Phytophthora Dieback Management Plan:
Elverdton

Report prepared for
Department of Mines,
Industry Regulation and Safety (DMIRS)
May 2023

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Citation: Rathbone, DA (2023). Phytophthora Dieback Management Plan: Elverdton, Department of Mines, Industry Regulation and Safety 2023. Unpublished report by Southern Ecology for DMIRS (SE2205).

Rev. No.	Date	Author	File Name
Draft(RevA)	15/04/2023	DRathbone	SE2205_ElverdtonDMP_RevA_20230415
Final(Rev0)	19/05/2023	DRathbone	SE2205_ElverdtonDMP_Rev0_20230519

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1 SUMMARY

The Department of Mines, Industry Regulation and Safety (DMIRS) seeks to address safety risks associated with historic mine workings within the abandoned Elverdton copper-gold mine site in the Shire of Ravensthorpe under the Abandoned Mines Program. Southern Ecology was engaged to map the occurrence of *Phytophthora* species and specify hygiene management requirements to enable a Detailed Site Investigation (DSI) to be completed for the project area and adjacent areas of interest. The survey area encompassed a 250 metre (m) buffer around the abandoned mine site and approximately 3.7 kilometres (km) of the Steere River to the south-east of the mine site, with the total extent of the survey area encompassing 308 hectares (ha).

The survey area contained 283 ha of remnant vegetation composed primarily of six broad vegetation formations (Mallee, Mallet, Drainage Line Woodlands, *Melaleuca* Woodlands and Shrublands of either *Melaleuca* or She-oak) that encompass 23 regional mapping units. The majority of the vegetation in the survey area was in ‘’Excellent’ condition (204.92 ha). Vegetation disturbance (soil excavation and weed invasion) was most evident surrounding the abandoned Elverdton mining area and deposition of tailings downstream in the Steere River. Infestations of three significant weeds were recorded (Bridal Creeper (**Asparagus asparagoides*), Two Leaved Cape Tulip (**Moraea miniata*) and Arum Lily (**Zantedeschia aethiopica*).

The field interpretation combined with the soil and root sampling determined the survey area to be mapped into two disease status categories for the purposes of managing the spread of *Phytophthora cinnamomi*. The entire survey was deemed to be Protectable from the introduction of *Phytophthora cinnamomi,* which comprised Uninterpretable (267.4 ha) and Excluded (40.7 ha) areas.

Phytophthora pseudocryptogea, *P. litoralis* and *P. boodjera* were recovered from seven soil and root samples from the survey area; 26 other samples collected were negative. The known or extrapolated presence of “*Phytophthora* species other than *cinnamomi*” was subsequently mapped as ‘Other Threats’ (total of 144.77 ha).

Phytophthora cinnamomi is putatively absent from the survey area. However, at least three other species of *Phytophthora* are confirmed to be present. Subsequently, the aim of the Hygiene Management Plan is to reduce the risk of introducing *Phytophthora cinnamomi* and to reduce the localised and regional spread of *Phytophthora* species other than *cinnamomi*. Uncommon in the Ravensthorpe Range, *Phytophthora cinnamomi* is known only from an isolated occurrence <1 km from the survey area. The abandoned Elverdton mining area occurs high in the landscape on a watershed that flows both north and south-east. Consequently, this site is highly undesirable for the introduction of *Phytophthora cinnamomi*.

2 INTRODUCTION

2.1 Background

Phytophthora Dieback disease caused primarily by the soil-born pathogen *Phytophthora cinnamomi* is a major threat to the biodiversity of south-western Australia and is recognised as a key threatening process under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (Department of the Environment (DotE) 2014). *Phytophthora* species can be spread in water, soil or plant material that contains the pathogen or its spores and dispersal is often favoured under warm and moist conditions (Shearer and Tippett 1989). It can be carried in surface or sub-surface water flow and by the movement of infested soil or organic material by either anthropogenic or natural vectors. Consequently, knowledge of the pathogens occurrence within the landscape is essential to inform suitable hygiene management practices to mitigate its spread during soil-disturbance activities.

The Department of Mines, Industry Regulation and Safety (DMIRS) seeks to address safety risks associated with historic mine workings within the abandoned Elverdton copper-gold mine site in the Shire of Ravensthorpe under the Abandoned Mines Program. The site is currently classified by the Department of Water and Environmental Regulation (DWER) as *"Possibly contaminated – investigation required"* under the *Contaminated Sites (CS) Act 2003.* The site is characterised by two (south and north) uncontained Tailings Storage Facilities (TSF), a large deposition fan of uncontrolled tailings and various abandoned mine features including open shafts. In addition, eroded tailings and associated mining slurry have been deposited beyond the site and into the upper reaches of the Steere River valley (DMIRS 2022).

In 2019, DMIRS engaged Golder Associates (2019) to undertake Preliminary Site Investigation (PSI) and based on the PSI results developed a Sampling and Analysis Quality Plan (SAQP) for the site to support the completion of the Detailed Site Investigation (DSI).

The sampling methodologies within the SAQP include disturbance activities that are necessary to complete the DSI. Southern Ecology was engaged to identify and map the occurrence of *Phytophthora* species and develop a hygiene management plan appropriate for the identified disturbance activities required for the DSI. The survey area encompassed a 250 metre (m) buffer around the abandoned mine site and approximately 3.7 kilometres (km) of the Steere River to the south-east of the mine site, with the total extent of the survey area encompassing 308 hectares (ha) (Figure 1.).

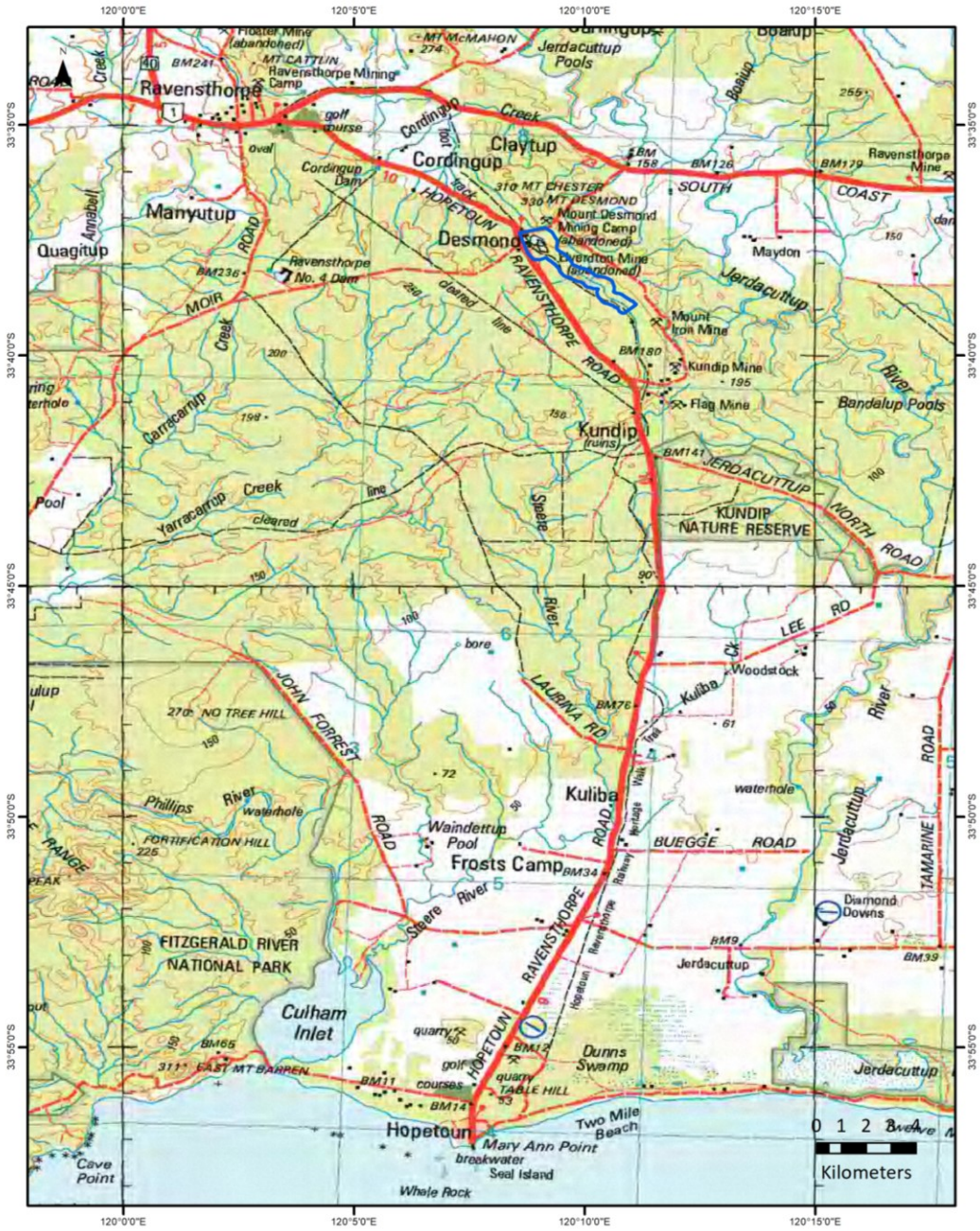

Figure 1. Location of the survey area (blue polygon).

2.2 Scope of Works

Southern Ecology was engaged to map the occurrence of *Phytophthora* species within the survey area and to provide hygiene management recommendations to reduce the spread of soil pathogens and weeds during soil disturbance activities.

The scope of works was to undertake the following:

1. Undertake a desktop assessment of known dieback locations, vegetation condition mapping and vegetation community mapping in the study area (10 km radius) to inform assessment.
2. Identify areas of native vegetation within the survey area.
3. Undertake a dieback survey in accordance with relevant Department of Biodiversity, Conservation and Attractions (DBCA) guidelines (Department of Parks and Wildlife [DPAW] 2015) to identify the presence (status) of *Phytophthora* species where native vegetation occurs within the survey area.
4. Prepare a Hygiene Management Plan for the project with details of appropriate management controls to prevent the spread of soil pathogens and weeds.

2.3 Physical and Biological Environment

2.3.1 Interim Biogeographic Regionalisation for Australia

The Interim Biogeographic Regionalisation for Australia (IBRA version 7) divides the Australian continent into 89 large geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. The survey area is located within the Esperance Plains Interim Biogeographic Regionalisation of Australia (IBRA) Region and Fitzgerald Subregion (Department of Climate Change, Energy, the Environment and Water [DCCEEW] 2022).

2.3.2 Tenure and Environmentally Sensitive Areas (ESAs)

No conservation reserves occur within the survey area. The nearest conservation reserve is Kundip Nature Reserve, approximately 7.5 km to the south (DPIRD 2019a). The site is largely situated upon Class C crown reserve, within three mining/prospect tenures (M 74/102, P74/340, M74/246). The site is adjacent to the Ravensthorpe Range, of which large areas are formally recognised as Environmental Sensitive Areas (ESAs) and have previously been recommended for inclusion in the conservation estate (proposed nature reserve) by the Environmental Protect Authority, Western Australia (EPA 1993).

2.3.3 Vegetation and Flora

Broad scale pre-European vegetation mapping (Shepherd *et al.* 2002) indicates that the native vegetation of the area is composed of:

- “Eucalypt shrubland *Eucalyptus eremophila*, *E. redunca*, *E*. spp.” (Vegetation Association: 516).

The survey area occurs within part of the Ravensthorpe Range where regional vegetation mapping has previously been undertaken (Craig *et al*. 2008), which identifies the occurrence of approximately 23 vegetation units within the survey area.

2.3.4 Land Systems and Soils

One soil-landscape unit has been mapped within the survey area (DPIRD 2019a):

- Ravensthorpe 2 Subsystem (244Ra_2) - undulation plain and low hills colluvial slopes

2.3.5 Existing Dieback Information

No previous comprehensive Phytophthora Dieback mapping or sampling has been officially registered within the survey area prior to 2022 (Dieback Information Delivery System (DIDMS) (GAIA 2019). *Phytophthora cinnamomi*, *P. pseudocryptogea*, *P. boodjera, P. boodjera/arenaria, P. nicotianae, P. cassamura* and *P. thermophila* have been recovered from multiple soil and root samples within 10 km of the study area (includes samples collected by Southern Ecology 2019-2022) (Figure 2). The survey area occurs within a separate water catchment to the known *Phytophthora cinnamomi* infestation on Desmond Track.

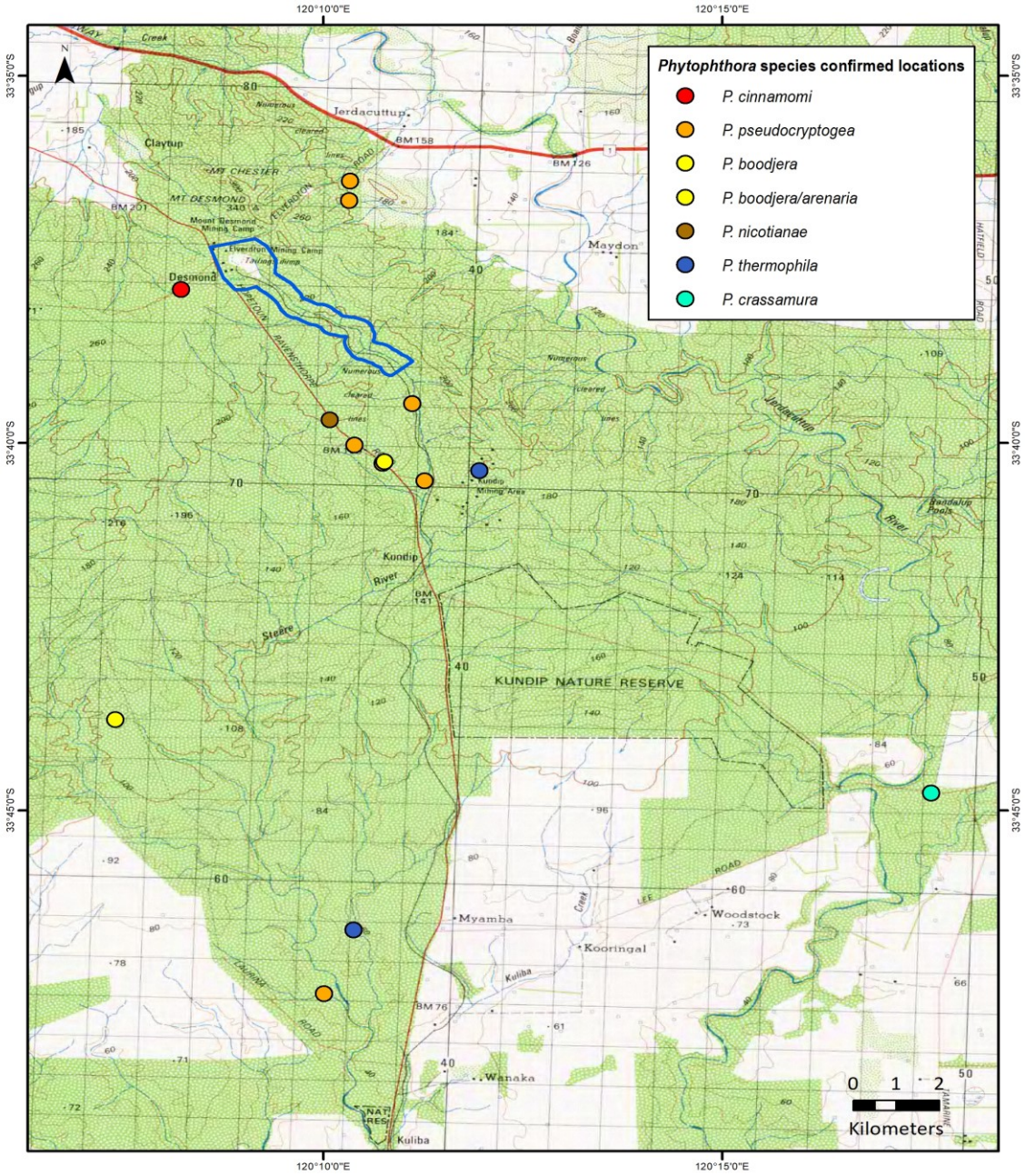

Figure 2. The survey area (blue polygon) and closest known *Phytophthora* species records derived from the Dieback Information Delivery System (DIDMS) (GAIA 2019) and Southern Ecology (2019-2022).

2.3.6 Weather

Seasonal conditions and the climatic characteristics of a site can influence the perceptibility of disease caused by *Phytophthora* species and pathogen recovery from soil and root samples (Shearer and Tippett 1989). The survey area occurs within a moderate rainfall zone for Phytophthora Dieback (Figure 3). The conditions during and preceding the survey are considered suitable for the interpretation and sample recovery of *Phytophthora* species from the survey area.

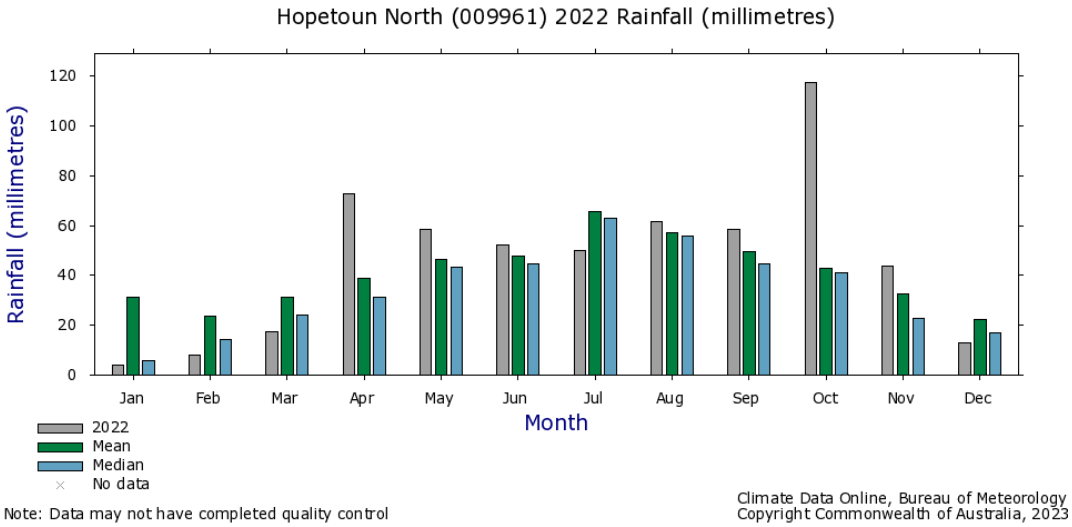

Figure 3. Climate statistics for 2022 compared with historic averages (all years available) from the nearest weather station (Hopetoun North) (Bureau of Meteorology [BOM] 2023).

3 METHODS

3.1 Personnel

The assessment (desktop and field assessment) was conducted by Damien Rathbone (BScHons Plant Science, Scientific License FB2000229) and Colin Crane. Damien has over 14 years of experience conducting biological surveys in southern Western Australia. Within the south coast region, he has previously undertaken DBCA regional surveys (Albany Regional Vegetation Survey, Fitzgerald River National Park Flora Survey, Ravensthorpe Range Flora Survey), threatened species survey and recovery implementation. Damien is also an accredited interpreter for dieback assessments on DBCA estate (Accreditation PDI-032).

Colin Crane is a plant disease specialist with over 30 years' experience within southern Western Australia. Colin was previously the manager of the Vegetation Health Service (Department of Biodiversity, Conservation and Attractions) and has undertaken extensive research on the structural, functional and genetic diversity of fungal plant pathogens and their hosts.

3.2 Desktop Assessment

A desktop assessment of existing *Phytophthora* occurrence information and contextual vegetation and flora values within the study area (approximately 10 km radius of the survey area) was undertaken using the following sources:

- Dieback Information Delivery System (DIDMS) (GAIA 2019).
- Unpublished reports and management documents:

Craig 2004, Craig *et al.* 2008, Gleven 2006, Golder Associates 2019, Great Southern Bio Logic 2021, NRG 2011, Rathbone 2020, 2021, 2022 and Terratree 2013.

3.3 Field Assessment

3.3.1 Schedule

The field assessment was undertaken from the 12th to the 17th of September 2022 (traverse of the survey area and soil and root sample collection). The assessment was undertaken using a combination of a targeted survey of micro-catchments and vectors in the abandoned Elverdton mining area and a 'linear' survey of the Steere River, the Ravensthorpe-Hopetoun heritage trail and other relevant access tracks (7.5 km).

3.3.2 Interpretation (Phytophthora cinnamomi)

Field interpretation was conducted following the standard operating procedures for linear assessments as described in the "*Phytophthora Dieback Interpreters Manual for Lands Managed by the Department*" (DPAW 2015a). Most of the area was interpreted by foot or vehicle traverse, with particular emphasis on sites where pathogen vector pathways were present. The condition of the remnant vegetation was also broadly mapped using categories defined for Environmental Impact Assessments in Western Australia (Table 1, Environmental Protection Authority [EPA] 2016).

The potential occurrence of *Phytophthora* species was determined through observation of the symptomatic evidence of disease and supported by sampling of soil and roots of recently dead susceptible host plants. Areas were defined into six potential disease status categories relevant to *Phytophthora cinnamomi*:

- *Infested* (disease symptoms present, *Phytophthora cinnamomi* only).
- *Uninfested* (disease symptoms absent).
- *Uninterpretable* (undisturbed areas where susceptible host plants are absent, or sparse).
- *Temporarily Uninterpretable* (indeterminate due to disturbance with anticipated short to medium term recovery e.g. fire or rehabilitation).
- *Not yet resolved* (indeterminate due to inconsistent or incomplete evidence in low interpretability climatic zones (400mm to 600mm rainfall range)).
- *Excluded* (sealed roads and cleared area devoid of native vegetation)

3.3.3 Interpretation (Phytophthora species other than cinnamomi)

Mapping the occurrence of *Phytophthora* species other than *P. cinnamomi* is only partially addressed within the regulatory guidelines (DPAW 2015a). Within this report, point sample data indicates the location of soil and roots samples where *Phytophthora* species other than *cinnamomi* have been recovered (Appendix A). Surrounding areas at risk of these *Phytophthora* species through water mediated dispersal are mapped as 'Other threats' and are represented as a hatched overlay. The term 'Infested' is reserved for *Phytophthora cinnamomi* only.

3.3.4 Soil and Root Sampling

Soil and root samples associated with dead or dying susceptible host plants were collected to confirm the presence of *Phytophthora* species. Diagnostic baiting of the samples was conducted by the Department of Biodiversity Conservation and Attractions (DBCA) Vegetation Health Service (VHS), Kensington, Perth, which determined the potential presence and species identity of any *Phytophthora* isolated.

3.3.5 Protectable Areas

Protectable Areas are generally defined as areas that will not be invaded by *Phytophthora* (relating specifically to *Phytophthora cinnamomi*) via autonomous spread in the short term (10 to 20 years) and anthropogenic spread can be mitigated by soil hygiene management (DPAW 2015a). Regulatory guidance indicates the minimum patch size threshold for Protectable Areas is > 4 ha. However, where other high conservation or social values are present this threshold may be reduced.

3.3.6 Demarcation

Protectable Areas and risk areas are demarcated with management Clean on Entry (CoE) points to guide construction activities. Buffers applied to Infested areas are located 15 m upslope or 25 m (or greater) downslope from the active disease edge. The Clean on Entry management points, disease status boundaries (including buffers), soil and root samples and field observations were recorded with a non-differential, hand-held global positioning system (GPS) (Garmin Oregon 7000, ± 5 m accuracy) (MGA zone 51, GDA94).

Table 1. Vegetation condition scale (EPA 2016).

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance or damage caused by human activities since European settlement.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. Damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle tracks.
Very Good	Vegetation structure altered, obvious signs of disturbance. Disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds at high density, partial clearing, dieback and grazing.
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 and shrubs.

3.3.7 Survey Limitations

To aid in the identification of potential survey limitations, guidelines in the EPA document *Technical Guidance - Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) were adopted (Table 2). No avoidable limitations were identified that can be expected to have affected the reliability of the results of the field survey.

Table 2. Assessment of potential survey limitations (EPA 2016).

Potential for Limitation	**Assessment**
Availability of contextual information	Very few positive root and soil samples have previously been collected within the vicinity of the survey area. However, it was assumed that *Phytophthora* species would be more widespread than records indicated. Regional vegetation mapping was available to allow for an appropriate level of contextual information prior to the field survey.
Personnel experience	Personnel undertaking the survey have in excess of 10 years' experience within southern bioregions of WA.
Extent of survey and site access	The site was very large (308 ha), access was nearly entirely limited to foot traverse and many areas contained dense vegetation. The presence of abandoned mine shafts was also a significant safety concern, which required working in pairs (in sight) in high-risk areas, therefore increasing labour requirement. The site was not comprehensively covered by 50 m transect due to extent of Uninterpretable vegetation and limitations above. Targeted assessment and high intensity sampling of micro-catchments and potential pathogen vectors was deemed as a suitable method.
Seasonal conditions	Rainfall preceding the survey was close to average. As such the seasonal conditions were considered suitable for dieback expression, interpretation and sampling (Figure 3). The relatively high rate of pathogen recovery indicates the survey timing was ideal.
Disturbances	A large proportion of the survey area is long unburnt vegetation dominated by Myrtaceous species therefore any *Phytophthora* expression may be difficult to detect.

4 RESULTS & DISCUSSION

4.1 Vegetation Type and Susceptibility

The survey area encompassed approximately 283 ha of remnant vegetation and 25 ha of cleared areas. The vegetation within the survey area was composed primarily of six broad vegetation types (percentages shown) that encompass 23 regional mapping units (Craig *et al*. 2008) (Appendix A, Map 1):

1. Mallet – 4.36%
   - *Eucalyptus clivicola* (Ecli)
   - *Eucalyptus cernua* (Ecer)
2. Mallee – 74.34%
   - *Eucalyptus falcata/ E. pleurocarpa* (Efal/Eple)
   - *Eucalyptus falcata/ Allocasuarina campestris* (Efal/Alca)
   - *Eucalyptus flocktoniae/ Eucalyptus* species (Eflo/Espp)
   - *Eucalyptus uncinata/ Eucalyptus incrassata* (Eunc/Einc)
   - *Eucalyptus uncinata/ Eucalyptus species* (Eunc/Espp)
   - *Eucalyptus pleurocarpa/ Banksia media* (Eple/Bmed)
   - *Eucalyptus* species/ *Melaleuca* species (Mallee/Mspp)
   - *Eucalyptus pileata* (Epil)
   - *Eucalyptus desmondensis/ Allocasuarina campestris* (Edes/Alca)
   - *Eucalyptus proxima* (Epro)
   - *Eucalyptus proxima/ Melaleuca* species (Epro/Mspp)
   - *Eucalyptus suggrandis/ Melaleuca* species (Esug/Mspp)
   - *Eucalyptus sporadica (Espo)*
   - *Eucalyptus flocktoniae/ Melaleuca cucullata* (Eflo/Mcuc)
3. Drainage Line Woodland - 2.24%
   - *Eucalyptus occidentalis* (Eocc)
4. *Melaleuca* Shrublands – 7.7%
   - *Melaleuca hamata* (Mham)
   - *Melaleuca elliptica* (Mell)
   - *Melaleuca stramentosa* (Mstr)
   - *Melaleuca acuminata* (Macu)
5. *Melaleuca* Woodlands - 0.13%
   - *Melaleuca cuticularis* (Mcut)
6. She-oak Shrublands – 3.39%
   - *Allocasuarina campestris* (Alca)

The Mallet, Mallee, *Melaleuca*/She-oak Shrublands occurred on hill slopes and ridges and were composed mainly of plant species from the Myrtaceae and Cyperaceae that are unsusceptible to *Phytophthora* (will not exhibit disease symptoms), therefore these vegetation types are generally considered Uninterpretable (Plate 1 and 2). Drainage Line Woodlands were confined to the riparian zone (Steere River) within the valley floor and were composed of various shrub species with an emergent canopy of *Eucalyptus occidentalis* (Plate 3). This vegetation was considered Uninterpretable despite containing occasional susceptible species that were sampled at isolated locations.

Susceptible Proteaceous species did not form a dominant shrub layer within any vegetation type in the survey area that would be considered Interpretable. Symptomatic evidence of disease related to *Phytophthora* species was assessed by subtle evidence of isolated indicator species deaths and association with water gaining sites.

A list of susceptible host species in the vegetation types described above is provided (Table 3). The incidence and pattern of disease symptoms in these taxa was considered an indication of the potential presence of *Phytophthora* species.

Plate 1. Mallet. *Eucalyptus clivicola* (Ecli).

Plate 2. Mallee. *Eucalyptus pileata* (Epil), with other units interspersed.

Plate 3. Drainage Line Woodland. *Eucalyptus* occidentalis.

Table 3. Susceptible species from the survey area considered useful indicators (likely to show disease symptoms) for the presence of *Phytophthora* species.

Family	Taxon
Ericaceae	*Leucopogon pendulus*
Ericaceae	*Leucopogon infuscatus*
Ericaceae	*Styphelia intertexta*
Fabaceae	*Daviesia teretifolia*
Fabaceae	*Daviesia decurrens*
Iridaceae	*Patersonia limbata*
Iridaceae	*Patersonia occidentalis*
Proteaceae	*Banksia cirsioides*
Proteaceae	*Banksia lemanniana*
Proteaceae	*Banksia media*
Proteaceae	*Banksia tenuifolia*
Proteaceae	*Hakea laurina*
Proteaceae	*Hakea nitida*
Proteaceae	*Hakea lissocarpha*
Proteaceae	*Isopogon* sp. Fitzgerald
Proteaceae	*Petrophile squamata*
Proteaceae	*Petrophile fastigiata*
Proteaceae	*Isopogon trilobus*
Proteaceae	*Synaphea petiolaris*
Xanthorrhoeaceae	*Xanthorrhoea platyphylla*

4.2 Vegetation Condition and Weeds

The majority of the vegetation in the survey area was in 'Excellent' condition (204.92 ha, Table 4, Appendix A, Map 2). Vegetation disturbance (soil excavation and weed invasion) was most evident surrounding the abandoned Elverdton Mining area due to historic activities (Plate 4 and 5). Downstream areas within the Steere River were devoid of vegetation in some areas, smothered by tailings deposition (Plate 6). Extensive vegetation slashing has occurred in serval linear strips adjacent to road and tracks for fire hazard reduction.

Table 4. Extent (ha) and condition of remnant vegetation in the survey area.

	Condition					
	Cleared	**Degraded**	**Good**	**Very Good**	**Excellent**	**Total:**
Extent (ha)	24.77	37.98	15.51	24.95	204.92	**308.14**

Plate 4. Old mine workings near Elverdton Road, 235385mE, 6276177mN (MGA zone 51, GDA94).

Plate 5. Extensive weed invasion of understory layer, 235329mE, 6275501mN (MGA zone 51, GDA94).

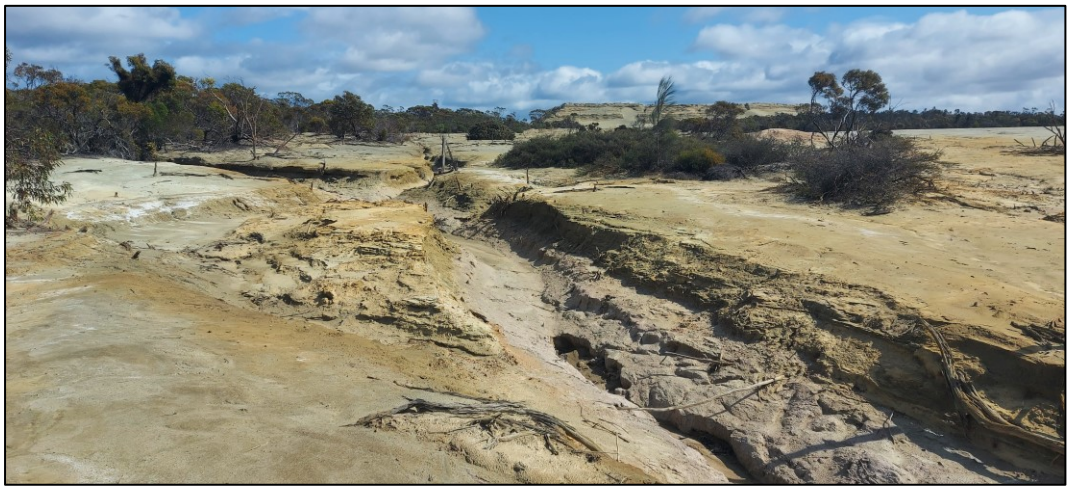

Plate 6. Tailings deposition area in the Steere River.

4.3 Weeds

Cleared areas were not comprehensively surveyed, therefore not all weeds within the survey area were necessarily recorded. Weeds considered to be significant (Declared Pests (DP) (DPIRD 2022b) or Weeds of National Significance (WoNS) (DotEE 2019)) or that were commonly encountered within remnant vegetation were recorded and/or mapped. Infestations of three significant weeds were recorded (Appendix A, Map 2): Bridal Creeper (**Asparagus asparagoides*, WoNS and DP), Two Leaved Cape Tulip (**Moraea miniata,* DP) and Arum Lily (**Zantedeschia aethiopica,* DP) (Plate 7 and 8).

Plate 7. Dense infestation of Two Leaved Cape Tulip (**Moraea miniata,* **DP), 235185mE, 6276099mN (MGA zone 51, GDA94).**

Plate 8. Bridal Creeper (**Asparagus asparagoides***, WoNS and DP) in the Steere River.**

4.4 Soil and Root Sampling

Soil and root samples were collected to provide empirical evidence to support the disease interpretation of the survey area. Samples were taken from recently dead or dying susceptible plant species at 33 locations (Plate 9., Table 5., Appendix A, Map 3A and B).

Thirty-three soil and root samples were collected and analysed; all were negative for *Phytophthora cinnamomi*. However, *P. pseudocryptogea* was recovered from three samples and *P. boodjera* and *P. litoralis* were recovered from two samples each. The recovery of *Phytophthora* species other than *cinnamomi* were generally associated with water gaining sites where scattered deaths of indicator species were observed. *Phytophthora cinnamomi*, *P. boodjera, P. boodjera/arenaria* and *P. nicotianae* have also been previously recovered in close vicinity to the survey area and were considered in mapping disease and pathogen risk.

Plate 9. Soil and root sample collection of indicator species death (*Petrophile fastigiata*).

Table 5. Results of soil and root samples from Vegetation Health Service (VHS). All sample locations (MGA zone 51, GDA94) are mapped in Appendix A, Map 3A and B. *Phytopythium* sp. is not considered a pathogen of concern.

Coll_No	Date	Host	Result	Easting	Northing
Dar268	11/06/2022	*Banksia media*	Negative	235664	6276230
Dar269	11/06/2022	*Banksia media*	Negative	235888	6276120
Dar282	17/09/2022	*Patersonia limbata*	Negative	238247	6273400
Dar292	12/09/2022	soil only	Negative	235494	6275590
Dar293	12/09/2022	*Daviesia decurrens*	Negative	235446	6275580
Dar294	12/09/2022	soil only	*Phytopythium* sp.	235164	6275960
Dar295	12/09/2022	soil only	Negative	235134	6275780
Dar296	12/09/2022	soil only	Negative	235131	6275680
Dar297	12/09/2022	*Petrophile fastigiata*	Negative	235220	6275440
Dar298	12/09/2022	soil only	Negative	235513	6275440
Dar299	12/09/2022	soil only	Negative	235568	6275360
Dar300	12/09/2022	soil only	Negative	235479	6275340
Dar301	12/09/2022	soil only	*Phytopythium* sp.	235412	6275330
Dar302	13/09/2022	soil only	*Phytopythium* sp.	235354	6275970
Dar303	13/09/2022	*Petrophile fastigiata*	Negative	235315	6276120
Dar304	13/09/2022	soil only	Negative	235387	6276180
Dar308	15/09/2022	*Petrophile fastigiata*	Negative	236055	6275320
Dar309	15/09/2022	soil only	Negative	236194	6275170
Dar310	15/09/2022	*Hakea laurina*	Negative	236374	6275000
Dar311	15/09/2022	*Hakea laurina*	Negative	236870	6274570
Dar312	15/09/2022	*Petrophile fastigiata*	Negative	237511	6274200
Dar313	15/09/2022	soil only	*P. litoralis*	237866	6273490
Dar314	15/09/2022	soil only	*P. litoralis*	236814	6274370
Dar315	15/09/2022	*Banksia cirsioides*	*P. pseudocryptogea*	235300	6275380
Dar316	16/09/2022	*Grevillea patentiloba*	*P. pseudocryptogea*	235226	6276140
Dar317	16/09/2022	*Banksia lemanniana*	*P. boodjera*	235904	6276050
Dar318	16/09/2022	*Isopogon* sp. Fitzgerald River	*P. boodjera*	236227	6275610
Dar319	16/09/2022	*Petrophile fastigiata*	Negative	236230	6275531
Dar320	16/09/2022	*Beaufortia schaueri*	Negative	235828	6276160
Dar321	16/09/2022	*Petrophile fastigiata*	Negative	236158	6275320
Dar322	16/09/2022	soil only	*Phytopythium* sp.	236137	6275170
Dar323	16/09/2022	soil only	Negative	236145	6276020
Dar324	16/09/2022	soil plus *Acrotriche ramiflora*	*P. pseudocryptogea*	235542	6276230

4.5 Disease Status and Protectability

The field interpretation combined with the soil and root sampling determined the survey area to be mapped into two disease status categories for the purposes of managing the spread of *Phytophthora* species; the entire site is determined to be Protectable from the introduction of *Phytophthora cinnamomi* (Table 6).

The majority of the survey area was determined to be Uninterpretable (267.4 ha) due to a low natural incidence of indicator species. All Uninterpretable vegetation was included as a Protectable Area due to a lack of evidence of *Phytophthora cinnamomi* and the putative absence of infestations upslope of the survey area. Areas mapped as Excluded (40.7 ha), including the abandoned Elverdton mining area, are generally hydrologically contiguous with the surrounding area that is putatively free of *P. cinnamomi*, therefore were also included as Protectable. The abandoned Elverdton mining area occurs high in the landscape on a watershed that flows both north and south-east. Consequently, this site is highly undesirable for the introduction of *P. cinnamomi*.

Phytophthora species other than cinnamomi ('Other Threats')

Methods for detecting and mapping the occurrence of *Phytophthora* species other than *cinnamomi* are only partially addressed within the regulatory guidelines (DPAW 2015a), primarily due to their infrequent recovery in the Perth region and a paucity of information on their impacts and expression in host species. However, in accordance with DBCA policy 3 (DPAW 2015b) introduced *Phytophthora* species should be managed similarly to *P. cinnamomi.*

Phytophthora pseudocryptogea, *P. litoralis* and *P. boodjera* were recorded widely across the survey area. The known or potential presence of "*Phytophthora* species other than *cinnamomi*" has subsequently been mapped as 'Other Threats' (total of 144.77 ha). An accurate occurrence map of these species cannot be determined using standard interpretation principles (DPaW 2015a), therefore a precautionary approach had been adopted in this plan. The extent is based on observed symptomatic evidence (subtle) and extrapolation of water mediated dispersal and other potential vectors (Plate 10, 11, 12 and 13). This extent should be treated as indicative only. Soil disturbance activities and movement through areas at risk of *Phytophthora* species other than *cinnamomi* should be avoided in wet soil conditions; Clean on Exit (CoEx) will be required for plant, equipment, vehicles and footwear exiting the Steere River (see Hygiene Plan).

Table 6. Extent of disease status categories within the survey area. The entire survey area is considered Protectable (from introduction of *P. cinnamomi*). A large proportion of the survey area was also mapped as an overlay of ''Other Threats'' due to the known or potential presence of *Phytophthora* species other than *cinnamomi* (144.77 ha).

Status	Area (ha)
Uninterpretable (Protectable)	267.44
Excluded (Protectable)	40.69
Total:	**308.14**

Plate 10. Abandoned tailings drain conducive for *Phytophthora pseudocryptogea,* 235357mE, 6275991mN (MGA zone 51, GDA94).

Plate 11. Water storage dam conducive for *Phytophthora pseudocryptogea.*

Plate 12. Hopetoun Ravensthorpe Heritage Trail overlies the historic railway formation. Vector for potential pathogens.

Plate 13. Old access track off Elverdton Road into the survey area, closed to public by bunding mound, 235031mE, 6276086mN (MGA zone 51, GDA94).

4.6 Hygiene Management Plan

4.6.1 Risk Assessment

A risk assessment that determines the 'Likelihood' and 'Consequence' of introducing or spreading *Phytophthora* during the proposed DSI activities was undertaken in accordance with the *Phytophthora Dieback Management Manual* (DBCA 2017). The DSI will require soil disturbance activities at single points and no use of heavy machinery is proposed. Restricted access will limit vehicle movement within the project area and any movement through remnant vegetation will be limited to foot traverse. No importation of soil or raw materials is proposed. Consequently, the 'Likelihood' of introducing or spreading *Phytophthora* without hygiene strategies during these activities is considered 'Possible'.

The potential 'Consequence' of introducing or spreading *Phytophthora* is dependent on the values of the biodiversity that may potentially be impacted. The 'Consequence' for the proposed activities is considered 'Significant' due to the presence of large areas of Uninfested vegetation (*Phytophthora cinnamomi* is not known to occur within the project area or the Steer River Catchment below). The combined overall risk rating for the activities are considered 'Moderate' under dry soil conditions and 'High' under wet soil conditions.

The risk of introducing or spreading *Phytophthora* can be partially mitigated by operating in low soil moisture conditions and through implementing soil hygiene management strategies.

4.6.2 Hygiene Management Strategies

The aim of hygiene management is to minimise the anthropogenic spread of *Phytophthora* species through the movement of contaminated soil or plant tissue. Best management principals include; demarcation of disease boundaries, minimising entry points; ensuring Clean on Entry (CoE) is applied to plant, equipment, vehicles, and footwear and allowing only uninfested basic raw materials to enter Protectable Areas (Conservation and Land Management [CALM] 2003).

The proposed activities occur within an area where *Phytophthora cinnamomi* was determined to be absent. However, other species of *Phytophthora* were confirmed to be present. Subsequently, the aim of the hygiene management recommendations are to reduce the risk of introducing *Phytophthora cinnamomi* and to reduce the potential localised and regional spread of *Phytophthora* species other than *cinnamomi*. All disease status categories, management and sample points are presented in Appendix A, Map 4A&B.

Project Planning

1. Ensure all *Phytophthora* dieback occurrence information is valid/up-to-date for the period of project operation (see section 4.7). Protectable Areas should be checked/retaped if required, shortly prior to the proposed activities (the entire project area is considered Protectable due to the putative absence of *Phytophthora cinnamomi*).
2. Ensure all staff and contractors working within the project area have undertaken appropriate awareness training of *Phytophthora* (i.e., Green Cards are recommended, but only mandatory on DBCA estate).
3. Timing of all operations should be conducted in dry soil conditions where possible (generally between November and April), to reduce the adhesion of soil material during operation.
4. Contractors with demonstrated experience in *Phytophthora* hygiene management should be favoured during procurement.
5. Contractors are required to demonstrate record keeping and standard operating procedures for hygiene relevant to all equipment and vehicles (i.e., this includes a washdown checklist specific to each vehicle e.g.,'FEM080' (DBCA 2023-)). It is recommended that inspections (routine and/or random) of contractors at CoE points are undertaken by an independent party (i.e., internal staff/ external consultant).
6. Basic biosecurity hygiene management procedures are required for all operations and include consideration of weeds and other potential pathogens (including other isolates and species of *Phytophthora*).
7. All plant, equipment, vehicles and footwear should be free of soil and weed seeds prior to entering the survey area and should be cleaned after operations / before commencing work in new locations.
8. Strategies to further reduce the risk of spreading weeds and other pathogens is to operate from areas of high to low elevation and to operate from areas of high to low vegetation condition (i.e., Excellent to Degraded).
9. DMIRS will be responsible for supervision of contractors and evaluation of any environmental or hygiene breaches.

On-Ground Actions

1. Clean on Entry (CoE) points are key locations where inspection/clean down of vehicles or plant may be required prior to gaining access into Protectable Areas (or crossing relevant disease status boundaries). Four key Clean on Entry points are identified for the project, including the main entrance gate off the sealed Hopetoun-Ravensthorpe Road and three gravel tracks (Ridgeline, Northern and Southern access track).
2. Effective clean down prior to accessing the site should be conducted at an appropriate facility or site to remove all soil and plant material (including weed seeds). Publicly available washdown facilities are available near the project area in Hopetoun. The key components of an appropriate washdown are:

a) All effluent is captured during washdown i.e., sump, for later transport and disposal, or diverted into the same disease status category.
b) Cleaned objects exit washdown area without becoming re-contaminated.
c) Transportation of cleaned vehicles and equipment to Protectable areas should be undertaken via sealed roads where possible.

3. Clean on Exit (CoEx) points are locations within the survey area where inspection/clean down after completion of activities may be required. Clean down effluent must either be confined within the Infested/Risk area or at an appropriate facility if it is possible to transport equipment without dislodging contaminated soil and plant material. CoEx is required when exiting areas of the Steere River at risk of *Phytophthora* species other than *cinnamomi* 'Other Threats' (i.e., Southern Access track).
4. Inspections of all plant, equipment, vehicles and footwear at the CoE/CoEx points must be undertaken and recorded.
5. In some instances, a dry brush-down can be used to clean down (i.e., using brush and compressed air). Generally, this can only be undertaken in low soil moisture conditions where there is low adhesion of soil.
6. Footwear and equipment should be clean (i.e., free of soil and plant material) when moving between all point sampling locations. This should be undertaken to reduce the risk of spreading species of *Phytophthora* other than *cinnamomi* within the site. For effective cleaning, use a stiff brush and disinfectant, see ancillary information in DBCA (2023 -).

4.7 Assessment Validity

The *Phytophthora* occurrence information in this report is valid as of the 17th September 2022. *Phytophthora* species can spread autonomously or by unauthorised vehicles, bush walkers, animals and via root-to-root plant contact, therefore the results of this assessment are not valid indefinitely. Guidance documents (DPaW 2015a) specify Uninfested boundaries should be revalidated after one year and a full re-interpretation should be undertaken after three years (if on DBCA estate).

In this survey area, no active *P. cinnamomi* or Uninfested boundaries were mapped, therefore a re-evaluation is not currently required. All areas invaded by *Phytophthora* species other than *cinnamomi* will remain as 'other Threats' indefinitely. Assuming no disturbance activities (or new pathogen introductions) occur within the project area, the assessment of the Uninterpretable/Protectable area should remain accurate for three years. After this period a full assessment, including soil and root sampling, will be required (17th September 2025).

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6 APPENDIX A – DIEBACK OCCURRENCE AND MANAGEMENT MAPS

Map 1: Vegetation Type.
Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

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Elverdton Survey Area

Vegetation Type

- *Alca - Allocasuarina campestris (42)*
- *Alhu - Allocasuarina huegeliana (43)*
- *Ecer - Eucalyptus cernua (27)*
- *Ecli - Eucalyptus clivicola (14)*
- *Edes/Alca - Eucalyptus desmondensis/ Allocasuarina campestris (44)*
- *Efal/Alca - Eucalyptus falcata/ Allocasuarina campestris (4)*
- *Efal/Eple - Eucalyptus falcata/ E. pleurocarpa (1)*
- *Eflo/Espp - Eucalyptus flocktoniae/ E. species (17)*
- *Eflo/Mcuc - Eucalyptus flocktoniae/ Melaleuca cucullata (53)*
- *Eocc - Eucalyptus occidentalis (66)*
- *Epil - Eucalyptus pileata (23)*
- *Eple/Bmed - Eucalyptus pleurocarpa/ Banksia media (55)*
- *Epro - Eucalyptus proxima (45)*
- *Epro/Mspp - Eucalyptus proxima/ Melaleuca species (46)*
- *Espo - Eucalyptus sporadica (67)*
- *Esug/Mspp - Eucalyptus suggrandis/ Melaleuca species (47)*
- *Eunc/Einc - Eucalyptus uncinata/ E. incrassata (18)*
- *Eunc/Espp - Eucalyptus uncinata/ Eucalyptus species (19)*
- *Macu - Melaleuca acuminata (68)*
- *Mallee/Mspp - Eucalyptus species/ Melaleuca species (20)*
- *Mcut - Melaleuca cuticularis (69)*
- *Mell - Melaleuca elliptica (49)*
- *Mham - Melaleuca hamata (22)*
- *Mstr - Melaleuca stramentosa (65)*
- *Mine_site/Cleared*

0 100 200 300
Metres

N

1:13,000

Map 2: Vegetation Condition, Weeds and Abandoned Mine Features. Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

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Elverdton Survey Area

Weeds

- **Asparagus asparagoides*
- **Moraea miniata*
- **Zantedeschia aethiopica*

Vegetation Condition

- Excellent
- Very Good
- Good
- Degraded
- Cleared

Other Features

- Watershed divide
- Hopetoun Ravensthorpe Heritage Trail
- Hopetoun Ravensthorpe Road
- Elverdton Road
- Ravensthorpe Range Ridge Track
- Access Tracks (Walking Only)
- Abandonded Mine Features

0 100 200 300
Metres

N

1:13,000

Map 3A: Soil and Root Samples and Hydrology Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

southern ecology
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235000 120°8'45"E 235500 120°9'0"E 236000 120°9'15"E 120°9'30"E

33°37'15"S 6276000 33°37'30"S 6275500 33°37'45"S

P. pseudocryptogea
P. boodjera
Phytopythium sp.
Elverdton Road
Hopetoun Ravensthorpe Road
Ravensthorpe Range Ridge Track
Watershed divide
Northern Access Track
Hopetoun Ravensthorpe Heritage Trail

Elverdton Survey Area

Soil and Root Samples

- *P. pseudocryptogea*
- *P. boodjera*
- *Phytopythium sp.*
- *Negative*

Other Features

- Watershed divide
- Hopetoun Ravensthorpe Heritage Trail
- Hopetoun Ravensthorpe Road
- Elverdton Road
- Ravensthorpe Range Ridge Track
- Access Tracks (Walking Only)
- Contours 10m

0 100
Metres

N

1:5,000

Map 3B: Soil and Root Samples, Hydrology and Weeds. Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

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Elverdton Survey Area

Soil and Root Samples

- *P. litoralis*
- *Phytopythium sp.*
- *Negative*

Weeds

- **Asparagus asparagoides*

Other Features

- Hopetoun Ravensthorpe Heritage Trail
- Hopetoun Ravensthorpe Road
- Ravensthorpe Range Ridge Track
- Access Tracks (Walking Only)
- Contours 10m

0 100 200
Metres

N

1:9,000

Map 4A: Dieback Status and Management Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

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235000 120°8'45"E 235500 120°9'0"E 236000 120°9'15"E 120°9'30"E
6276000 6275500 33°37'15"S 33°37'30"S 33°37'45"S

Elverdton Survey Area

Soil and Root Samples (Positive Only)

- *P. pseudocryptogea*
- *P. boodjera*
- *Phytopythium sp.*

Dieback Status

- Uninterpretable
- Excluded

Other Threats

- *Phytophthora* species other than *cinnamomi*

Management Point and Direction

- CoE - Clean on Entry
- CoEx - Clean on Exit

Other Features

- Watershed divide
- Hopetoun Ravensthorpe Heritage Railway
- Hopetoun Ravensthorpe Road
- Elverdton Road
- Ravensthorpe Range Ridge Track
- Access Tracks (Walking Only)

DSI Proposed Sampling Sites

- Soil and Tailings Samples
- Water Samples
- Surface Soil and Vegetation Condition Samples
- Transects

0 100 Metres

N

1:5,000

Map 4B: Dieback Status and Management Elverdton Dieback Management Plan.

Map produced by Damien Rathbone on 14/04/2023.
Map Projection: Transverse Mercator Horizontal Datum GDA 1994
Grid: MGA Zone 51 Map Size: A3

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Phytopythium sp.
S04
S05
S06
SW10
P. litoralis
S07
S08
S09
S19
SW11
S20
S21
CoE
CoEx
Ravensthorpe Range Ridge Track
Southern Access Track
Hopetoun Ravensthorpe Road
Hopetoun Ravensthorpe Heritage Trail

120°9'30"E 236500 120°9'45"E 237000 120°10'0"E 237500 120°10'15"E 238000 120°10'30"E 238500 120°10'45"E 120°11'0"E
33°38'0"S 6275000
33°38'15"S 6274500
33°38'30"S 6274000
33°38'45"S 6273500
33°39'0"S 6273000

Elverdton Survey Area

Soil and Root Samples (Positive Only)

- *P. litoralis*
- *Phytopythium sp.*

Dieback Status

- Uninterpretable
- Excluded

Other Threats

- *Phytophthora* species other than *cinnamomi*

Management Point and Direction

- CoE - Clean on Entry
- CoEx - Clean on Exit

Other Features

- Watershed divide
- Hopetoun Ravensthorpe Heritage Trail
- Hopetoun Ravensthorpe Road
- Elverdton Road
- Ravensthorpe Range Ridge Track
- Access Tracks (Walking Only)

DSI Proposed Sampling Sites

- Soil and Tailings Samples
- Water Samples

0 100 200
Metres

N

1:9,000