verticillata* sampled (Crane and Burgess 2012).

Some visual evidence of canker or other pathogenic fungi were observed within the assessment area with single limbs of *Banksia* species being dead while the remainder of the tree is healthy.

7 Conclusions

In conclusion, the majority of the assessment area (97%) has been categorised as Excluded. Dieback is widespread within Whiteman Park, which is immediately adjacent to the west of the assessment area. One soil sample, ETRS01, returned a positive result for *P. cinnamomi*; this small infested area is the only assessable vegetation within the assessment area and represents only 0.34% of the overall assessment area.

Uninterpretable areas comprise 2.63% (6.55ha) of the assessment area. Vegetation in the Uninterpretable area is dominated by resistant wetland species, including *Melaleuca preissiana* and *M. raphiophylla*, and contains none or very few Disease Indicator Species. While the Uninterpretable vegetation included scattered *Xanthorrhoea preissii*, some of which were dead, the abundance was considered too low for the vegetation to be interpretable for disease.

The Uninterpretable areas do not meet the requirements for Protectable, under DPaW's Protocol for identifying Protectable Areas, due to their size and shape (e.g. > 4 ha with axis >100 m) (DPaW, 2015). In addition, these areas do not form any linkages to larger Protectable areas outside the assessment area. Conversely, due to the widespread occurrence of Dieback within vegetation and surface water drainage in Whiteman Park, it is possible that the pathogen has been vectored into these areas but disease symptoms are not evident.

Although the majority of Lord Street between Reid Highway and Gnangara Road is categorised as Excluded, Dieback has been recovered at multiple locations along Lord Street, therefore as a precautionary measure this section of the assessment area should be managed as Infested.

While access was limited to the assessment area, Terratree has not identified any Protectable areas through the desktop assessment in potential receiving environments adjacent to, down-gradient or downstream of the proposed Ellenbrook Transit Corridor project area.

8 Dieback Management Recommendations

As the majority of the assessment area should be managed as Infested, with no areas of Protectable vegetation identified within or adjacent to the assessment area, Terratree makes the following recommendations for managing *Phytophthora* Dieback during the Ellenbrook Transit Corridor project:

- All vehicles and machinery should be inspected on arrival to site and be 'clean on entry' i.e. no soil or vegetative material adhering to the vehicle or machine when arriving on site;
- All vehicles and machinery should be inspected before leaving the site and be 'clean on exit' to prevent the spread of Dieback outside the assessment area;
- Personnel should ensure that footwear is 'clean on entry' and 'clean on exit' i.e. free of soil or vegetative material;
- All personnel should be informed about Dieback, in terms of why it poses a significant threat to biodiversity, how the pathogen is spread, and how to avoid spreading it. This information should be incorporated into an induction package for all personnel;
- Dieback management procedures should be developed and implemented, with actions and responsibilities clearly defined to ensure compliance with management recommendations. A recommended Vehicle Hygiene Inspection form is included in **Appendix 1**;
- All soil removed from the site should be disposed of in such a fashion so that the Dieback pathogen is not vectored into Protectable areas; and
- Any native plant species used in revegetation programs should be resistant to the Dieback pathogen to minimise risk to revegetation development and survival. All plants and seedlings should be sourced from Nursery Industry Accreditation Scheme (NIASA) accredited nurseries.

9 References

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10 Glossary of Terms (DPaW, 2015)

Diagnosis - A determining or analysis of the cause or nature of a problem or situation

Dieback (*Phytophthora*) - In the south-west of Western Australia, a disease of plants caused by infection by the soil-borne organisms of the genus *Phytophthora*, of which *P. cinnamomi* is the most widespread.

Dieback (*Phytophthora*) Interpreter - A registered person who does *Phytophthora* Dieback interpretation

Dieback (*Phytophthora*) Interpretation - The method of determining *Phytophthora* Dieback infestation using procedures in the Dieback Interpreter Guidelines (*FEMO47: Phytophthora Dieback Interpreter's Manual for lands managed by the Department, Forest and Ecosystems Management, Department of Parks and Wildlife, March 2015.*)

Disease - the combination of a pathogen, host and correct environmental conditions, which results in disease symptoms or death of a host.

Environment - the sum of all external factors which act on an individual organism during its lifetime.

Excluded Area- areas that have been disturbed to an extent that they are not assessable and therefore excluded from dieback interpretation

Host - means the plant which is invaded by a pathogen and from which the pathogen derives its energy.

Infested Areas - areas that accredited person have determined have plant disease symptoms consistent with the presence of the pathogen *Phytophthora*

Inoculum - cells, tissue, or viruses that are used to inoculate a new culture

Pathogen - any organism or factor causing disease within a host

Protectable Area - Defines areas of land managed by the department, over which hygiene management rules for the plant pathogen *Phytophthora*, including clean on entry, will apply. These areas are generally free of disease.

Susceptible - influenced or able to be harmed by *Phytophthora* Dieback

Sporulation - a type of reproduction that occurs in fungi, algae, and protozoa and involves the formation of spores by the spontaneous division of a cell into four or more daughter cells, each of which contains a part of the original nucleus.

Not Yet Resolved - areas that are interpretable for Dieback but where a determination regarding the disease status cannot be made due to a lack of evidence in the form of positive sample results.

Unprotectable Area -A disease free area that is likely to become infested within a given time.

Uninfested Areas - areas that an accredited person has determined to be free of plant disease symptoms that indicate the presence of the pathogen *Phytophthora* Dieback

Uninterpretable Areas - areas situated in areas receiving > 600+ mm per annum rainfall or are water gaining sites (e.g. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600mm per annum rainfall zone where indicator plants are absent or too few to determine the presence or absence of disease caused by *Phytophthora* Dieback

Vector - Any agent that acts as a carrier or transporter.

11 Figures

Figure 1: Project Location

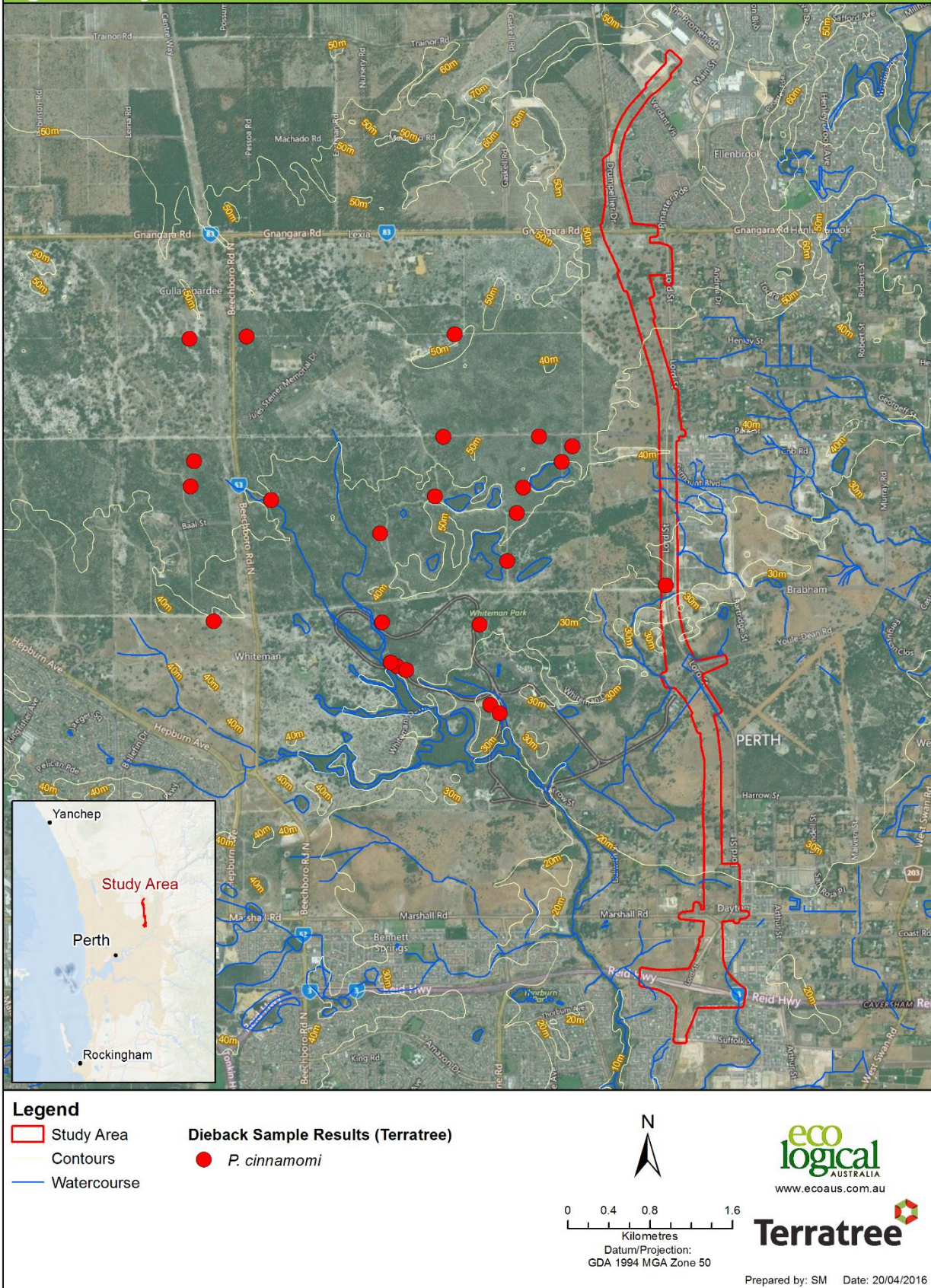


Figure 1: Project Location

Figure 2: Dieback Occurrence Map-Ellenbrook Transit Corridor (North)

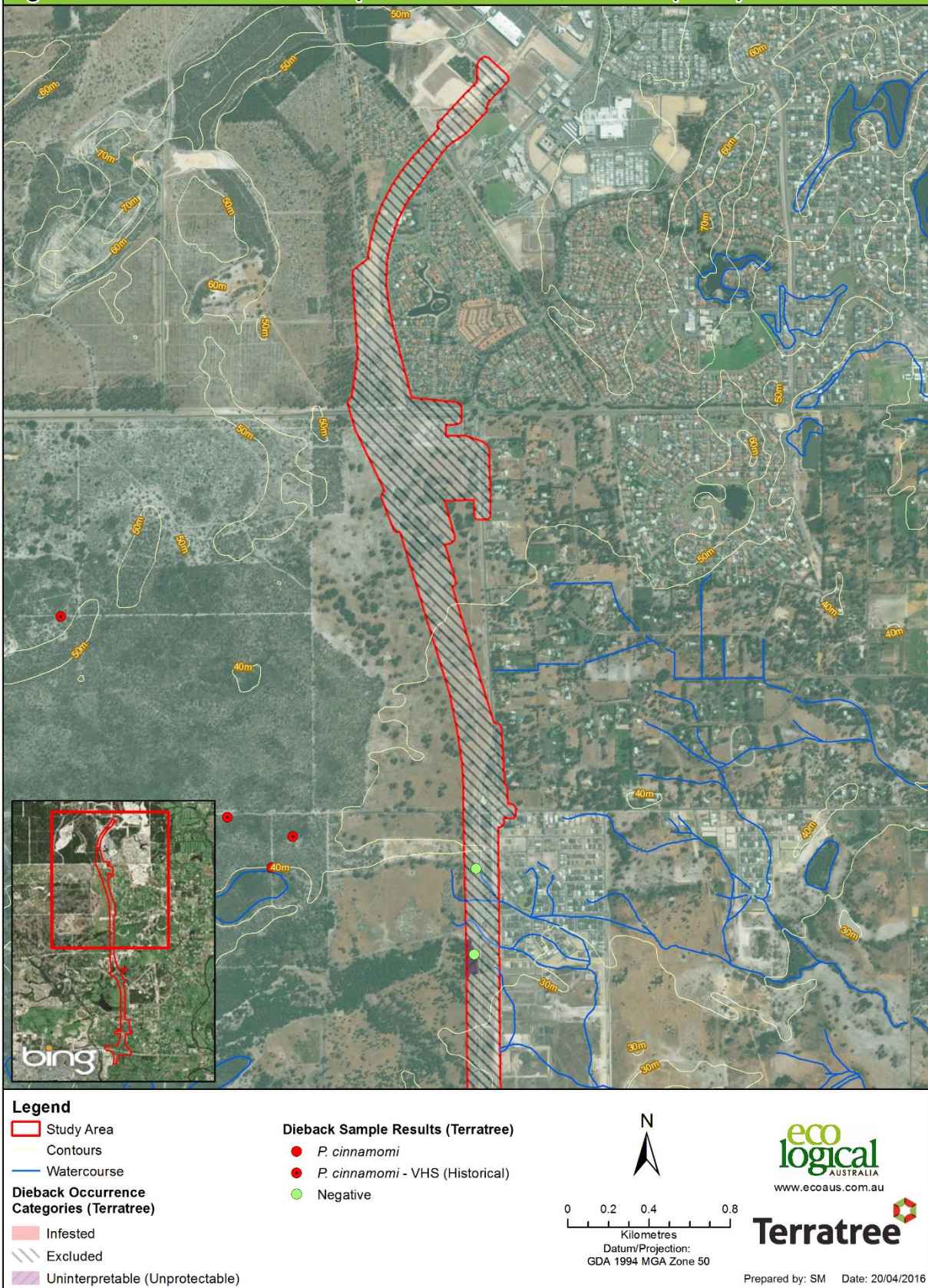
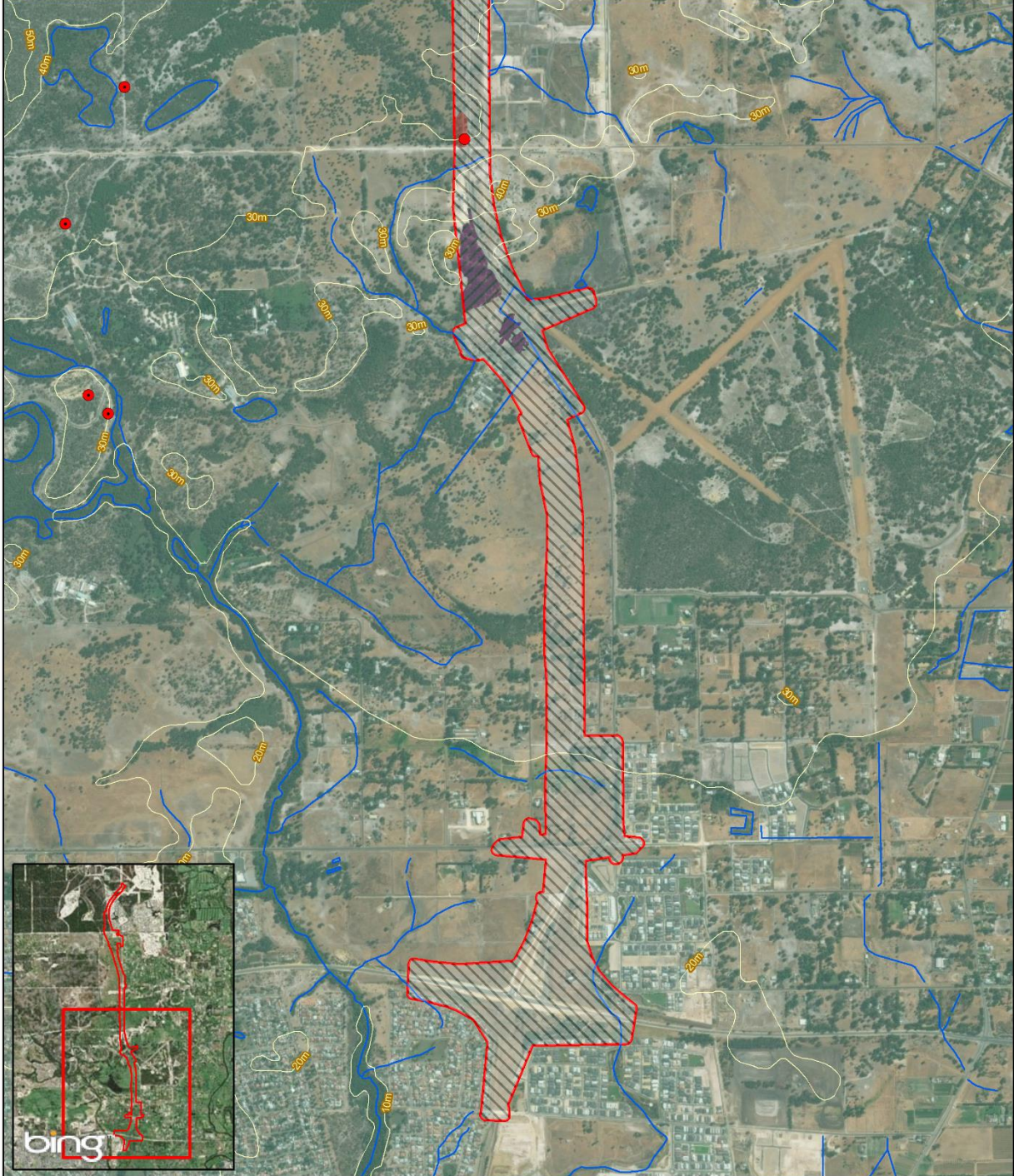


Figure 2: Dieback Occurrence North

Figure 3: Dieback Occurrence Map-Ellenbrook Transit Corridor (South)




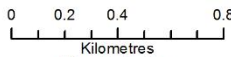











Legend		  Datum/Projection: GDA 1994 MGA Zone 50	 www.ecoaus.com.au 
 Study Area  Contours  Watercourse Dieback Occurrence Categories (Terratree)  Infested  Excluded  Uninterpretable (Unprotectable)	Dieback Sample Results (Terratree)  <i>P. cinnamomi</i>  <i>P. cinnamomi</i> - VHS (Historical)  Negative		

Figure 3: Dieback Occurrence South

12 Plates



Plate 1: Excluded area, due to a vegetation condition



Plate 2: Sample site ETCS03 in Excluded area due to Degraded vegetation condition



Plate 3: Infested sample site ETCS02



Plate 4: Uninterpretable vegetation, due to a lack of Disease Indicator Species



Plate 5: Epicormic re-shooting on a *Banksia attenuata* is evidence of senescence due to drought



Plate 6: Example of canker lesion on a *Banksia* sp.

13 Appendix 1 - Vehicle Inspections (Field Sheet) Dieback Hygiene