Main Roads

Mitchell Freeway Extension

Phytophthora Dieback occurrence assessment – Version 1.0

GLEVAN CONSULTING

Disclaimer

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

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

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

Author Evan Brown

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1 Summary

Main Roads Western Australia (Main Roads) is currently progressing the Mitchell Freeway Extension from Hester Avenue to Romeo Road and Wanneroo Road Upgrade from Dunstan Road to Trian Road (the Project, Figure 1). The Project is located in the City of Wanneroo.

The Mitchell Freeway provides the primary road access route from the Perth north-west corridor towards the city of Perth. The freeway currently terminates at Hester Avenue. The freeway has been constructed in several stages since the 1960's, with further extension from Hester Avenue to Romeo Road being developed as part of this Project. The upgrade of Wanneroo Road to dual carriageway in both directions, extending from Dunstan Road to Trian Road Straight Line Kilometre (SLK) 34.50 – 40.40 approximately, is also being developed as part of these works. (Main Roads WA, 2018)

Glevan Consulting was commissioned by Main Roads WA (via Woodman Environmental Consulting Pty Ltd) to conduct an assessment of the vegetation within and immediately adjacent to the Project Area for the presence of Phytophthora Dieback.

The assessment was conducted by Evan Brown of Glevan Consulting in October 2018

Known databases of *Phytophthora* locations were searched to determine previous recoveries of *Phytophthora* within or near the project area. This data showed two previous recoveries of *P. multivora* within the Project Area and one recovery of *P. nicotianae* adjacent to Wanneroo Road. No recoveries of *Phytophthora cinnamomi* have been recorded within or immediately adjacent to the Project Area.

The Project Area covers approximately 257 hectares, of which 90 ha had intact vegetation that could be assessed for the presence of Phytophthora Dieback. In general, the area exhibited evidence of significant disturbance, with extensive rubbish disposal observed along every track in the area, as well as signs of frequent use by off-road vehicles.

The greater Project Area is underlain by calcareous soils, which are considered antagonistic to *Phytophthora cinnamomi*, however broad calcareous landforms may also have micro soil environments more favourable to the pathogen (Department of Parks and Wildlife, 2015).

Phytophthora Dieback has been recorded in calcareous soils, relating to poor hygiene used in developments.

All vegetation within the Project Area that could be assessed for the presence of Phytophthora Dieback has been classified as Uninfested. The remaining infrastructure areas, road surfaces and extensively degraded vegetation has been excluded from the assessment.

Twelve samples were taken to assist the interpretation process. Three samples adjacent to Wanneroo Road showed the presence of *P. nicotianae* whilst the remaining samples proved negative.

2 Introduction

2.1 Background

Main Roads Western Australia (Main Roads) is currently progressing the Mitchell Freeway Extension from Hester Avenue to Romeo Road and Wanneroo Road Upgrade from Dunstan Road to Trian Road (the Project, Figure 1). The Project is located in the City of Wanneroo.

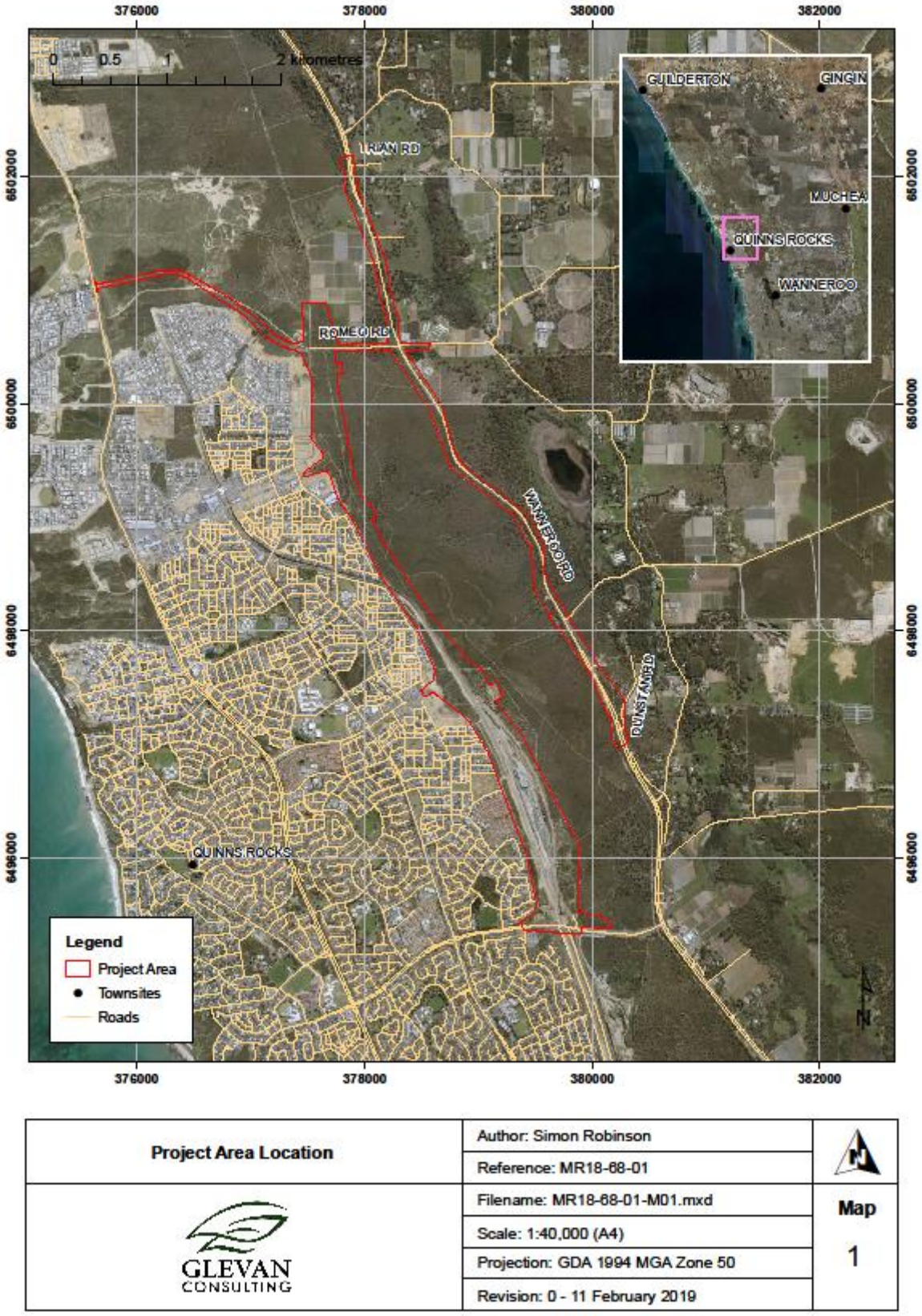
A Dieback assessment was previously undertaken for a large portion of the current Project area in 2013. Given the age of the Dieback mapping and the additional smaller project areas that were previously not surveyed, the Project requires resurvey to confirm the Dieback boundaries on site. The Project construction is anticipated to commence mid-late 2020.

The Mitchell Freeway provides the primary road access route from the Perth north-west corridor towards the city of Perth. The freeway currently terminates at Hester Avenue. The freeway has been constructed in several stages since the 1960's, with further extension from Hester Avenue to Romeo Road being developed as part of this Project. The upgrade of Wanneroo Road to dual carriageway in both directions, extending from Dunstan Road to Trian Road Straight Line Kilometre (SLK) 34.50 – 40.40 approximately, is also being developed as part of these works. (Main Roads WA, 2018)

Glevan Consulting was commissioned by Main Roads WA (via Woodman Environmental Consulting Pty Ltd) to conduct an assessment of the vegetation within and immediately adjacent to the Project Area for the presence of Phytophthora Dieback.

2.2 Study team

The assessment was conducted by Evan Brown of Glevan Consulting in October 2018. Mr Brown is registered (DPW-PDI-004) with the Department of Biodiversity, Conservation and Attractions (DBCA) in the detection, diagnosis and mapping of the Dieback disease. This accreditation recognises the skills and experience of Mr Brown.



Project Area Location	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M01.mxd	**Map** 1
	Scale: 1:40,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 1 - Location of Project Area

3 Phytophthora Dieback

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

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

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

3.1 The Pathogen

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

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

3.2 Host

A population of hosts is made up of susceptible, infected and immune or resistant individuals. The infection of host plants is an unseen activity happening constantly beneath the soil at an infested site.

The environmental conditions favouring or disfavouring the pathogen may change at a critical point during disease development, temporarily changing the rates of infection and invasion. This can be observed symptomatically after soil temperature change through winter months.

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

- Proteaceae
- Ericaceae
- Xanthorrhoeaceae.

3.3 Environment

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

Certain soil properties influence Phytophthora Dieback disease development within the vulnerable areas:

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

greater than 35°C are unfavourable for the persistence of survival of spores and the vegetative mycelia of *P. cinnamomi.*

4 Methods

4.1 Defining the assessment area

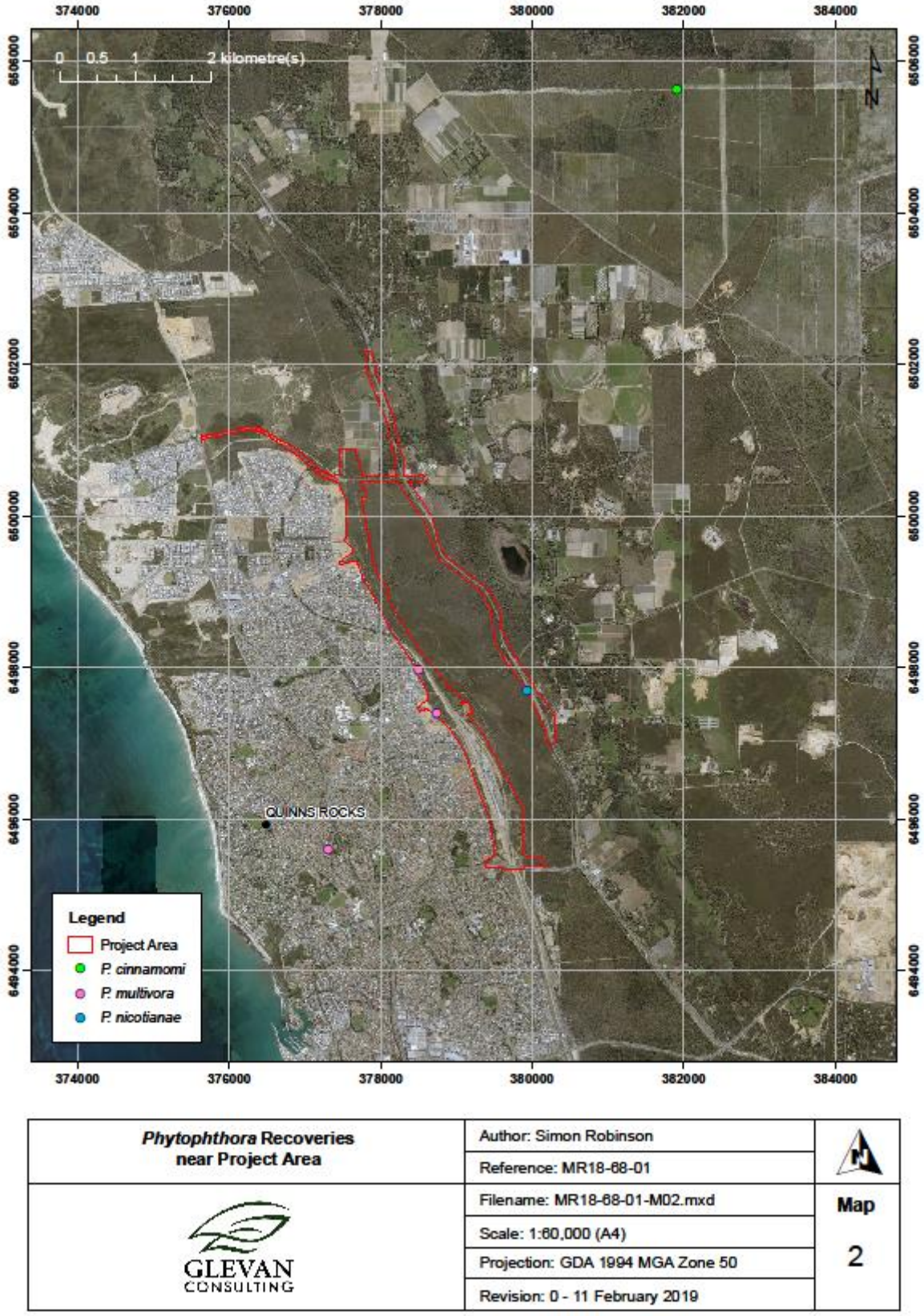
The assessment area covers all assessable vegetation within the Project Area, and vegetation that may be outside of the Project Area that if infected with Phytophthora Dieback, would have hygiene or management implications on the Project Area. This would generally be vegetation immediately upslope of the Project Area or adjacent sites with recent disturbance.

Assessable vegetation is defined as "Naturally vegetated areas with a Keighery disturbance rating of 3 or less and where Phytophthora occurrence categorisation is possible." (Department of Parks and Wildlife, 2015). This vegetation will be categorised following the assessment as being:

- **Infested**: Determined by a qualified interpreter to have plant disease symptoms consistent with the presence of *Phytophthora cinnamomi.*
- **Uninfested**: Determined by a registered interpreter to be free of plant disease symptoms that indicate the presence of *P. cinnamomi.*
- **Uninterpretable**: undisturbed areas where susceptible plants are absent, or too few to make a determination of the presence or absence of *P. cinnamomi.*
- **Not yet resolved:** Phytophthora occurrence diagnosis cannot be made at the time of assessment because of inconsistent or incomplete evidence.

Areas that cannot be assessed because of disturbance will be categorised as:

- **Temporarily Uninterpretable:** vegetation structure is temporarily altered and assessment will be possible when the vegetation recovers, e.g. post-burn
- **Excluded:** areas of high disturbance where natural vegetation has been cleared and is unlikely to recover to a level that is interpretable.



***Phytophthora* Recoveries near Project Area**	Author: Simon Robinson	N
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M02.mxd	Map 2
	Scale: 1:60,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 2 - Phytophthora recoveries near Project Area

4.2 Interpreting the vegetation for Phytophthora

Phytophthora Dieback will only be observable when the pathogen is causing the death of susceptible species. The interpretation will focus on those species that are reliably susceptible to Phytophthora. The deaths will only occur when the three components of the disease triangle (pathogen, host and environment) are satisfied.

When observing possible deaths caused by Phytophthora, consideration will be given to the relationship between the death and other factors including:

Is the death isolated?: These are single dead indicator species plants that have no apparent association with any other death and may be within an area populated by many other healthy indicator plants. These deaths are often unrelated to Phytophthora Dieback, but they will be fully examined because of the possibility of infestation.

Are there scattered deaths?: There may be many healthy indicator species between scattered deaths which may occur over a wide area and have no apparent association between deaths.

Clusters of deaths: are two or more dead plants of one species near one another with an apparent association between the deaths?

Multiple deaths: Some or all of the indicator species are dead within the same area and multiple species deaths are observed.

Chronology of deaths: A strong chronological pattern exhibiting in multiple indicator species would suggest a high likelihood of Phytophthora presence. Weaker chronological patterns may indicate non-Phytophthora factors.

Pattern of deaths: The spatial distribution of the deaths may suggest a logical progression of the disease, based on topography, soil type, vegetation type and drainage characteristics of an area.

Topographical position: The topographical position of the deaths may indicate the probability of infestation. In lower rainfall areas, Phytophthora deaths may be confined to gullies and other water-gaining sites.

Vectoring: consideration will be given to any possible cause of introduction of the pathogen to the Project Area, through uncontrolled access, water flow, soil and rubbish dumping etc.

Biomass change: sites may undergo a change in vegetation density and composition post infection with indicator species being less dense and the possible dominance of non-susceptible species.

Other causes of plant deaths:

- *Armillaria luteobubalina*
- various cankers
- insects
- drought, wind scorch and frost
- salinity and waterlogging
- fire and lightning
- senescence and competition
- physical damage
- herbicides and chemical spills.

All assessable vegetation was interpreted during the assessment for possible presence of Phytophthora Dieback.

4.3 Mapping

Evidence is collected in the field to substantiate the diagnosis of possible Phytophthora Dieback presence. These points will also justify the categorisation of the vegetation on the Phytophthora Dieback Occurrence Map. The primary evidence collected can be:

- Points located at deaths where field diagnosis is certain or almost certain of Phytophthora Dieback infestation.
- Points located at an area of healthy indicator species where field diagnosis is almost certain of the site being uninfested.
- Points located at sites with too few or devoid of indicator species, thus supporting uninterpretable classification.
- Points located at areas of disturbance, which are temporarily uninterpretable or excluded from assessment.
- Points located at soil and tissue sample sites
- Points located where field diagnosis is certain or almost certain of Armillaria Rot Disease (Department of Parks and Wildlife, 2015).

All data was collected using the ESRI Collector App with the recorded data then transferred to a desktop computer and used to produce the relevant maps.

4.4 Limitations of disease mapping

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

5 Project area environmental data

The pathogen requires a suitable host and environment for disease to occur. As detailed in the following sections, the soil type is predominantly alkaline and hostile to Phytophthora cinnamomi (Department of Parks and Wildlife, 2015) (but possibly favourable to other species). The majority of the Project Area contains species that are susceptible to Phytophthora and would exhibit the disease symptoms if the pathogen was present.

5.1 Rainfall

The area (Tamala Park weather station) has received approximately 659 mm of rainfall this calendar year (Bureau of Meteorology). This would place the area as being within the vulnerable zone, as defined by DBCA (Department of Parks and Wildlife, 2015). Significant rainfall occurred in January 2018 which would provide suitable conditions of warm, moist soil for Phytophthora to flourish.

5.2 Soil types

The Project Area is located over three landscapes as defined by the Department of Primary Industry and Regional Development's 027 dataset (DPIRD, 2018). The Karrakatta complex is dominant in the Project Area covering 93.7%, whilst the Spearwood complex (5.7%) and Quindalup complexes (0.6%) are less prevalent in the Project Area (Figure 3). The Karrakatta, Quindalup and Spearwood complexes contain calcareous soils.

Table 1 - Soil profiles in Project Area

Name	Description
Karrakatta shallow soils Phase	Low hills and ridges. Bare limestone or shallow siliceous or calcareous sand over limestone. Dense low shrub dominated by *Dryandra sessilis, Melaleuca huegellii* and species of Grevillea.
Karrakatta Sand Yellow Phase	Low hilly to gently undulating terrain. Yellow sand over limestone at 1-2 m. Banksia spp. woodland with scattered emergent *E. gomphocephala* and *E. marginata* and a dense shrub layer.
Quindalup South deep sand flat Phase	Undulating landscapes with deep calcareous sands overlying limestone. Soils have dark grey-brown sand to about 50 cm and then pale brown sand. Remnants of hummocks are often present.
Quindalup South second dune Phase	The second phase. A complex pattern of dunes with moderate relief. Calcareous sands have organic staining to about 20 cm, passing into pale brown sand; some cementation below 1 m.
Spearwood Sand	Irregular banks of karst depressions. Some limestone outcrop. Shallow

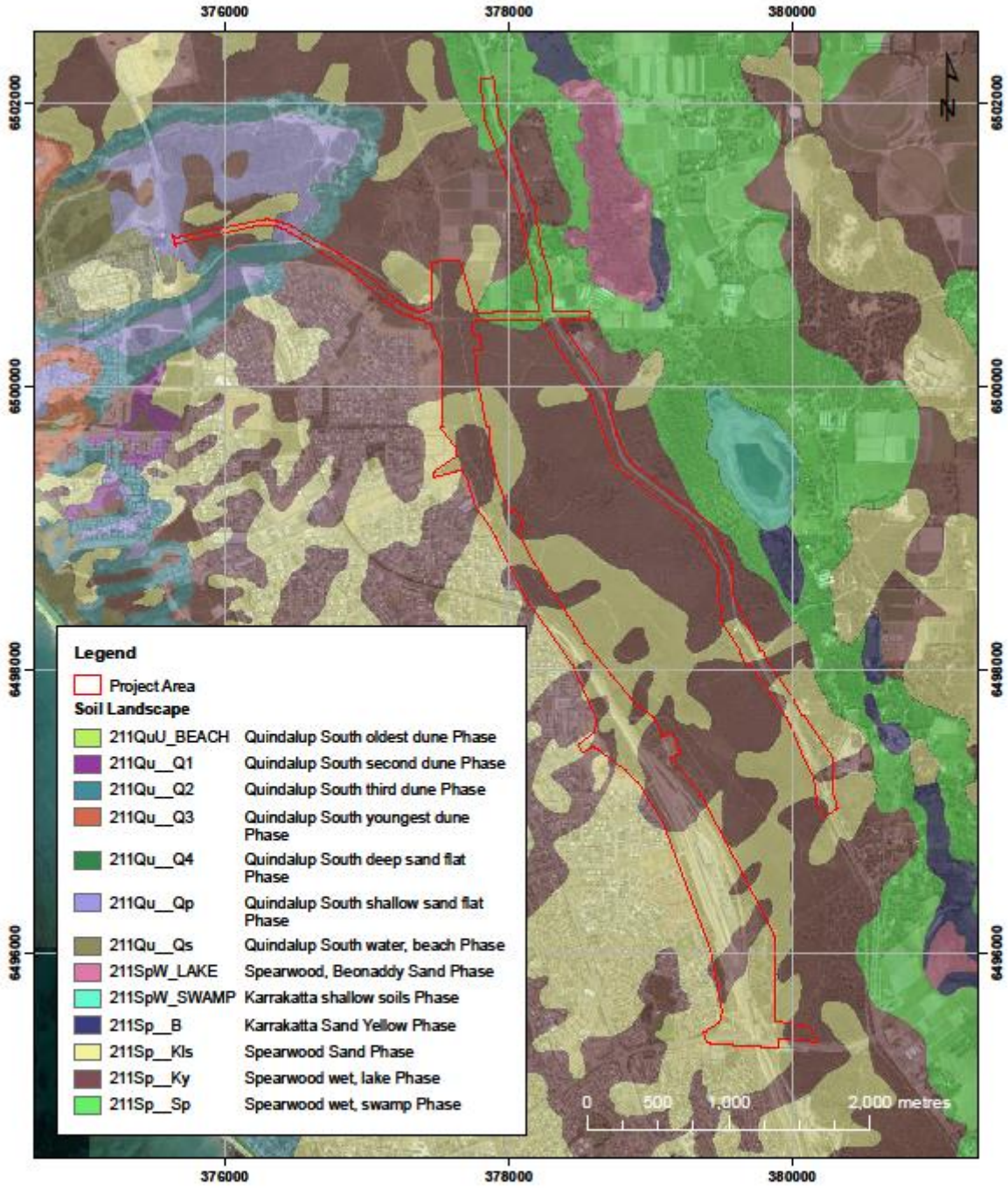
Phase	brown sands. *Banksia* spp. woodland with emergent *E. gomphocephala* and *E. marginata*; dense shrub layer.

5.3 Vegetation structure

The Vegetation Types (Table 2, Figure 4) have been extracted from the SLIP data "VegetationComplexes_SwanCoastalPlainDBCA_046" and are listed in Table 2 below. The Cottesloe Complex has numerous species that are considered reliable indicators to the presence of Phytophthora.

Table 2 - Vegetation Types in Project Area

Vegetation Type	Description
Herdsman Complex	Sedgelands and fringing woodland of *Eucalyptus rudis* (Flooded Gum) - Melaleuca species.
Cottesloe Complex-Central and South	Mosaic of woodland of *Eucalyptus gomphocephala* (Tuart) and open forest of *Eucalyptus gomphocephala* - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri); closed heath on the Limestone outcrops.
Quindalup Complex	Coastal dune complex consisting mainly of two alliances - the strand and fore-dune alliance and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata* (Rottnest Teatree) - *Callitris preissii* (Rottnest Island Pine), the closed scrub of *Acacia rostellifera* (Summer-scented Wattle) and the low closed *Agonis flexuosa* (Peppermint) forest of Geographe Bay.



Soil Landscapes	Author: Simon Robinson	N
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-f03.mxd	**Figure**
	Scale: 1:35,000 (A4)	**3**
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 3 - Landscapes in Project Area

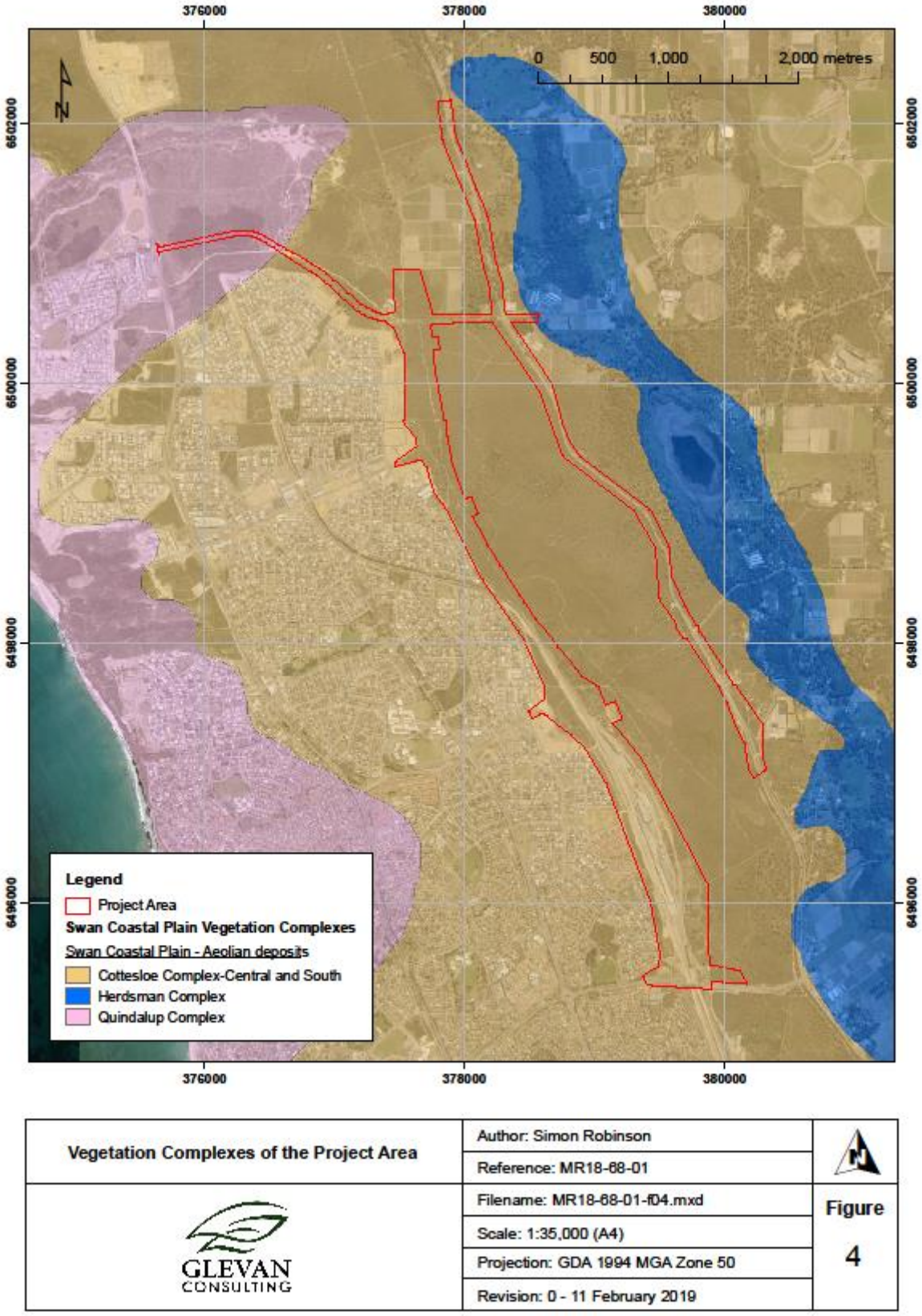


Figure 4 - Vegetation Complexes in Project Area

6 Results

6.1 Pre survey desktop study

Known databases of *Phytophthora* locations retained by Glevan Consulting, Vegetation Health Services (DBCA) and the Dieback Information Delivery and Management System (DIDMS) were searched to determine previous recoveries of *Phytophthora* within or near the project area.

These Phytophthora locations (Figure 2) show two recoveries of *P. multivora* (from the 2013 and 2000 surveys) within the Project Area and one recovery of *P. nicotianae* (from a 2001 survey) adjacent to Wanneroo Road.

No recoveries of *Phytophthora cinnamomi* have been recorded within or immediately adjacent to the Project Area.

6.2 Field Assessment

All intact vegetation within the Project Area that could be assessed for the presence of Phytophthora Dieback has been classified as Uninfested (Section 10 – Appendix A). The remaining infrastructure areas, road surfaces and extensively degraded vegetation has been excluded from the assessment (**Table 3)**.

The results of the current assessment align mostly with the results of an assessment undertaken by Glevan Consulting in 2013. In that survey however, (Glevan Consulting, 2013) an area in the Romeo Road alignment was classified as Infested. This area was showing multiple *Banksia attenuata* deaths with some chronology and pattern to the deaths. A sample taken at the time, and another sample taken during the current assessment have returned a negative result to the presence of Phytophthora. This area is now classified as Uninfested.

Table 3 - Area Summary

Category	Total Area (ha)	% Assessed Area	%Project Area
Infested			
Uninfested	89.8273	100%	34.97%
Uninterpretable			
Temporarily Uninterpretable			
Not yet resolved			
Total Assessed Area	89.8273		
Excluded	167.0271		65.03%
Project Area	256.8544		

Twelve samples were taken to assist the interpretation process (Figure 5). Three samples taken adjacent to Wanneroo Road recovered *P. nicotianae,* whilst the remaining samples returned a negative result (Table 4).

Table 4 – Project Area Sample Summary

Sample	Plant sampled	Easting	Northing	Result
1	*B. sessilis*	379527	6498342	Negative
2	*B.attenuata*	379301	6499082	Negative
3	*B.attenuata*	379209	6499153	*P. nicotianae*
4	*B.attenuata*	378934	6499389	*P. nicotianae*
5	*B. menziesii*	378718	6499823	*P. nicotianae*
6	*B.attenuata*	377538	6500409	Negative
7	*B.attenuata*	377336	6500487	Negative
8	*Xanthorrhoea* sp.	379157	6497346	Negative
9	*B. menziesii*	379464	6496823	Negative
10	*B.attenuata*	377544	6499831	Negative
11	*B. menziesii*	378773	6497605	Negative
12	*B.attenuata*	379400	6496138	Negative

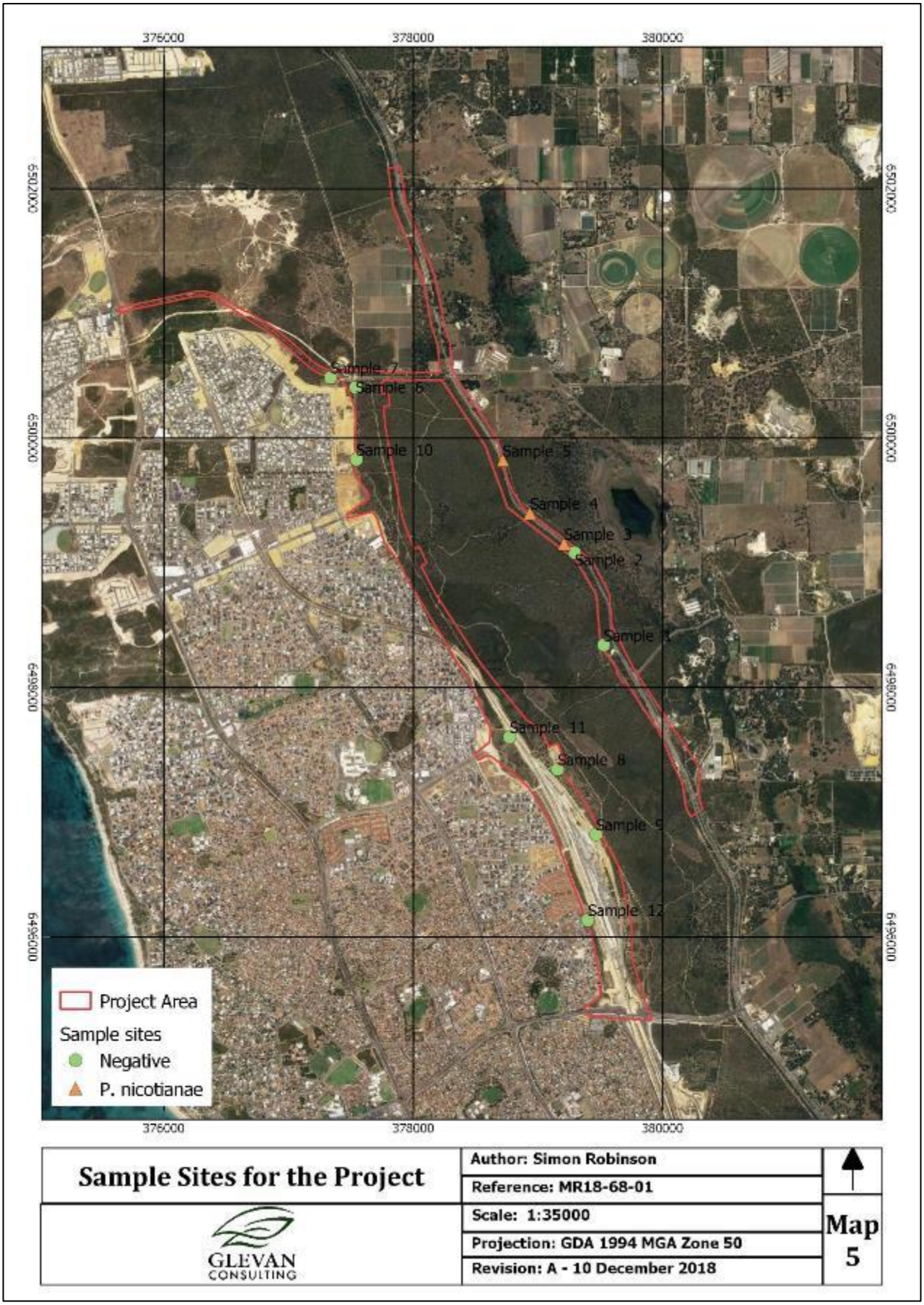


Figure 5 - Sample locations

7 Discussion

The Project Area covers approximately 257 hectares, of which 90 ha had intact vegetation that could be assessed for the presence of Phytophthora Dieback. In general, the area exhibited evidence of significant disturbance, with extensive rubbish disposal observed along every track in the area, as well as signs of frequent use by off-road vehicles.

The greater Project Area is underlain by calcareous soils which are considered antagonistic to *Phytophthora cinnamomi*, however broad calcareous landforms may also have micro soil environments more favourable to the pathogen. (Department of Parks and Wildlife, 2015). Phytophthora Dieback has been recorded in calcareous soils, relating to poor hygiene used in developments.

Romeo Road (north).

The majority of the survey area on Wanneroo Road from the intersection with Romeo Road to Trian Road has been excluded from the assessment due to the vegetation along the road verge being degraded or completely degraded. One section has been classified as Uninfested due the vegetation being in better condition, and also being contiguous with vegetation extending into Lot 6286 Wanneroo Road, Carabooda, currently vested with the Water Corporation. (Appendix A, Figure 8).

The vegetation on the northern and southern side of Romeo Road varies in condition, with no areas of good quality vegetation considered large enough to be assessed. The section of the alignment west of Romeo Road that extends to Marmion Avenue was observed to contain two sections of Uninfested vegetation (Figure 5).

One of these sections was considered to be Infested from the 2013 assessment. At that time, the vegetation was showing some decline in the Banksia species with some chronology in the deaths adjacent to a disturbed area. A sample taken at the time (2013 Sample 10) did not prove the presence of Phytophthora. An additional sample (Sample 7) taken during the current survey (Appendix B, Plate 7) also did not prove the presence of Phytophthora and it is now considered that the Banksia decline has been caused by other factors.

At the western end of the sealed section of Romeo Road, Uninfested vegetation is located on the northern side. This vegetation is bound by disturbed vegetation on the western boundary and farmland on the northern and eastern boundaries and is not contiguous with the Uninfested vegetation on the southern side as the verges of Romeo Road have suffered significant disturbance.

Freeway alignment (south of Romeo Road)

Sample 6 was taken at the entrance to the Uninfested vegetation on the southern side of Romeo Road (Figure 5; Appendix B, Plate 6). This sample returned a negative result for the presence of Phytophthora. This site is associated with a well-used track, which then intersects with all tracks that traverse south through the Neerabup NR.

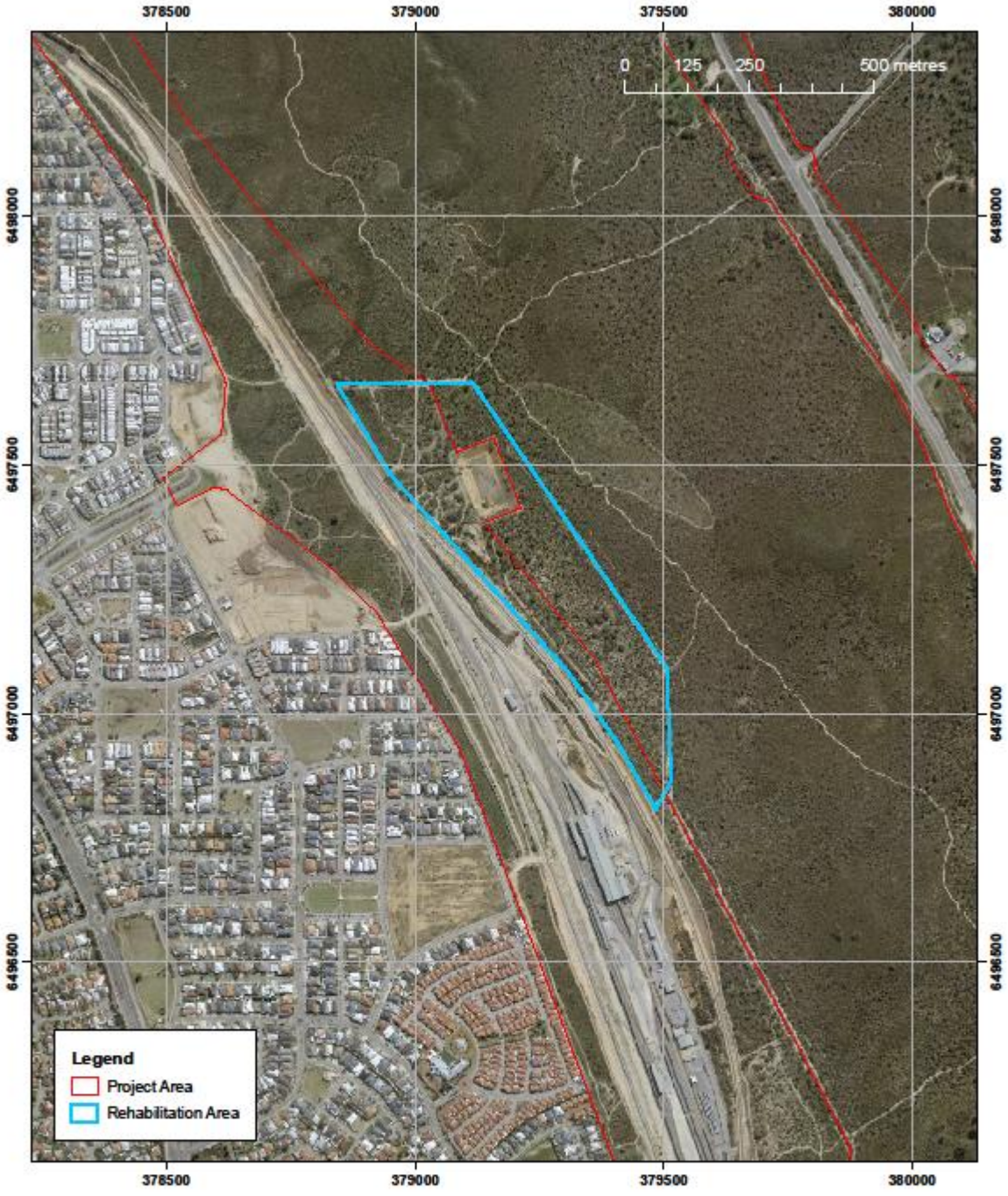
The vegetation through this area generally has a dense coverage of *Banksia* and *Xanthorrhoea* species that should allow Phytophthora Dieback to be visible, if the pathogen is present. Some smaller areas are dominated by a myrtaceous heath, although scattered Phytophthora Dieback indicating species were still present.

Within this area is a fenced section that has been rehabilitated (Figure 6). Although there are numerous Phytophthora Dieback indicating species within this area, the site has been classified as Excluded because of the overall disturbance. Two samples were taken in this area, Sample 9 (Figure 5; Appendix B Plate 9) at the southern end adjacent to the gate which returned a negative result. There were many deaths of many different species along the fence line which were probably caused by poisoning. One sample was taken (Sample 8) (Figure 5; Appendix B, Plate 8) at a location with a cluster of *Xanthorrhoea* deaths. This sample returned a negative result which added support to Phytophthora not being the cause of the deaths along the fence line.

The vegetation from Romeo Road to the fenced rehabilitation area has been classified as Uninfested (Figure 5; Appendix A, Figures 8 & 9). Some small areas are devoid of vegetation or heavily disturbed, however it was not considered necessary to isolate these areas because of the low risk of Phytophthora presence. Sample 10 (Figure 5; Appendix B, Figure 21) was taken on the western boundary in this area and returned a negative result.

A section of vegetation is situated on the western side of the rail alignment that contains one small area of Uninfested vegetation. A sample from 2013 showed the presence of *P. multivora* in this area but it was not causing significant disease symptoms at that time. Sample 11 (Figure 5; Appendix B, Plate 11) was taken to the south of the Uninfested area in a section of vegetation that was disturbed and returned a negative result.

On the eastern side of the rail alignment, and south of the fenced rehabilitation area, two areas of Uninfested vegetation were denoted (Appendix A, Figure 10). The remaining vegetation has been Excluded from the assessment due to the area being significantly disturbed.



Fenced Rehabilitation Area	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M06.mxd	Map 6
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 6 - Fenced rehabilitation area

Wanneroo Road, south of Romeo Road intersection

The western side of Wanneroo Road, south of Romeo Road contains one section of uninfested vegetation which extends almost to Nowergup Road (Appendix A, Figure 8). The eastern side of the road contains three small sections of uninfested vegetation, two north of Nowergup Road and one on the southern boundary (Appendix A, Figures 8 & 9). The two northern areas are contiguous with the larger area of the Neerabup NR whilst the southern Uninfested area is bound by roads.

Four samples were taken in this area during the current survey. Three samples (Sample 3, Sample 4 and Sample 5) proved the presence of *P. nicotianae* at the sampled locations (Figure 5; Appendix B, Plates 3, 4 and 5). All samples locations were on the boundary of vegetation with the road verge. One sample from the current survey (Sample 2) and two from the previous survey (2013 Sample 9 and 2013 Sample 11) returned negative results (Appendix B, Plate 2).

Sample 1 was taken adjacent to a highly disturbed site that extends from Wanneroo Road to the western boundary and returned a negative result (Appendix B, Plate 1). This area is densely covered in weeds and some historic soil dumping was evident. Because of the disturbance, and a the depauperate nature of the vegetation to the south, this section has been classified as Excluded.

8 Recommendations

- Soil and plant material of infested or unknown dieback status should not be introduced to Uninfested sections of the study area.

- Soil and plant material should not be transported from the Excluded sections of the Project Area for use at any protectable area.

- Vehicles and machinery should be clean upon entry into the uninfested sections of the Project Area.

- While the impact of the pathogens *P. nicotianae* and *P. multivora* (recovered during previous survey) does not appear to be significant at this stage, it is still recommended that movement of soil and plant material from the areas immediately surrounding (i.e. 20m radius) the sites from which they were recovered, to any protectable areas, be avoided.

Table 5 – Table of Management Measures and Actions

Mitchell Freeway and Wanneroo Road Extension - Phytophthora Dieback Management Actions and Monitoring Programme				
Project Component	**Management Action**	**Monitoring Programme**	**Responsible Person**	**Completion Timeframe**
Pre-Construction Dieback Survey and Assessment				
Survey and Assess Dieback Status	Undertake a Dieback survey of the project area using a Phytophthora Dieback Interpreter registered with DBCA, prior to the commencement of project activities.	As part of pre-construction environmental approvals.	Environment Officer	Completed
	Identify and map the Dieback status of the project area (and surrounds) from the Dieback survey.			
Identify Dieback Occurrence Areas	Dieback interpretation boundaries to be marked on site as per DBCA standards	As part of pre-construction environmental approvals.	Environment Officer	To be completed
	This tape must be renewed and remarked at 12 monthly intervals; re-assessment due October 2019.	Will require potential re-check during project depending upon project timeline		Potential recheck depending upon project timeline
Project Specific Aspects and Clearing Permit Approval				
Dieback Controls	All works are to be undertaken under the requirements as stipulated in the relevant Clearing Permit	Pre-construction planning and during project works	Project Manager / Site Supervisor and Environmental Officer	Pre-construction and during Project Works

Mitchell Freeway and Wanneroo Road Extension - Phytophthora Dieback Management Actions and Monitoring Programme				
Project Component	**Management Action**	**Monitoring Programme**	**Responsible Person**	**Completion Timeframe**
	All vehicles, machinery and tools shall arrive at site clean of soil, mud or vegetative material, will be inspected for compliance and sterilised prior to work if necessary (full hygiene clean down)	Daily visual inspections and vehicle inspection log kept at project site.	Project Manager / Site Supervisor	During project works
	Plan works to be undertaken in dry soil conditions. If movement of soils is to occur in non-dry soil conditions, a Dieback Management and Hygiene Plan (DMP) must be prepared, implemented and adhered to	During contruction planning; see Dieback Management and Hygiene Plan (DMP) (below)	Project Manager / Site Supervisor and Environmental Officer	Pre-construction and during Project Works
	No dieback affected-soil, mulch, fill or other material to be imported to the Project Area at any time	During construction planning; appropriate records of source of any such material and associated proof of dieback-status brought into the Project site to be retained	Site Supervisor / Contractor	Throughout Project Works
	Movements of machines and other vehicles to be restricted to the areas of clearing for the project	During construction planning	Site Supervisor / Contractor	Throughout Project Works
	Soil movement within a hygiene category permissible. No soil movement or movement of vegetation material to occur between hygiene categories	During construction planning	Site Supervisor / Contractor	Throughout Project Works
Training	Staff on site must be trained in dieback washdown procedures as well as vehicle hygiene checks	Evidence of training and site inductions to be provided to Main Roads including names of participating staff and date	Site Supervisor / Contractor	Prior to commencement of work at site

Mitchell Freeway and Wanneroo Road Extension - Phytophthora Dieback Management Actions and Monitoring Programme				
Project Component	**Management Action**	**Monitoring Programme**	**Responsible Person**	**Completion Timeframe**
	Training (induction/toolbox) undertaken for site personnel including sub-contractors regarding dieback and the importance of preventing the spread of the pathogen			Throughout Project Works
Dieback Management and Hygiene Plan				
Consult and Prepare a Dieback Management and Hygiene Plan (DMP) if works are to be conducted in conditions other than dry soil conditions	Prepare a DMP in consultation with DBCA when undertaking vegetation clearing or revegetation activities if works are required outside of dry soil conditions	As part of pre-construction environmental approvals.	Environment Officer	To be undertaken prior to Project Works
	Include a map of project Dieback occurrence areas within the DMP			
	Include a map of hygiene management areas and associated Clean on Entry (CoE) points			
Dieback Controls Required - Non Dry Soil Conditions	Clearing will be undertaken in non-dry conditions only if unavoidable to reduce the risk of spread of the pathogen.	Project timing	Project Manager / Site Supervisor	Throughout Project Works
	Vehicles, machinery and tools should be inspected to be free of soil, mud or plant matter as well as other contaminants before work is commenced and sterilized if necessary (complete hygiene washdown)	Daily visual inspections and vehicle inspection log kept at project site.		

Mitchell Freeway and Wanneroo Road Extension - Phytophthora Dieback Management Actions and Monitoring Programme				
Project Component	**Management Action**	**Monitoring Programme**	**Responsible Person**	**Completion Timeframe**
	If material is clinging to equipment or machinery in wet conditions, washdown will be required to remove material prior to commencing work and when moving between hygiene categories	Maintain weekly tool box meetings and minutes of each meeting to notify of dieback infested / uninfested / uninterpretable areas and breaches of the DMP.		
	If using a grader or loader lift the blade and clean the equipment before traversing into uninfested locations			
Standard Record Keeping Management				
Dieback Management Plan	The DMP to be submitted to CEO (DWER) for approval prior to associated clearing works; if modifications are required, these modifications are to be made and approved by CEO prior to clearing activites	Part of pre-construction approvals	Environmental Officer	Prior to commencement of work at site
GIS Data Record Keeping	Dieback interpretation mapping GIS data logged as per current Dieback Data Specification	To be included in data provision during reporting	Environmental Officer	Completed
	Dieback hygiene mapping GIS data logged as per current Dieback Data Specification			To be undertaken during DMP production
Record Keeping	Ensure standard record keeping requirements are completed.	During construction audits by Environmental Officer	Environmental Officer; Project Manager	Within 2 months of completion

Mitchell Freeway and Wanneroo Road Extension - Phytophthora Dieback Management Actions and Monitoring Programme				
Project Component	**Management Action**	**Monitoring Programme**	**Responsible Person**	**Completion Timeframe**
	Copies of daily hygiene logs, training records and imported material dieback status to be provided to Environment Officer	Post-construction record maintenance to occur within 2 months of completion of the project activities.		

9 Bibliography

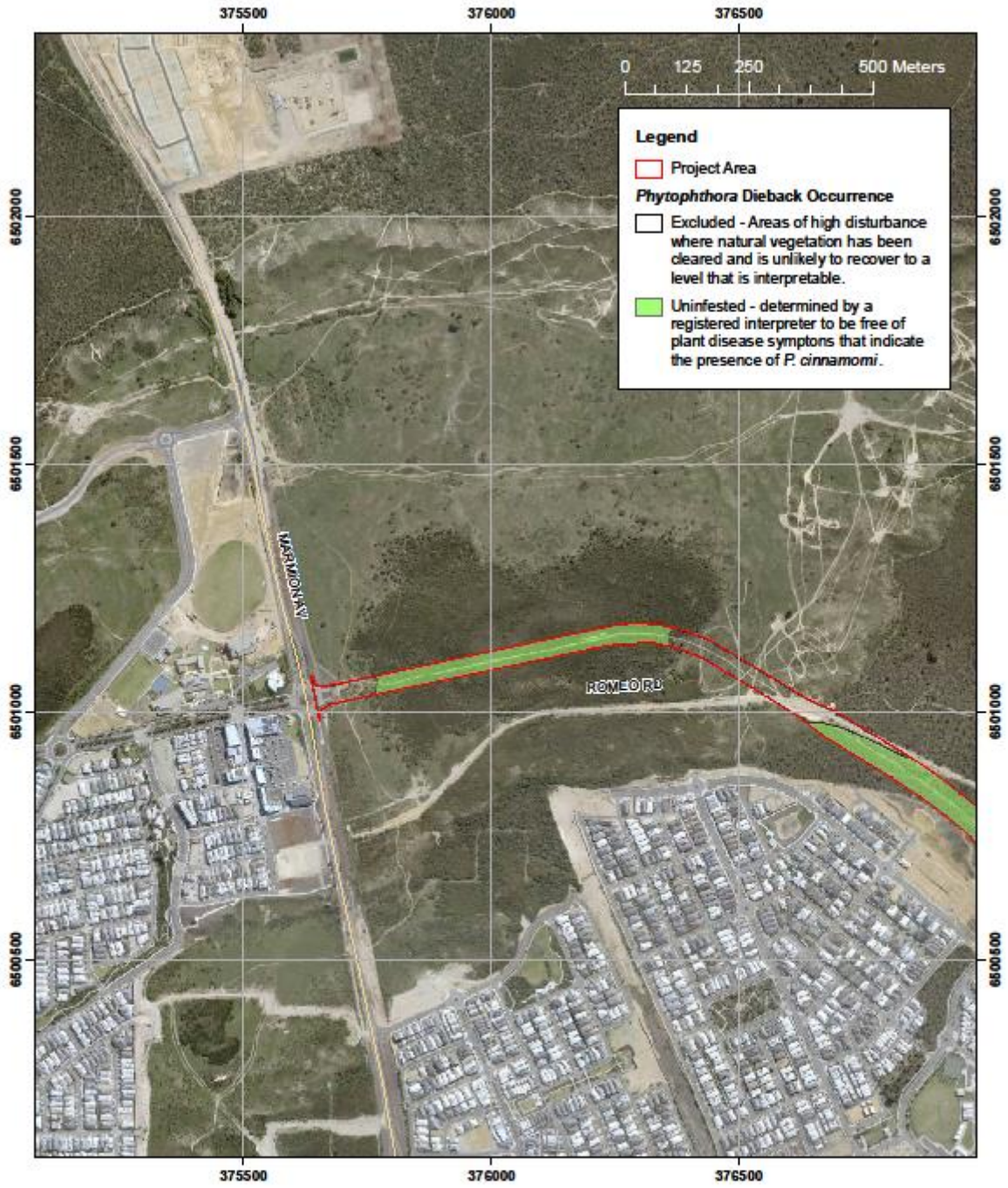
Bureau of Meteorology. (n.d.). *Average annual, seasonal and monthly rainfall*. Retrieved from Average annual, seasonal and monthly rainfall

Department of Parks and Wildlife. (2015). *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the department.* Unpublished.

Glevan Consulting. (2013). *Mitchell Freeway Extension Phytophthora Dieback occurrence assessment and Management Plan.* Prepared for GHD.

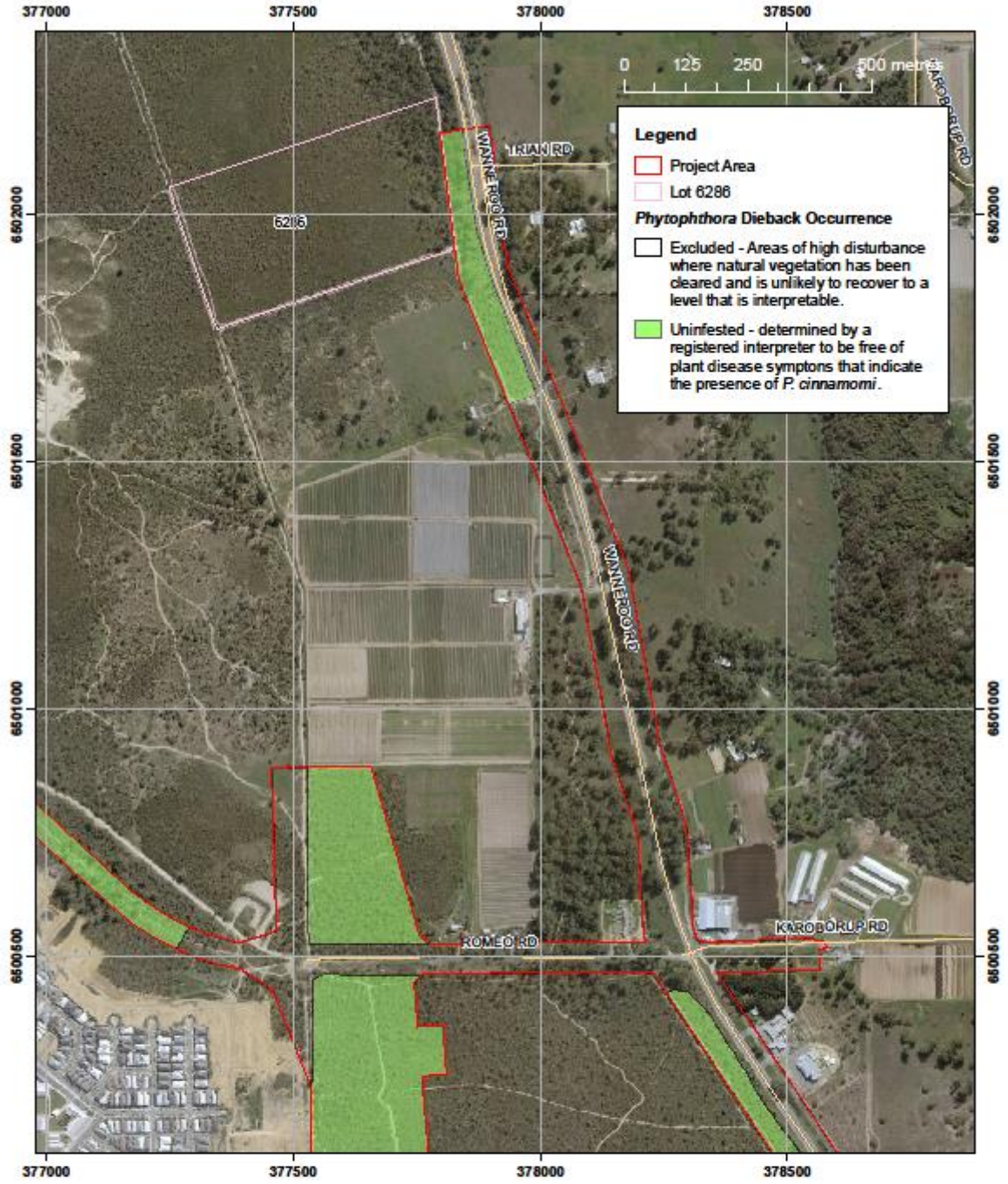
Main Roads WA. (2018). Dieback Survey Consultant Brief. *D18#792329*.

10 Appendix A – Phytophthora occurrence maps (Figures 7 – 13)



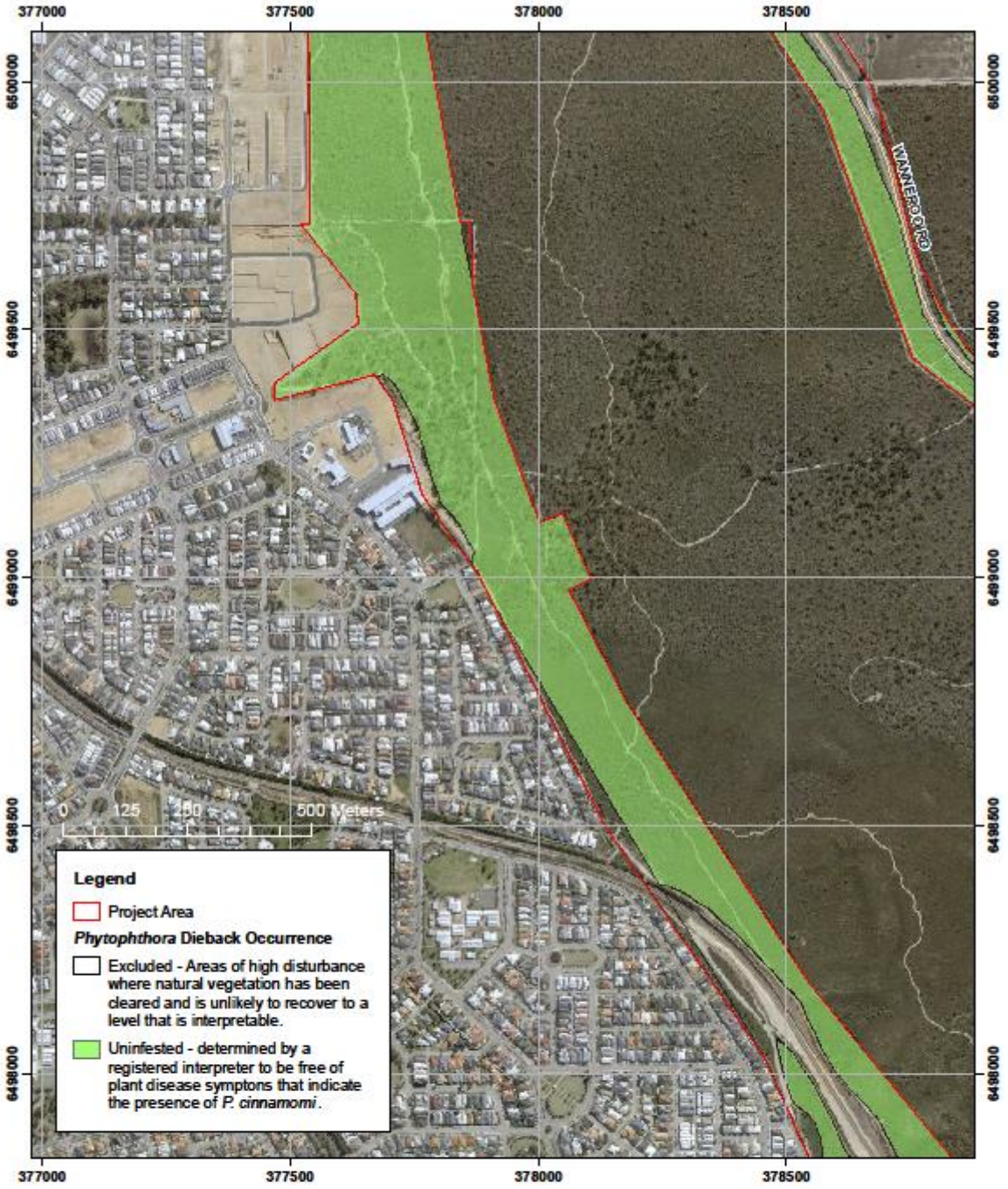
***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 7
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 7 – Romeo Road (north)



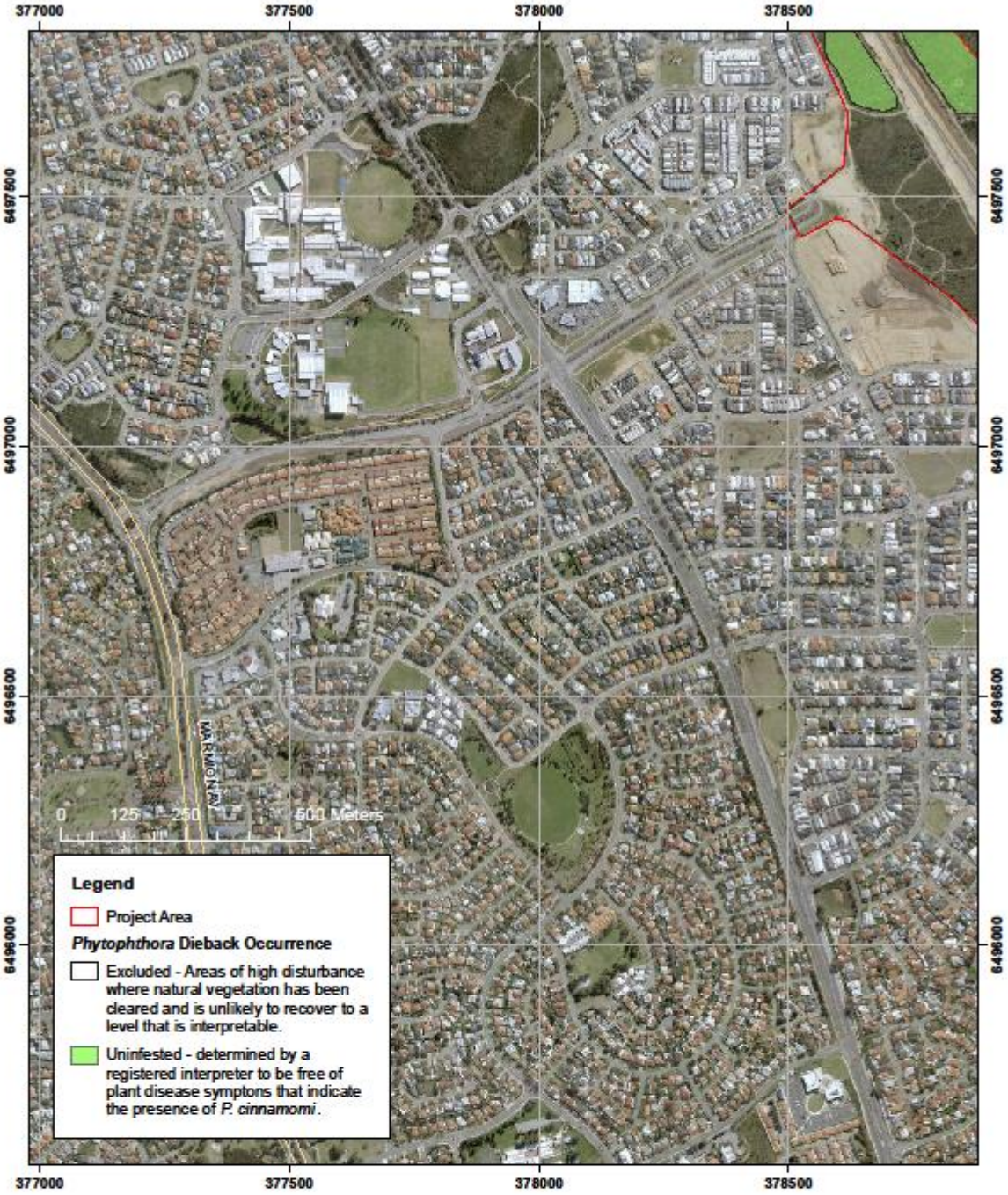
***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 8
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 8 – Romeo Road (south)



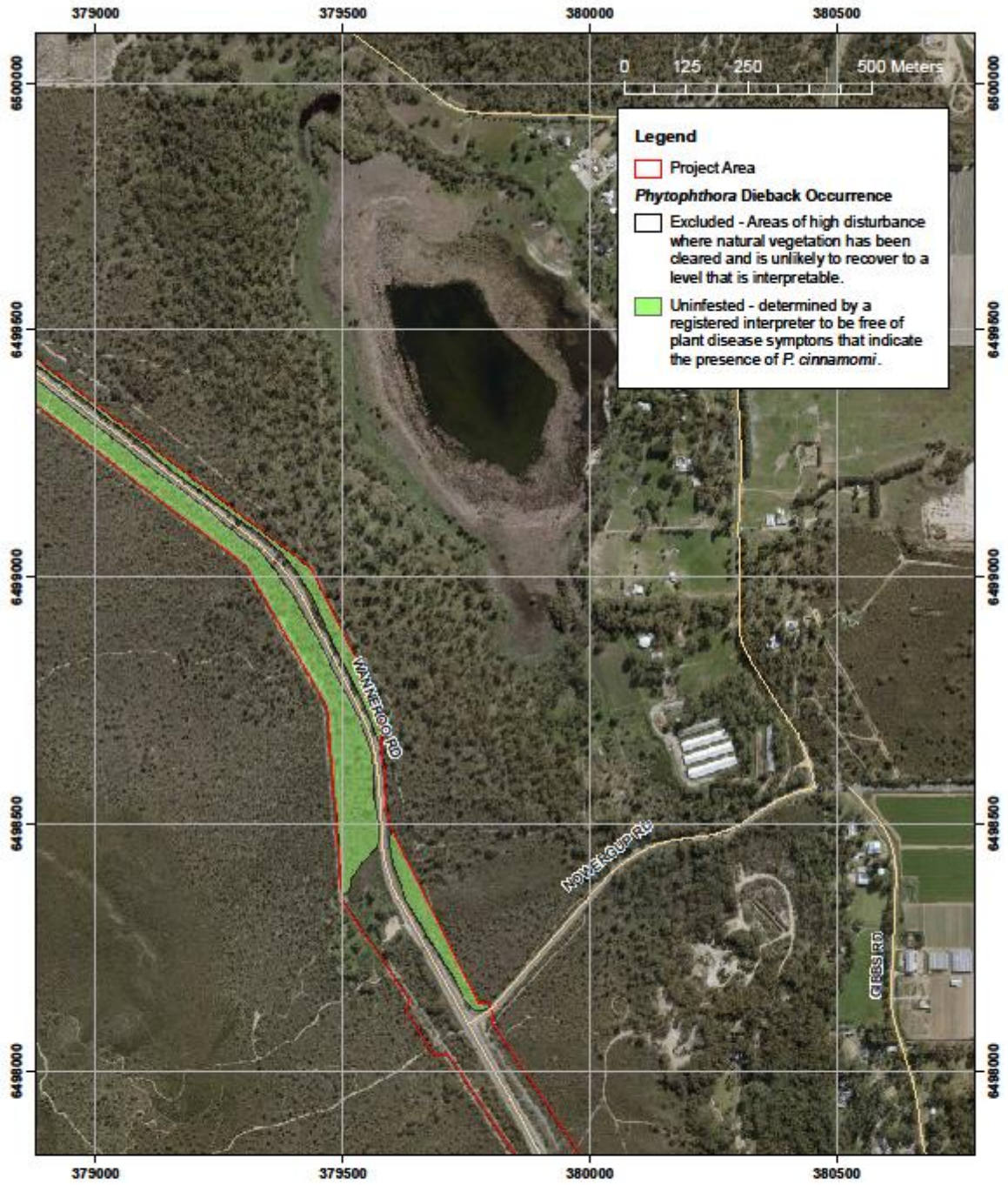
***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	N
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 9
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 9 – Mitchell Fwy, Butler



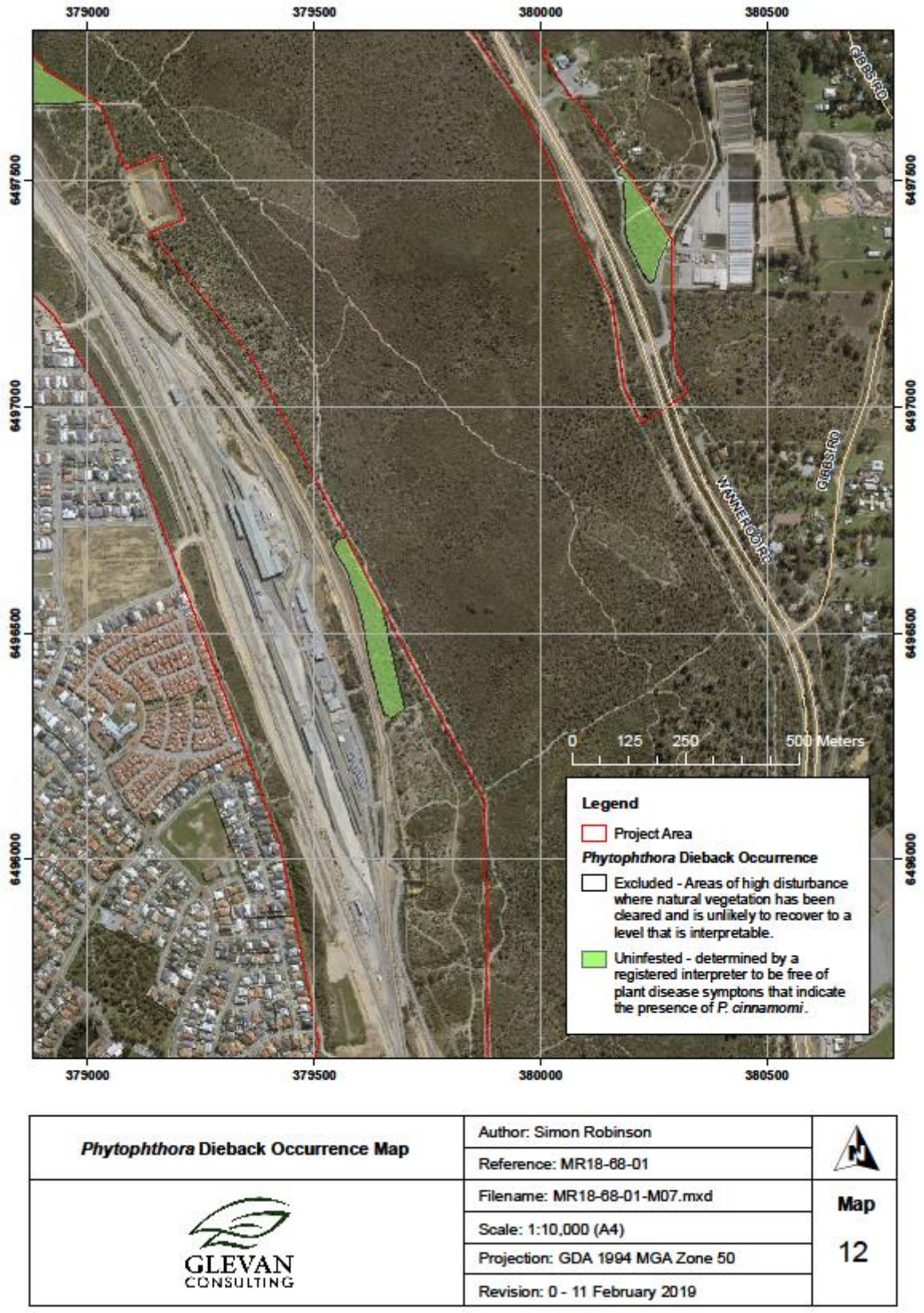
***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 10
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 10 – Mitchell Freeway, Butler (near Lukin Drive)



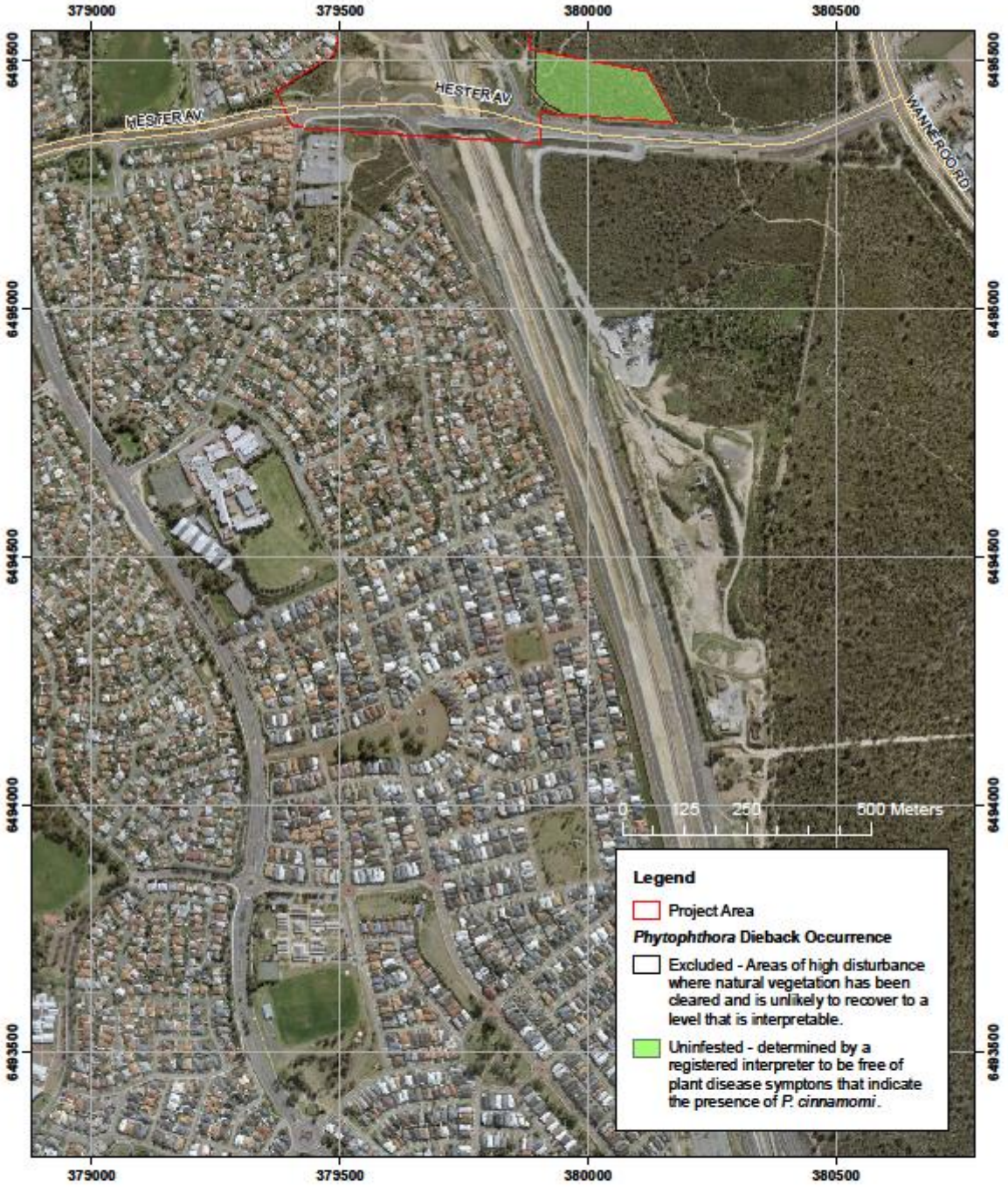
***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 11
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 11 – Wanneroo Road (near Lake Nowergup)



***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 12
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 12 - Mitchell Freeway, Ridgewood and Wanneroo Road / Dunstan Road



***Phytophthora* Dieback Occurrence Map**	Author: Simon Robinson	
	Reference: MR18-68-01	
GLEVAN CONSULTING	Filename: MR18-68-01-M07.mxd	Map 13
	Scale: 1:10,000 (A4)	
	Projection: GDA 1994 MGA Zone 50	
	Revision: 0 - 11 February 2019	

Figure 13 -Mitchell Fwy / Hester Avenue Intersection

11 Appendix B – Sample sites (Plates 1 – 12)

Plate 1 - Sample 1

Plate 2 - Sample site 2

Plate 3 - Sample site 3

Plate 4 - Sample site 4

Plate 5 - Sample site 5

Plate 6 - Sample site 6

Plate 7 - Sample site 7

Plate 8 - Sample site 8

Plate 9 - Sample site 9

Plate 10 - Sample site 10

Plate 11 - Sample site 11

Plate 12 - Sample site 12

12 Appendix C – Keighery disturbance scale

Assessability	Scale		Vegetation 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.
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 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.