



***Phytophthora* Dieback assessment – Clean Energy Link North Project**

Prepared for Western Power

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Abbreviations and Acronyms

BoM	Bureau of Meteorology
CALM	former Department of Conservation and Land Management (now DBCA)
CPSM	Centre for Phytophthora Science & Management
DBCA	Department of Biodiversity, Conservation and Attractions, WA Government
DCCEEW	Department of Climate Change, Energy, the Environment and Water, Australian Government
Dieback Interpreter's Manual	FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department
Dieback Management Manual	FEM049 Phytophthora Dieback Management Manual
DMIRS	Department of Mines, Industry Regulation and Safety
DPIRD	Department of Primary Industries and Regional Development, WA Government
EPA	Environmental Protection Authority
FEMD	Forest and Ecosystem Management Division of DBCA, WA Government
FMIS	Forest Management Information System
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation for Australia
ISD	Indicator Species Death
VHS	Vegetation Health Services

Executive Summary

Western Power commissioned Terratree to undertake a Comprehensive Linear *Phytophthora* Dieback (Dieback) assessment for the Clean Energy Link North project to install new transmission line infrastructure within the North Metropolitan area. The objective of the Dieback assessment was to map the extent of Dieback occurrence along the project corridor which will be used to inform Dieback hygiene management during construction.

The Clean Energy Link North project corridor (hereafter referred to as the 'assessment area') is a linear corridor along Western Power's transmission line infrastructure between Northern Terminal, bounded by Beach Road and Weir Road in Malaga, City of Swan to Neerabup Terminal, adjacent to Old Yanchep Road in Pinjar, City of Wanneroo. The assessment area spans approximately 35 km, covering 413.8 ha.

The Comprehensive Linear assessment was undertaken by DBCA-registered Dieback Interpreters Joseph Grehan and Norman Lai, along with Trainee Interpreter's Elisa Brendel, Julian Beasley, and Kyren Cleave between February 27th and July 11th, 2025.

The assessment was conducted according to the *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department produced by the Forest and Ecosystem Management Division* (FEMD 2015).

Twenty-one soil and tissue samples were collected during the Dieback assessment. Of these, two samples (CELS12 and CELS19) tested positive for *P. cinnamomi*, two samples (CELS06 and CELS08) were positive for *P. arenaria*, and one sample (CELS21) tested positive for *P. nicotianae* through diagnostic baiting.

In total, 413.8 ha of vegetation was assessed comprehensively including 171.8 ha of native vegetation. The majority of the assessment area, 242 ha (58.5%), has been categorised as Excluded due to Degraded to Completely Degraded vegetation condition associated with infrastructure, pastoral lands, roadside vegetation, and revegetated and/or regenerated areas.

A total of 131.8 ha (31.9%) of the assessment area has been mapped as Infested. The majority of the Infested areas mostly corresponds to the infestations from FMIS and those previously mapped by Terratree.

Two discrete areas of *Phytophthora nicotianae* infestation (0.03 and 0.05 ha) have been mapped during this assessment. One infestation is located within the remnant vegetation adjacent to the assessment area to the east of Guadalupe Drive, Malaga. The other infestation is located in the bushland between Tonkin Highway and Beechboro Road North, Whiteman. Both infestations have not been demarcated as the *P. nicotianae* pathogen exhibited only a small, localised impact on the vegetation. A nominal 20 m Infested buffer has been applied from the location of the samples to delineate the Infested boundary.

A new *P. cinnamomi* infestation (4 ha) was found within the assessment area overlapping with Gngangara-Moore River State Forest.

Two new *P. arenaria* infestations were found to the north and south of Neaves Road, Mariginiup respectively. The *P. arenaria* infestation to the south of Neaves Road has been incorporated into the *P. cinnamomi* infestation (9.3 ha) originating from the unnamed damland, as the *P. arenaria* infestation lies downslope from the *P. cinnamomi* infestation. The overlapping patterns of *Banksia* mortality in the area also obscure the ability to differentiate Dieback symptoms attributable to each *Phytophthora* species. The *P. arenaria* infestation (0.07 ha) within the Uninfested vegetation to the north of Neaves Road has not been demarcated as the pathogen exhibited only a small, localised impact on the vegetation. A nominal 20 m Infested buffer has been applied from the location of the sample to delineate the Infested boundary.

A total of 40 ha (9.7%) of the assessment area has been mapped as Uninfested. The vegetation condition in the Uninfested areas is Very Good to Excellent, with healthy *Banksia* spp., *X. preissii*, and few annual weeds present.

Terratree makes the following recommendations:

- Implement the management requirements specified in the completed Dieback Hygiene Management Plan which has been prepared in accordance with the *Phytophthora Dieback Management Manual* (DBCA 2020).
- Ensure key personnel have completed Green Card biosecurity training for example: environmental personnel and field supervisors to ensure compliance with the Dieback Management Plan.
- Provide clear instruction to staff and contractors about hygiene requirements when entering protectable areas (Uninfested and Uninterpretable areas).
- Signage should be installed to clearly identify vehicle and machinery inspection locations and Clean on Entry points within the assessment area.
- Conduct a post-construction Dieback assessment of the disturbance area to ensure that the pathogen has not been introduced into protectable areas.

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1 Introduction

Western Power commissioned Terratree Pty Ltd (Terratree) to undertake a Comprehensive Linear *Phytophthora* Dieback (Dieback) assessment for the Clean Energy Link North project to install new transmission line infrastructure within the North Metropolitan area. The objective of the Dieback assessment was to map the extent of Dieback occurrence along the project corridor which will be used to inform Dieback hygiene management during construction.

1.1 Project Location and Size

The Clean Energy Link North project corridor (hereafter referred to as the 'assessment area') is a linear corridor along Western Power's transmission line infrastructure between Northern Terminal, bounded by Beach Road and Weir Road in Malaga, City of Swan to Neerabup Terminal, adjacent to Old Yanchep Road in Pinjar, City of Wanneroo. The assessment area spans approximately 35 kilometres (km), covering 413.8 hectares (ha) (**Figure 1**).

1.2 Phytophthora Dieback

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

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

The most recent Western Australian State of the Environment Report lists Dieback as a Priority 1 threat to biodiversity (EPA 2007). A recent review of threats to species listed as threatened under the Federal *Environment Protection and Biodiversity Conservation Act 1999* shows that *P. cinnamomi* is the second greatest invasive species threat in Australia after rabbits (Kearney *et al.* 2018).

Dieback has a significant effect in WA for the following reasons:

- 40% of native plant species in Southwest WA (over 2,200 species), including almost half the endangered species, are susceptible to the pathogen (Shearer *et al.* 2004). This includes 49% of WA's threatened flora (EPA 2007).
- Changes in the composition and structure of floral communities resulting from the spread of Dieback have flow-on impacts throughout the ecosystem, including habitat alteration negatively affecting indigenous fauna populations.
- Dieback can lead to significant soil erosion through the loss of susceptible vegetation.

Disease expression caused by *Phytophthora* species occurs in native vegetation when the following variables and environmental conditions are present:

- **Host** - plant species are present that are susceptible to *Phytophthora* spp.
- **Pathogen** - a *Phytophthora* spp. pathogen must be present, either residing in susceptible or resistant species.
- **Environment** - soil temperatures of 15-30 °C and pH 5-6 (acidic) are required for *P. cinnamomi* survival and activity. Some *Phytophthora* species, including *P. multivora*, can survive in alkaline soils (pH 7+).

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

Dieback is spread through the movement of water and soil within the landscape. Major vectors of Dieback include, but are not limited to, wet soil adhering to vehicle tyres/tracks and earthmoving equipment. Therefore, quarantine management procedures are an effective tool in reducing the spread of Dieback associated with any earthmoving activity.

1.3 Regulatory Context

Phytophthora Dieback management is required under several regulatory mechanisms including:

- The Federal *Environment Protection and Biodiversity Conservation Act 1999*, which lists Phytophthora Dieback as a key threatening process.
- Projects being assessed under the Western Australian *Environmental Protection Act 1986*, which requires the Department of Biodiversity, Conservation and Attractions (DBCA) and/or Department of Mines, Industry Regulation and Safety (DMIRS) to comment on Dieback management and provides these agencies with the right to impose conditions on new approvals.
- The *Environmental Protection Act 1986* Part V S.50A “Serious Environmental Harm” provisions.
- A National Threat Abatement Plan (DCCEEW 2018) has been developed to abate the threat of Phytophthora Dieback caused by *P. cinnamomi*, to Australia’s biodiversity. On state level DBCA is responsible for its implementation on *Conservation and Land Management Act 1984* (CALM Act).

2 Existing Environment

2.1 Biogeography

The Interim Biogeographic Regionalisation for Australia (IBRA) has defined 89 bioregions and 419 subregions across Australia, based on climate, geology, landforms, native vegetation and species (DCCEEW 2022). These provide a useful method for reporting biodiversity patterns and categorising assessment areas. The assessment area falls within the Swan Coastal Plain (SWA2) IBRA subregion.

The Swan Coastal Plain is primarily covered with woodlands. Sandy soils are dominated by Banksia or Tuart trees, while *Casuarina obesa* is found on outwash plains, and Paperbarks in swampy areas. In the eastern part, the plain rises to duricrusted Mesozoic sediments, dominated by Jarrah woodlands. The climate is characterised as Warm Mediterranean. Relief is provided by three phases of marine sand dune development. Outwash plains, once largely covered by *C. obesa* - Marri woodlands and Melaleuca shrublands, are now mainly found in the southern region (Mitchell *et al.* 2002).

The Perth subregion (SWA2) consists of colluvial and aeolian sands, alluvial river flats, and coastal limestone. It features heath and/or Tuart woodlands on limestone, as well as Banksia and Jarrah-Banksia woodlands on Quaternary marine dunes of different ages. Marri trees are found on colluvial and alluvial soils. The area also includes a complex series of seasonal wetlands (Mitchell *et al.* 2002).

Dominant land uses in the area include dry land agriculture, conservation, UCL and Crown reserves, Urban and rural residential areas and infrastructure, irrigated horticulture, forestry plantations, and grazing. There are smaller areas of mining and defence lands (Mitchell *et al.* 2002).

2.2 Regional Vegetation

The assessment area lies in the Drummond Botanical Subdistrict within the Swan Coastal Plain Subregion (SWA2) and is described as 'Mainly *Banksia* low woodland on leached sands with melaleuca swamps where ill-drained; woodland of tuart (*Eucalyptus gomphocephala*), jarrah (*E. marginata*) and marri (*E. calophylla*) on less leached soils.' (Beard 1990).

2.3 Vegetation Complexes

Vegetation complexes are a broad level of vegetation description which is based on the underlying geomorphology and rainfall (Hedde *et al.* 1980). The assessment area intersects with five vegetation complexes within the Swan Coastal Plain Subregion as described in **Table 1**.

Table 1: Vegetation complexes within the assessment area

Vegetation Complex	Description (DBCA 2018)
Bassendean Complex-Central and South	Vegetation ranges from woodland of <i>Eucalyptus marginata</i> (Jarrah) - <i>Allocasuarina fraseriana</i> (Sheoak) - Banksia species to low woodland of Melaleuca species, and sedgeland on the moister sites. This area includes the transition of <i>Eucalyptus marginata</i> (Jarrah) to <i>Eucalyptus todtiana</i> (Prickly bark) in the vicinity of Perth.
Bassendean Complex-North	Vegetation ranges from a low open forest and low open woodland of Banksia species <i>Eucalyptus todtiana</i> (Prickly bark) to low woodland of Melaleuca species and sedgeland which occupy the moister sites.
Bassendean Complex-North Transition	A transition complex of low open forest and low woodland of Banksia species - <i>Eucalyptus todtiana</i> (Prickly bark) on a series of high sand dunes. The understorey species reflect similarities with both the Bassendean-North and Karrakatta-North vegetation complexes.
Southern River Complex	Open woodland of <i>Corymbia calophylla</i> (Marri) - <i>Eucalyptus marginata</i> (Jarrah) - Banksia species with fringing woodland of <i>Eucalyptus rudis</i> (Flooded Gum) - <i>Melaleuca raphiophylla</i> (Swamp Paperbark) along creek beds.
Pinjar	Vegetation ranges from woodland of <i>Eucalyptus marginata</i> (Jarrah) - Banksia species to a fringing woodland of <i>Eucalyptus rudis</i> (Flooded Gum) - <i>Melaleuca preissiana</i> (Moonah) and sedgeland.

2.4 Soils

The Department of Primary Industries and Regional Development soil mapping for Western Australia (DPIRD 2022) shows that the assessment area intersects mainly with the Bassendean zone (212), with a small section around to the Northern terminal that lies within the Pinjarra Zone (213).

The Bassendean zone (212) is described by 'Mid-Pleistocene Bassendean sand. Fixed dunes inland from coastal dune zone. Non-calcareous sands, podsolised soils with low-lying wet areas' (Purdie *et al.* 2004).

The Pinjarra zone (213) is characterised by 'alluvial deposits (early Pleistocene to Recent) between the Bassendean Dunes Zone and the Darling Scarp, colluvial and shelf deposits adjacent to the Darling Scarp. Clayey to sandy alluvial soils with wet areas' (Purdie *et al.* 2004).

The characteristics of the soil systems within the assessment area are listed in **Table 2**.

Table 2: Soil systems within the assessment area (DPIRD 2022)

Subsystem Name (and symbol)	Bassendean, Jandakot phase (212Bs_Ja)
Phase Description	Depressions with free water in winter. Humus podzols and peat. Dense <i>M. preissiana</i> ; <i>M. raphiophylla</i> and <i>E. rudis</i> around the edges with reeds and sedges in the centre.
Subsystem Name (and symbol)	Bassendean seasonal swamps phase (212Bs__Ws)
Phase Description	Irregular banks of karst depressions. Some limestone outcrop. Shallow brown sands. <i>Banksia</i> spp. woodland with emergent <i>E. gomphocephala</i> and <i>E. marginata</i> ; dense shrub layer.
Subsystem Name (and symbol)	Bassendean, Gavin phase (212Bs__G)
Phase Description	Flat or gently undulating landscape. Iron-humus podzols and some diatomite deposits. <i>Banksia</i> spp. Low open woodland with scattered emergent <i>Eucalyptus calophylla</i> and <i>Melaleuca preissiana</i> dense shrub layer.
Subsystem Name (and symbol)	Bassendean, Joel phase (212Bs__J)
Phase Description	Poorly drained depressions. Humus podzols. Scattered <i>M. preissiana</i> , <i>E. rudis</i> and <i>Banksia ilicifolia</i> with a dense shrub layer.
Subsystem Name (and symbol)	Bassendean permanent lakes and swamps phase (212Bs__Wp)
Phase Description	Depressions. Humus podzols and peats around the edges often with some diatomite zoned vegetation with heath on upper slopes. <i>Melaleuca</i> spp. and <i>E. rudis</i> at waters edge. Reeds and sedges in shallow water.
Subsystem Name (and symbol)	Bassendean, Joel Phase (212Bs__J)
Phase Description	Poorly drained depressions. Humus podzols. Scattered <i>M. preissiana</i> , <i>E. rudis</i> and <i>Banksia ilicifolia</i> with a dense shrub layer.
Subsystem Name (and symbol)	Bassendean drainage lines phase (212Bs__DL)
Phase Description	Broad, shallow channels, peaty soils, fringe of <i>Melaleuca</i> spp. and <i>E. rudis</i> ; reeds and sedges in central zone.

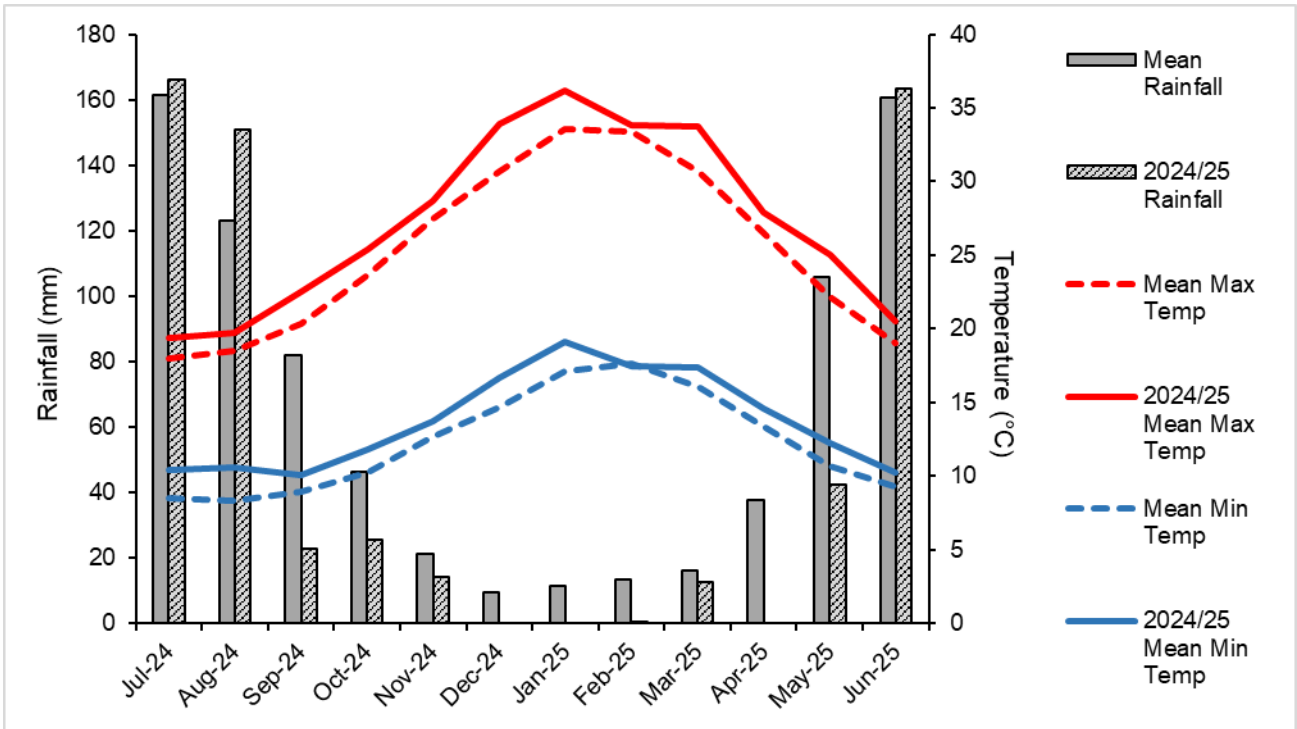
Subsystem Name (and symbol)	Bassendean Yanga phase (Bassendean) (212Bs__Ya)
Phase Description	Flat, poorly drained complex landscape; soils include shallow sand over limestone or ferruginous pan, deep leached sand, and saline soils; dense <i>Melaleuca spp.</i> along drainage lines.
Subsystem Name (and symbol)	EnvGeol S8 phase (212Bs__S8)
Phase Description	SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted of eolian origin
Subsystem Name (and symbol)	EnvGeol S10 phase (213Pj__S10)
Phase Description	SAND - as S8 as relatively thin veneer over sandy clay to clayey sand. Of eolian origin
Subsystem Name (and symbol)	EnvGeol Cps phase (212Bs__Cps)
Phase Description	Peaty clay - dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin

2.5 Climate

The Drummond Botanical Sub-district experiences a warm mediterranean climate with winter precipitation of 600-1000 mm and 5-6 dry months per year (Beard 1990). Rainfall and temperature data were taken from Wanneroo (#9150) and Pearce RAAF (#9053) weather stations respectively to gather information on long-term and recent climate data for the region. Wanneroo and Pearce RAAF weather stations are approximately 11.7 km and 14.6 km from the middle section of the assessment area.

Rainfall and temperature data from Wanneroo (#9150) and Pearce RAAF (#9053) weather stations respectively are shown in **Graph 1**. At the time of writing, the climate data for July 2025 is not yet available from BoM. Hence, these data are not included in **Graph 1**. Mean annual rainfall is 787.9 mm, placing the assessment area within the transitional rainfall zone (300-800 mm annual rainfall) classified by Hopper (1979). Most rainfall occurs between May and September. Total rainfall recorded for the 12 months prior to and including the Dieback assessment was 597.8 mm, 190.1 mm lower than the mean annual rainfall for the area. The average maximum temperature for the region in the last 12 months is 1.9°C higher than the long-term mean, while the average minimum temperature in the last 12 months is 1.4°C higher than the long-term mean. As this fits with

the long-term trend of reduced rainfall, combined with increased temperatures being observed in Western Australia, it is not considered a limitation to the survey.



Graph 1: Rainfall and temperature data from Wanneroo (#9150) and Pearce (#9053) weather station (BoM 2025).

3 Methods

3.1 Linear Dieback Assessment

The Comprehensive Linear Dieback assessment was conducted in a two-stage process:

- A desktop review of relevant, available information regarding site characteristics plus previous Dieback mapping and sample results.
- A field assessment to observe disease symptoms, record Dieback occurrence category data and collect soil and tissue samples for diagnostic testing.

The Dieback Interpreter's Manual requires a comprehensive Dieback assessment every three years where ground disturbance activities are planned (FEMD 2015). Recheck assessments can be completed annually for up to three years to update Dieback occurrence maps. While this only applies to DBCA-managed lands, it is recommended that all land managers follow this guidance where ground disturbance activities are planned in areas of native vegetation.

3.2 Desktop Assessment

A desktop assessment has been conducted to collect information about the assessment area, landscape features, relevant disturbances and previous history of Phytophthora Dieback assessment.

Terratree obtained previous mapping and sample data from the following sources:

- Vegetation Health Services (VHS) laboratory – Dieback sample results from previous assessments in the area.
- Forest Management Branch of DBCA – Dieback occurrence data, fire and logging history sourced from Forest Management Information System (FMIS).

The desktop assessment also aimed to:

- Identify access to the assessment area and internal tracks,
- Examine topography and drainage of the assessment area and broader landscape,
- Identify possible disease vectors (e.g. tracks, utility corridors and ground disturbance),
- Determine the location of high-risk areas (e.g. areas of high disturbance and water-gaining sites) and
- Review relevant literature and maps.

3.3 Field Assessment

3.3.1 Survey Strategy

The field assessment requires visually assessing native vegetation within the assessment area, recording Dieback occurrence category data, and collecting soil and tissue samples from recently dead Disease Indicator Species for diagnostic testing.

The Comprehensive Linear assessment was undertaken by DBCA-registered Dieback Interpreters Joseph Grehan and Norman Lai, along with Trainee Interpreter's Elisa Brendel, Julian Beasley, and Kyren Cleave between February 27th and July 11th, 2025.

The assessment was conducted according to the *FEM047 Phytophthora Dieback Interpreter's Manual for lands managed by the Department produced by the Forest and Ecosystem Management Division* (FEMD 2015; hereafter referred to as 'the Dieback Interpreter's Manual').

The Comprehensive Linear assessment investigated a minimum 100 m wide corridor (50 m either side of the corridor centreline). Particular attention was applied in areas where high risk vectors (roads, low-lying areas, human activity) are intersecting or adjacent to the assessment area.

Spatial data, including disease evidence points, sample locations and photographs, were recorded using handheld Global Positioning System (GPS) units.

3.3.2 Assessability

The Keighery vegetation (1994) disturbance scale in the Dieback Interpreter's Manual (**Table 3**) was used to determine the assessability of vegetated areas within the assessment area.

Areas with a vegetation condition rating of 1-3 (Pristine - Very Good) and enough Disease Indicator Species present to enable a diagnosis of the disease status are considered assessable.

Other areas of vegetation may be categorised as possibly assessable based on a condition rating of 4 (Good). In these areas, significant impacts to vegetation, including grazing, forestry harvesting, weed incursion and frequent fire events, have altered vegetation composition and structure so that it is unlikely to recover in the medium to long-term. Assessability of these areas is at the discretion of the Interpreter.

Areas where native vegetation is significantly degraded or cleared are given a condition rating of 5 (Degraded) or 6 (Completely Degraded) and classified as Excluded from assessment. Non-vegetated areas are also excluded from assessment, including pasture, pits (including gravel pits), large roads (sealed and unsealed), permanently flooded areas and parkland tree stands.

Table 3: Keighery vegetation disturbance scale and assessability (Keighery 1994, as defined in FEMD 2015)

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

3.3.3 Dieback Occurrence Categories

The assessability of vegetated and non-vegetated areas and associated *Phytophthora* Dieback occurrence categories can be determined using **Table 4**.

Uninfested vegetation exhibits the following characteristics:

- No positive sample results received for *P. cinnamomi*.
- An acceptable diversity of healthy Disease Indicator Species is present
- Vegetation condition is in Pristine - Very Good (1-3) condition according to the Keighery scale (Keighery 1994) with a good density of vegetation cover and no obvious reduction in biomass or masking by resistant species.
- No evidence found of disease pattern or chronology.

Infested vegetation is identified and characterised by the following features:

- Positive sample results for *P. cinnamomi* are found either in the immediate area, upslope or upstream of the infested area.
- Multiple disease indicator species deaths (ISDs) are occurring.
- Disease pattern and chronology are visible.
- Vegetation structure and composition are obviously altered.

Uninterpretable vegetation is identified and characterised the following features:

- Insufficient amounts of Disease Indicator Species are present.
- Vegetation condition is in Pristine - Very Good (1-3) condition according to the Keighery scale (Keighery 1994) with a good density of vegetation cover, possible masking by resistant species and no obvious reduction in biomass.
- Environmental conditions occur that discourage the pathogen, such as highly fertile soils, fewer host species or a dominating resistant host.

Uninterpretable areas may contain Dieback (e.g. in very low levels as an endemic or incipient disease) without showing signs of its presence and determining the presence of the pathogen is not possible using interpretation methods (FEMD 2015). Uninterpretable areas that meet the protocols for identifying Protectable areas are managed as being both Infested and Uninfested so that the pathogen is neither imported into, nor exported from, these areas.

The Temporarily Uninterpretable category is allocated to areas of native vegetation that have been disturbed but will recover over time and become interpretable and mappable in the future (i.e. within five years). Examples of Temporarily Uninterpretable areas include vegetation that has been impacted by fire, timber harvesting, grazing, flooding or mining with subsequent rehabilitation (FEMD 2015).

Excluded areas are distinguished from Temporarily Uninterpretable areas in that they cannot normally regenerate naturally and become mappable for Dieback occurrence in the future. Excluded areas are mapped from both field data and, where applicable, aerial imagery.

Table 4: Assessability of vegetated and non-vegetated areas (adapted from FEMD 2015)

Description	Phytophthora occurrence category	Typically present	May be present
<p>Naturally vegetated areas Keighery disturbance rating (Keighery 1994) of 3 or less. Phytophthora occurrence categorisation is possible. Small unvegetated areas can exist and may be included in the assessment area, considering total environmental context.</p>	INFESTED	Dead and dying reliable indicator species	Healthy reliable indicator species Indicator species deaths that have been killed by other agents
	UNINFESTED	Healthy reliable indicator species	Indicator species deaths that have been killed by other agents
	UNINTERPRETABLE	Very few reliable indicator species	Occasional reliable indicators, but too few for Phytophthora Dieback interpretation
	NOT YET RESOLVED	Usually, reliable indicator species in an environment not favourable to disease development	Negative sample results for all Phytophthora species
<p>Vegetation structure temporarily altered Phytophthora occurrence assessment will be possible when vegetation structure recovers. Recovery times will be variable depending on severity and type of disturbance.</p>	TEMPORARILY UNINTERPRETABLE	Indicator species masked by disturbance typically from fire, harvesting, temporary flooding, poisoning	Occasional reliable indicator species, but disturbance prevents accurate placement of Phytophthora occurrence
<p>Road disturbance area</p>	DISEASE RISK ROAD (DRR)	Unformed track with shoulders of interpretable vegetation	Shoulders and batters with regenerated vegetation, incipient infestation
<p>Vegetation structure severely altered Keighery disturbance rating (Keighery 1994) 5 or greater. Phytophthora occurrence assessment is not possible. Can be determined by desktop assessment (aerial photo). Small-vegetated areas can exist and may be excluded from the assessment area considering total environmental context.</p>	EXCLUDED	Pasture, pits, easements, infrastructure, large roads (sealed and unsealed) permanent flooding, plantations, parkland tree stands	Sporadic reliable indicator species

3.3.4 Sampling Strategy and Methods

Potential sample locations were selected throughout the assessment area. Sampling strategies for the assessment of Dieback aim to resolve the following scenarios:

- Sampling to support an infested diagnosis - recently dead and dying indicator species are sampled to support an Interpreter's diagnosis of an area as Infested.
- Sampling to support an uninfested diagnosis - recently dead and dying indicator species are sampled to support an Interpreter's diagnosis of an area as Uninfested.

Samples must be collected of soil and tissue from recently dead or dying disease indicator species to confirm the presence, or indicate the possible absence, of Dieback and to inform interpretation of the assessment area. Caution must be applied to interpreting the results of sampling and claiming that an area is Uninfested. False negative results can be obtained for several reasons, including when inoculum levels are depleted due to prolonged unfavourable environmental conditions for the pathogen (FEMD 2015). Therefore, sample results should be considered within the context of other field evidence, including disease vectors, pattern, chronology, biomass reduction and changes in vegetation structure.

All sampling strictly adhered to the following procedures:

- All tools used in sampling are thoroughly sterilised with a 70:30 mixture of methylated spirits and water before samples are taken. Tools are dry prior to sampling so that the results are not compromised.
- The plant sampled are excavated to a depth that ensure adequate plant tissue material can be obtained from the roots and cambium layer around the collar of the plant being sampled (not more than 150 mm depth).
- Material from all around the plant is taken in addition to any obvious lesions to avoid missing any infected material. Plant tissue material plus soil from around the roots and other places in the soil profile are placed in a polythene bag.
- All relevant information pertaining to the plant sampled and sample location are recorded on the Sample Information Sheet.
- Two aluminium tags that provided the date, company name, sample number and species sampled are prepared. One tag is to be placed in the sample bag and the other is tied near the sample site, which is also demarcated with fluorescent pink flagging tape.
- The sample hole is backfilled to prevent fauna from becoming trapped.
- All tools are brushed off to remove excess soil and sterilised to prevent contamination of the next sample site and sample.

All soil and tissue samples are lodged with the VHS laboratory, where diagnostic baiting is conducted. All sample point locations are recorded using a hand-held GPS unit.

Dieback assessment is conducted in a manner to ensure it does not spread Dieback within the assessment area. The following procedures are followed:

- Start all field assessments with a clean vehicle and footwear free of soil and vegetative material.
- Only work in dry conditions (i.e., when soil is not adhering) to reduce the spread of soil from footwear and vehicle movement.
- In wet conditions on more exposed soils, carry a small cleaning brush and spray bottle with a 70:30 solution methylated spirits/water to remove soil and mud from footwear when moving from Infested to Uninfested areas.
- In wet conditions:
 - Aim to work from Uninfested into Infested or Uninterpretable or Excluded areas.
 - Drive vehicles only on well-formed tracks avoiding muddy and wet areas.
 - If Uninfested areas need to be entered, complete an in-field vehicle inspection, and clean down if required.
- If a water-crossing or muddy area must be driven through, drive through slowly to reduce mud-spraying and complete an in-field vehicle inspection and clean down if required.

An in-field vehicle inspection and clean down involves the following process:

- Before entering an Uninfested area or after completing a water/mud-crossing, stop at an appropriate site as soon as possible. This should be a dry and sandy or hard-pan location in the Infested area, draining onto or into the Infested area.
- Remove soil and mud from tyres, bumper, wheel arches, steps and under vehicle.
- Spray down the undercarriage and wheels of vehicle with 70:30 solution methylated spirits/water.
- Spray all equipment used to clean the vehicle and footwear with 70:30 solution methylated spirits/water.

3.4 Demarcation

Infested and Uninterpretable areas are demarcated in accordance with the guidelines in the Dieback Interpreter's Manual for linear Dieback assessments (**Table 5**). Infested areas are demarcated using 25 mm fluorescent pink flagging tape. Uninterpretable areas are demarcated using 25 mm pink-and-black tiger-stripe flagging tape.

Discontinued sections of demarcation will be annotated on a map as 'Not Demarcated'.

Demarcation tapes are placed at sufficient frequency so that an installed tape can be clearly seen from adjacent forward and backward tape positions. For all *Phytophthora* demarcation scenarios, the tape will indicate which side of the line the category is on by the position of the knot and tape tail that will face the category being demarcated. A double tape will indicate the start and end of a demarcation line.

Demarcated sections are tracked using a GPS to digitise the location of all demarcation associated with disease mapping. The recorded line is not the disease edge but covers Infested area plus variable buffer. Buffers are applied to *Phytophthora* boundaries to counteract incipient disease.

The following buffers are applied during assessments in accordance with the Dieback Interpreter's Manual:

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

Table 5: Demarcation Scenarios (adapted from Table 9, Page 122 FEMD 2016)

Boundary Being Demarcated	Demarcation Tape Colour, Width and Comments
Phytophthora Dieback Infested against protectable Uninfested and Protectable Uninterpretable	Fluoro pink 25 mm
Uninterpretable, Temporarily Uninterpretable and Excluded when required against Protectable Uninfested	Pink and black striped ('tiger tape') 25 mm
Uninterpretable against Excluded and Temporarily Uninterpretable	Double band pink and black tiger tape
Phytophthora Dieback Infested against unprotectable	No tape required
Other <i>Phytophthora</i> spp.	Fluoro pink 25 mm. Will be demarcated when impact is significant
Armillaria infestation	Not usually demarcated, but if required, double flagging of pink and black tiger tape and fluoro pink 25mm.

3.5 Mapping

Spatial data, including tracks and waypoints recorded on hand-held GPS units, were downloaded into a Geographic Information System (GIS) program. The GIS software used for the project was QGIS 3.40 (QGIS Development Team 2025).

Field evidence and observations plus spatial data were used to prepare a Dieback occurrence map for the assessment area. *Phytophthora* occurrence categories were mapped using the categories defined in **Table 4**.

For operational purposes, Dieback occurrence mapping is only valid for 12 months after the assessment is completed to counter for autonomous spread of the pathogen (FEMD 2015).

4 Results

4.1 Desktop Review

A desktop review confirmed that no *Phytophthora* spp. positive samples have been identified within the assessment area. However, historical records indicate:

- One *Phytophthora cinnamomi* and one *P. nicotianae* positive sample were found in 2020 within bushland adjacent to the assessment area, located between Tonkin Highway and Beechboro Road North, Whiteman.
- Six historical *P. cinnamomi* positive samples were recorded in Whiteman Park between 2002 and 2014, near the assessment area.
- Two historical *P. cinnamomi* positive samples were identified in the adjacent Gnangara-Moore River State Forest in 2008.

According to FMIS data, the area between Tonkin Highway and Beechboro Road North, Whiteman was last assessed in 2020 and is predominantly classified as Infested, with two isolated patches of Uninfested vegetation. Sections of the assessment area overlapping with the Gnangara-Moore River State Forest were mapped as Uninfested in 2006. An unnamed dampland west of the Neerabup Terminal was mapped as Uninterpretable. Additionally, two infestations were mapped within the assessment area in 2006: one within vegetation north of Neaves Road and another within an unnamed dampland south of Neaves Road.

Assessment conducted by Terratree in 2014 and 2017 indicates that the portion north of Marshall Road, Beechboro and up to Hennessy Road, Whiteman (adjacent to Tonkin Highway) is also predominantly Infested (Terratree 2014; Terratree 2017).

4.2 Disease Indicator Species

Disease Indicator Species observed within the project boundary include, but are not limited to representatives of the Casuarinaceae, Iridaceae, Fabaceae, Proteaceae, Ericaceae and Xanthorrhoeaceae families. Disease indicator species observed during the field survey are listed in **Table 6**.

Table 6: Disease Indicator Species within the assessment area

Family	Species
Casuarinaceae	<i>Allocasuarina fraseriana</i>
	<i>Allocasuarina humilis</i>
Dasygogonaceae	<i>Dasygogon bromeliifolius</i>
Ericaceae	<i>Styphelia tenuifolia</i>
Fabaceae	<i>Jacksonia floribunda</i>
	<i>Jacksonia furcellata</i>
	<i>Jacksonia sternbergiana</i>
Iridaceae	<i>Patersonia occidentalis</i>
Myrtaceae	<i>Eucalyptus marginata</i>
Proteaceae	<i>Adenanthos cygnorum</i>
	<i>Banksia attenuata</i>
	<i>Banksia dallanneyi</i>
	<i>Banksia grandis</i>
	<i>Banksia ilicifolia</i>
	<i>Banksia menziesii</i>
	<i>Banksia nivea</i>
	<i>Banksia sessilis</i>
	<i>Persoonia elliptica</i>
	<i>Stirlingia latifolia</i>
Xanthorrhoeaceae	<i>Xanthorrhoea preissii</i>
Zamiaceae	<i>Macrozamia fraseri</i>

4.3 Sample Results

A total of 21 soil and tissue samples were collected during the Dieback assessment. Of these, two samples (CELS12 and CELS19) tested positive for *P. cinnamomi*, two samples (CELS06 and CELS08) were positive for *P. arenaria*, and one sample (CELS21) tested positive for *P. nicotianae* through diagnostic baiting. Sample details are presented in **Table 7**. The CPSM laboratory Phytophthora testing results are provided in **Appendix A**.

Table 7: Sample results from the assessment area

Sample Label	Species	Easting	Northing	Result
CELS01	<i>Banksia grandis</i>	388312	6494358	Negative
CELS02	<i>Xanthorrhoea preissii</i>	390147	6494324	Negative
CELS03	<i>Banksia attenuata</i>	392668	6494228	Negative
CELS04	<i>Adenanthos cygnorum</i>	392817	6494228	Negative
CELS05	<i>Xanthorrhoea preissii</i>	392150	6494315	Negative
CELS06	<i>Banksia attenuata</i>	394202	6493944	<i>P. arenaria</i>
CELS07	<i>Banksia attenuata</i>	394328	6493690	Negative
CELS08	<i>Banksia attenuata</i>	394413	6493568	<i>P. arenaria</i>
CELS09	<i>Xanthorrhoea preissii</i>	393802	6594078	Negative
CELS10	<i>Banksia attenuata</i>	395097	6492500	Negative
CELS11	<i>Xanthorrhoea preissii</i> and <i>Banksia attenuata</i>	395286	6492157	Negative
CELS12	<i>Xanthorrhoea preissii</i>	396089	6490825	<i>P. cinnamomi</i>
CELS13	<i>Xanthorrhoea preissii</i>	396425	6490341	Negative
CELS14	<i>Xanthorrhoea preissii</i>	396539	6488814	Negative
CELS15	<i>Xanthorrhoea preissii</i>	391447	6494303	Negative
CELS16	<i>Xanthorrhoea preissii</i>	393156	6494154	Negative
CELS17	<i>Banksia menziesii</i>	392827	6494149	Negative
CELS18	<i>Banksia ilicifolia</i>	394266	6493788	Negative
CELS19	<i>Banksia attenuata</i>	396601	6489019	<i>P. cinnamomi</i>

Sample Label	Species	Easting	Northing	Result
CELS20	<i>Xanthorrhoea preissii</i>	396557	6487282	Negative
CELS21	<i>Banksia menziesii</i>	396506	6475085	<i>P. nicotianae</i>

4.4 Dieback Occurrence

Figure 2 to Figure 7 presents the Phytophthora occurrence map for the assessment area. Table 8 provides a breakdown of the Dieback Occurrence Categories and the area calculations.

In total, 413.8 ha of vegetation was assessed comprehensively. The majority of the assessment area, 242 ha (58.5%), has been categorised as Excluded. Infested areas comprised 131.8 ha (31.9%), while Uninfested areas accounted for 40 ha (9.7%).

Table 8: Dieback occurrence area statement for the assessment area

Occurrence Category	Area (ha)	% of Assessment Area
Infested	131.8	31.9
Uninfested	40.0	9.7
Excluded	242.0	58.5
Total	413.8	100

5 Discussion

5.1 Infested areas

In total, 131.8 ha (31.9%) of the assessment area has been mapped as Infested. The majority of the Infested areas mostly corresponds to the infestations from FMIS and those previously mapped by Terratree (**Section 4.1; Figure 2; Figure 3; Figure 5; Figure 6**; Terratree 2014; Terratree 2017). Disease expression was subtle to obvious and was evident in recently dead *Banksia* spp. and *Xanthorrhoea preissii* displaying disease pattern and chronology for an Infested diagnosis (**Photo 1** and **Photo 2**). These infestations were checked and the demarcation buffers adjusted as required.

Two discrete areas of *Phytophthora nicotianae* infestation (0.03 and 0.05 ha) have been mapped during this assessment. One infestation is located within the remnant vegetation adjacent to the assessment area to the east of Guadalupe Drive, Ballajura, where a positive sample (CELS21) for *P. nicotianae* was recovered (**Table 7**). The other infestation is located in the bushland between Tonkin Highway and Beechboro Road North, Whiteman. This infestation has been mapped from a historical positive sample for *P. nicotianae* recovered in 2020. Both infestations have not been demarcated as the *P. nicotianae* pathogen exhibited only a small, localised impact on the vegetation. Nevertheless, a nominal 20 m Infested buffer has been applied from the location of the samples to delineate the Infested boundary (**Figure 2**).

A new infestation (4 ha) caused by *P. cinnamomi* was found within the assessment area overlapping with Gngangara-Moore River State Forest where several recently dead or dying *X. preissii* were observed within the vegetation. A positive sample (CELS12) for *P. cinnamomi* was recovered, supporting an Infested diagnosis (**Figure 5; Table 7; Photo 3**).

Two new infestations caused by *P. arenaria* were found to the north and south of Neaves Road, Mariginiup respectively. Multiple recently dead or dying *Banksia* spp. were observed within these Infested areas, and two positive samples (CELS06 and CELS08) for *P. arenaria* were recovered, supporting an Infested determination (**Table 7**). The *P. arenaria* infestation to the south of Neaves Road (**Photo 4**) has been incorporated into the *P. cinnamomi* infestation (9.3 ha) originating from the unnamed dampland (**Photo 5**), as the *P. arenaria* infestation lies downslope from the *P. cinnamomi* infestation (**Figure 5**). The overlapping patterns of *Banksia* mortality in the area also obscure the ability to differentiate Dieback symptoms attributable to each *Phytophthora* species. The *P. arenaria* infestation (0.07 ha) within the Uninfested vegetation to the north of Neaves Road has not been demarcated as the pathogen exhibited only a small, localised impact on the vegetation (**Photo 6**). Nevertheless, a nominal 20 m Infested buffer has been applied from the location of the sample to delineate the Infested boundary (**Figure 5**).

5.2 Uninfested areas

In total, 40 ha (9.7%) of the assessment area has been mapped Uninfested. Uninfested vegetation within the assessment area is characterised by the presence of healthy *Banksia* spp. and *Xanthorrhoea preissii*, along with other, less reliable disease indicator species (**Photo 7** to **Photo 9**). This vegetation is generally found within or adjacent to State Forests, Bush Forever sites, and remnant road reserves (**Figure 2**; **Figure 5**; **Figure 6**; **Figure 7**). The condition of native vegetation within these Uninfested areas is categorised as Very Good to Excellent on the Keighery Vegetation Condition Scale, with few annual weeds present. Several dead *Banksia* spp. were observed and found to be affected by drought, with no evidence of a disease pattern or chronology in the vegetation. Negative results from samples CELS02, CELS03, CELS04, CELS07, CELS10, CELS11, CELS17, and CELS18 support the Uninfested determination for these areas (**Table 7**).

5.3 Excluded areas

The majority of the assessment area (101.4 ha; 82.9%) has been classified as Excluded. These areas are characterised by land cleared for infrastructure and areas heavily invaded by introduced grasses, such as Perennial Veldt Grass (*Ehrharta calycina*), African lovegrass (*Eragrostis curvula*) and aggressive weeds including Rose Geranium (*Pelargonium capitatum*) and Pigface (*Carpobrotus edulis*). Most are located in or adjacent to infrastructure, pastoral lands, and roads, where vegetation condition is classified as Degraded to Completely Degraded. Other Excluded areas include revegetated and/or regenerated patches (**Figure 2** to **Figure 7**). Due to grazing, disturbance, and/or weed invasion, vegetation structure is altered, soils are compacted, and vegetation is degraded, often with isolated or scattered pockets of remnant vegetation and minimal to no understorey (**Photo 10** to **Photo 17**).

While Excluded areas may contain disease indicator species, the high level of disturbance makes it difficult to distinguish Dieback symptoms from other vegetation health impacts. Nevertheless, several samples were collected from recently dead disease indicator species within Excluded areas or in the larger Uninfested vegetation adjacent to the Excluded areas to determine the risk of Dieback being present in the vicinity. Negative results from samples CELS01, CELS05, CELS09, CELS13, CELS14, CELS15, CELS16, and CELS20 suggest that the risk of Dieback being present in the Excluded areas is low (**Table 7**).

5.4 Limitations

The following limitations were encountered during the *Phytophthora* Dieback assessment:

- The lack of or absence of any disease indicator species or susceptible species meant that some areas were mapped as Uninterpretable.
- The lack of native vegetation in areas dominated by presence of aggressive weeds sections meant that some areas were categorised as Excluded from the assessment due to the Degraded to Completely Degraded vegetation condition.

5.5 Other Potential Impact to Vegetation

5.5.1 Drought

Impacts to vegetation through prolonged drought are distinguished from impacts caused by *Phytophthora* spp. by the following characteristics:

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

Evidence of drought impacts were observable throughout the assessment area where plants had senesced and died during period of prolonged drought.

6 Conclusion and Recommendations

In total, 413.8 ha of vegetation was assessed comprehensively including 171.8 ha of native vegetation. The majority of the assessment area, 242 ha (58.5%), has been categorised as Excluded due to Degraded to Completely Degraded vegetation condition associated with infrastructure, pastoral lands, roadside vegetation, and revegetated and/or regenerated areas.

A total of 131.8 ha (31.9%) of the assessment area has been mapped as Infested. The majority of the Infested areas mostly corresponds to the infestations from FMIS and those previously mapped by Terratree.

Two discrete areas of *Phytophthora nicotianae* infestation (0.03 and 0.05 ha) have been mapped during this assessment. One infestation is located within the remnant vegetation adjacent to the assessment area to the east of Guadalupe Drive. The other infestation is located in the bushland between Tonkin Highway and Beechboro Road North, Whiteman. Both infestations have not been demarcated as the *P. nicotianae* pathogen exhibited only a small, localised impact on the vegetation. A nominal 20 m Infested buffer has been applied from the location of the samples to delineate the Infested boundary.

A new *P. cinnamomi* infestation (4 ha) was found within the assessment area overlapping with Gngangara-Moore River State Forest.

Two new *P. arenaria* infestations were found to the north and south of Neaves Road respectively. The *P. arenaria* infestation to the south of Neaves Road has been incorporated into the *P. cinnamomi* infestation (9.3 ha) originating from the unnamed dampland, as the *P. arenaria* infestation lies downslope from the *P. cinnamomi* infestation. The overlapping patterns of *Banksia* mortality in the area also obscure the ability to differentiate Dieback symptoms attributable to each *Phytophthora* species. The *P. arenaria* infestation (0.07 ha) within the Uninfested vegetation to the north of Neaves Road has not been demarcated as the pathogen exhibited only a small, localised impact on the vegetation. A nominal 20 m Infested buffer has been applied from the location of the sample to delineate the Infested boundary.

A total of 40 ha (9.7%) of the assessment area has been mapped as Uninfested. The vegetation condition in the Uninfested areas is Very Good to Excellent, with healthy *Banksia* spp., *X. preissii*, and few annual weeds present.

Terratree makes the following recommendations:

- Implement the management requirements specified in the completed Dieback Hygiene Management Plan which has been prepared in accordance with the *Phytophthora Dieback Management Manual* (DBCA 2020).
- Ensure key personnel have completed Green Card biosecurity training for example: environmental personnel and field supervisors to ensure compliance with Dieback Management Plan.

- Provide clear instruction to staff and contractors about hygiene requirements when entering protectable areas (Uninfested and Uninterpretable areas).
- Signage should be installed to clearly identify vehicle and machinery inspection locations and Clean on Entry points within the assessment area.
- Conduct a post-construction Dieback assessment of the disturbance area to ensure that the pathogen has not been introduced into protectable areas.

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Glossary of Terms (adapted from FEMD 2015)

Assessment - (*Phytophthora* occurrence) any combination of activities including detection, diagnosis (interpretation), mapping and demarcation of *Phytophthora* Dieback disease in natural ecosystems.

Assessment Area - an area where *Phytophthora* occurrence assessment is possible or will be possible in the short to medium term. This area may be larger or smaller than the proponent's project area. Synonyms used in this report include "track alignment" and "corridor",

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

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

Dieback (*Phytophthora*) Interpreter - a registered person who conducts *Phytophthora* Dieback interpretation.

Dieback (*Phytophthora*) Interpretation - the method of determining *Phytophthora* Dieback infestation using procedures in the Dieback Interpreter's Manual (Forest and Ecosystem Management Division (2015). FEM047 *Phytophthora* Dieback Interpreter's manual for lands managed by the department. Version 1.0. Department of Parks and Wildlife, Perth, Western Australia).

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

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

Excluded Area - an area that has been disturbed to an extent that it is not assessable and therefore Excluded from Dieback interpretation.

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

Indicator species – a plant species that is more susceptible to *Phytophthora* disease and reliably shows symptoms earlier than other species.

Infection - the invasion of a host organism's bodily tissue by disease-causing organisms. In relation to Dieback, this refers to an individual plant and not the population.

Infested Area - an area that an accredited Dieback Interpreter has determined has plant disease symptoms consistent with the presence of the pathogen *Phytophthora cinnamomi*.

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

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

Pathogen - any organism or factor causing disease within a host.

Phytophthora Dieback - a term referring to the disease symptoms caused by Phytophthora species in susceptible vegetation.

Project area - The proponent's project area, demarcated by the "**Project boundary**". This area includes the "assessment area" of the survey.

Protectable Area - an area of land managed by the landowner where hygiene management rules for the plant pathogen Phytophthora, including clean on entry, will apply. These areas are generally free of disease.

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

Uninfested Area - an area that an accredited Dieback Interpreter has determined to be free of plant disease symptoms that indicate the presence of Phytophthora Dieback.

Uninterpretable Area - an area situated in locations receiving >600 mm rainfall per year or are water-gaining sites (e.g. granite outcrops, impeded drainage or engineering works that aggregate rainfall) in the 400-600 mm per year rainfall zone where indicator plants are absent or too few to determine the presence or absence of disease caused by Phytophthora Dieback.

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

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

Photos



Photo 1: Infested area displaying disease pattern and chronology with multiple *Banksia* spp. deaths and biomass reduction in the foreground.



Photo 2: Infested area with multiple *Banksia* spp. deaths.



Photo 3: Multiple recently dead *X. preissii* (CELS21) caused by *P. cinnamomi*.



Photo 4: *Banksia attenuata* death caused by *P. arenaria*.



Photo 5: Infested dampland caused by *P. cinnamomi* with recent *B. menziesii* death in the background and old *X. preissii* death in the foreground.



Photo 6: *Banksia attenuata* deaths caused by *P. arenaria* displaying small, localised impact within Uninfested vegetation.



Photo 7: Uninfested vegetation with healthy *Banksia* spp. and *A. cygnorum*.



Photo 8: Uninfested vegetation with healthy *X. preissii* along the powerline.



Photo 9: Uninfested vegetation with healthy *Banksia spp.*, *X. preissii*, and *A. cygnorum* within the assessment area.



Photo 10: Excluded vegetation in Completely Degraded vegetation condition within the Northern Terminal.



Photo 11: Excluded vegetation in Completely Degraded vegetation condition with some remnant vegetation within the Northern Terminal.



Photo 12: Excluded vegetation in Completely Degraded vegetation condition dominated by Perennial Veldt Grass (*Ehrharta calycina*), African lovegrass (*Eragrostis curvula*) and aggressive weeds including Rose Geranium (*Pelargonium capitatum*) and Pigface (*Carpobrotus edulis*).



Photo 13: Excluded vegetation in Completely Degraded vegetation condition under pine planation within Gngara-Moore River State Forest.



Photo 14: Excluded vegetation in Degraded vegetation condition with remnant *X. preissii* and Pigface (*C. edulis*) invasion within the assessment area.



Photo 15: Excluded vegetation around Neerabup Terminal



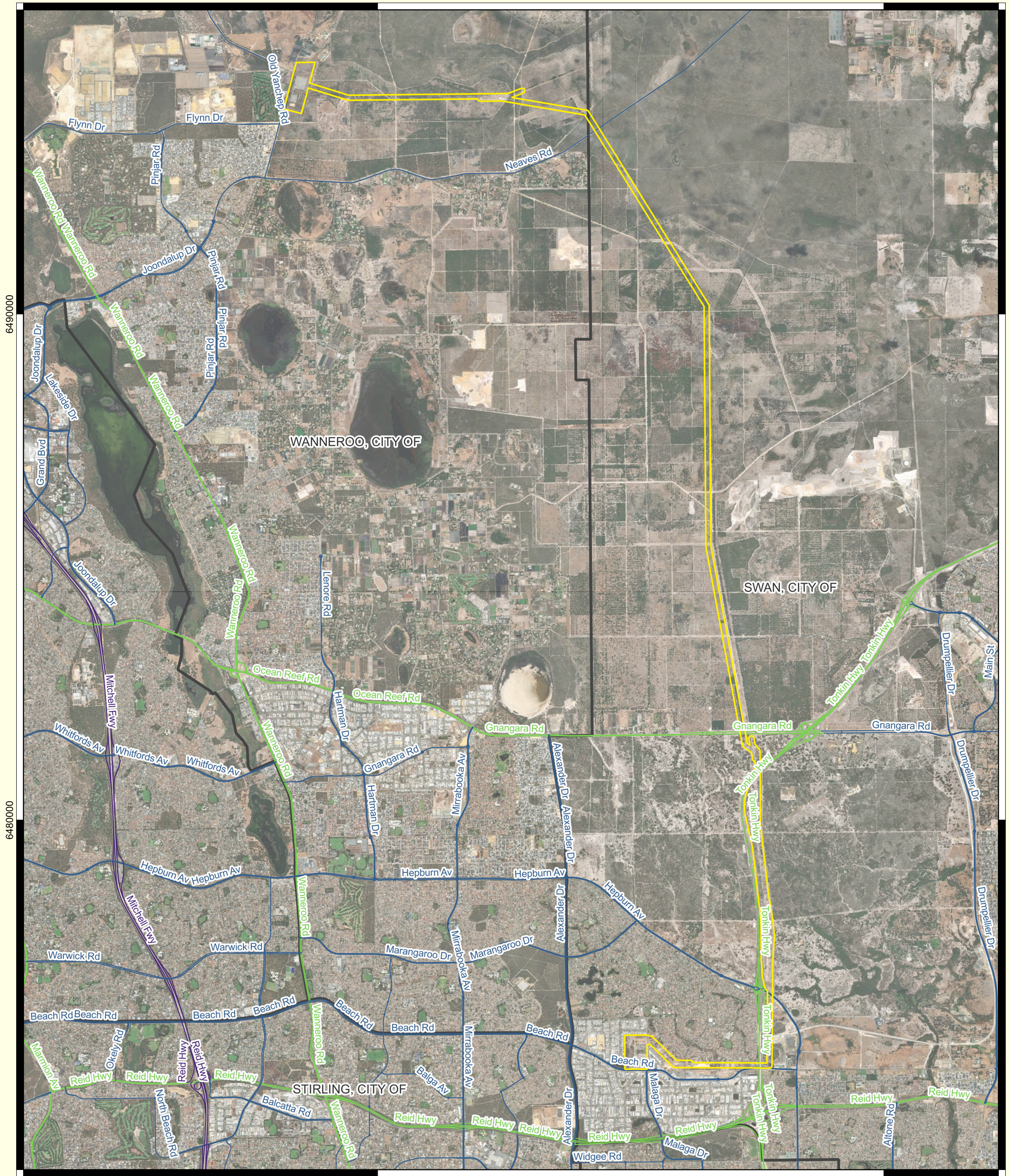
Photo 16: Excluded vegetation around Neerabup Terminal



Photo 17: Excluded vegetation in Neerabup Terminal

Figures

Figure 1: Project Location Map



6490000

0006490

6480000

0006480

Legend

- Clean Energy Link Assessment Area
- Local Government Authority Boundaries

Road Network

- Freeway
- Main
- State Highway



Project Location Map

2025 Linear Dieback Assessment - Clean Energy Link North

0 1 2 3 4 km

Datum: GDA 2020
Projection: MGA Zone 50

Scale: 1:1000
at A3

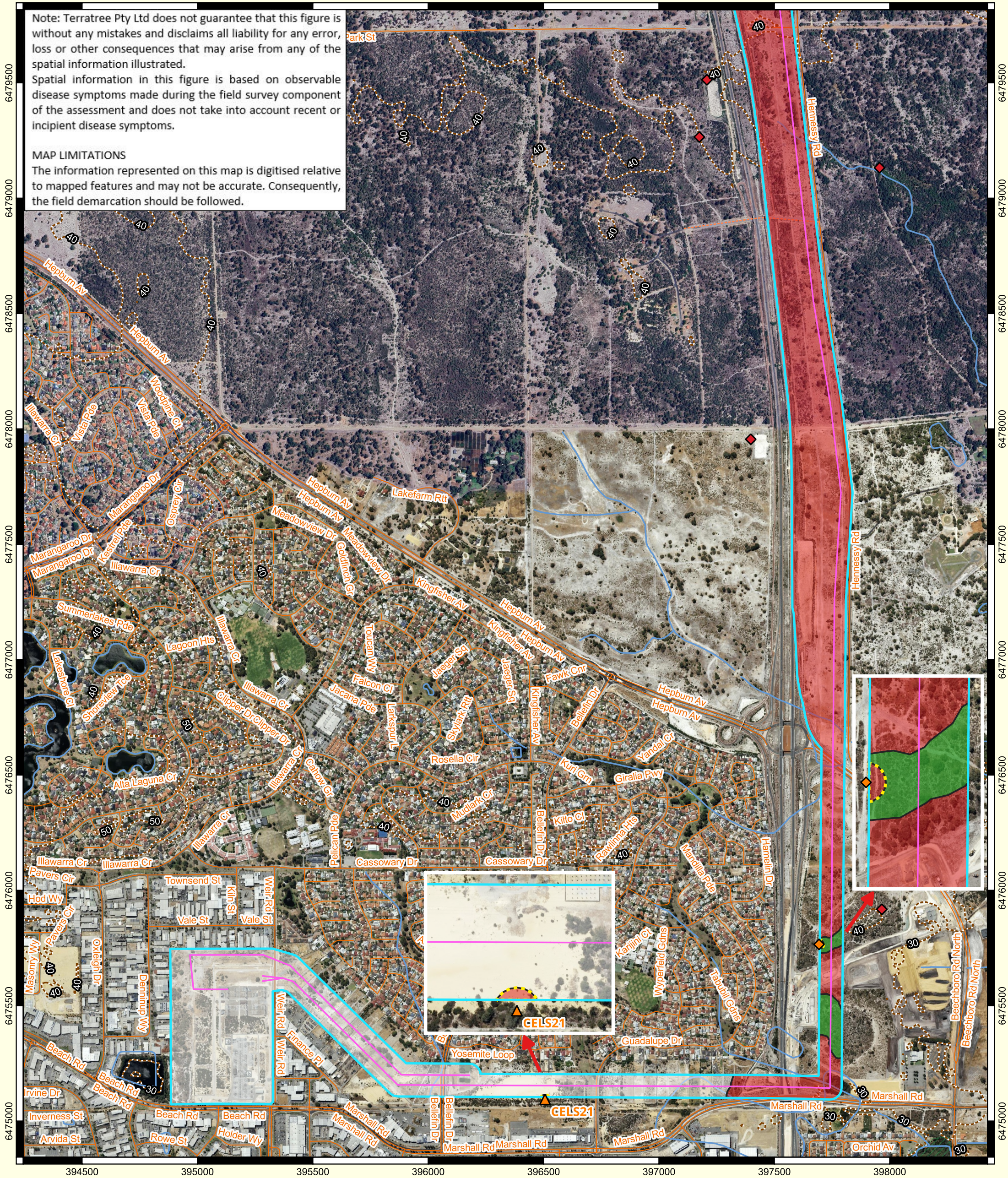
Date: 24/03/2025	Interpreter: NA	Project #: T25002
Expiry: NA	Prepared: E. Brendel	Terratree
Figure 1	Review: J. Grehan	
Revision:		

Figure 2 to 7: Phytophthora Occurrence maps

394500 395000 395500 396000 396500 397000 397500 398000

Note: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any error, loss or other consequences that may arise from any of the spatial information illustrated.
 Spatial information in this figure is based on observable disease symptoms made during the field survey component of the assessment and does not take into account recent or incipient disease symptoms.

MAP LIMITATIONS
 The information represented on this map is digitised relative to mapped features and may not be accurate. Consequently, the field demarcation should be followed.



Legend

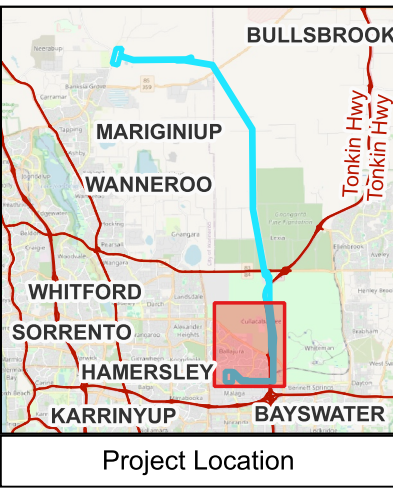
- Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area
- NT-NBT Centreline
- Watercourse Line
- Contour (10 m)
- Miscellaneous Road
- Local Road
- State Road

Sample Location and Result

- P. nicotianae*
- P. cinnamomi* (Historical)
- P. nicotianae* (Historical)

Phytophthora Occurrence

- Infested
- Uninfested
- Excluded
- Not Demarcated



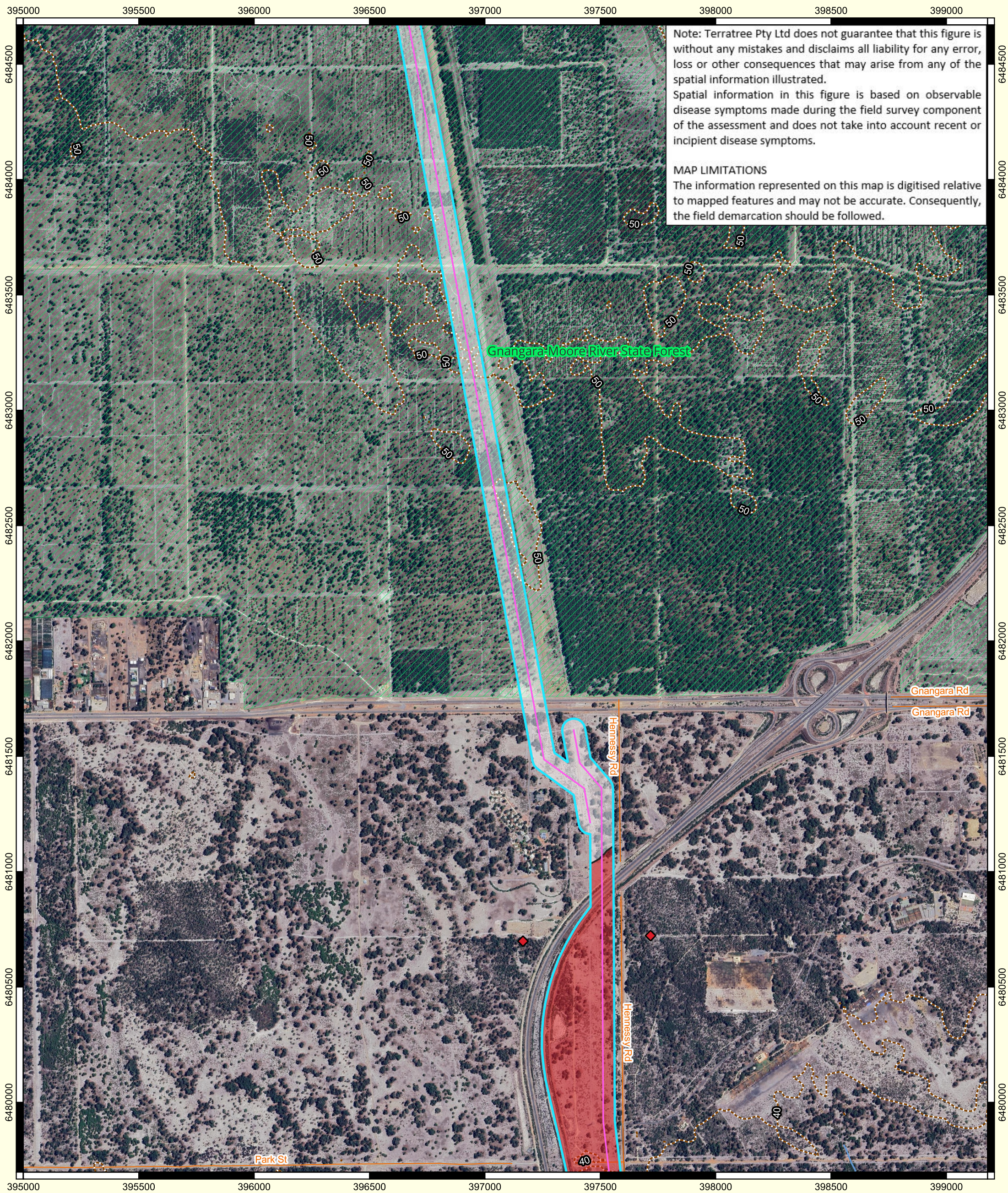
Phytophthora Occurrence Map
 2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project

0 250 500 750 1,000 m

Datum: GDA 1994 Scale: 1:15,000 at
 Projection: MGA Zone 50 A3

Date: 11/07/2025 Interpreter: J.G, N.L Project #: T25002
 Expiry: 11/07/2026 Prepared: N.L
 Review: J.G
 Revision:

Figure 2



Note: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any error, loss or other consequences that may arise from any of the spatial information illustrated. Spatial information in this figure is based on observable disease symptoms made during the field survey component of the assessment and does not take into account recent or incipient disease symptoms.

MAP LIMITATIONS
The information represented on this map is digitised relative to mapped features and may not be accurate. Consequently, the field demarcation should be followed.

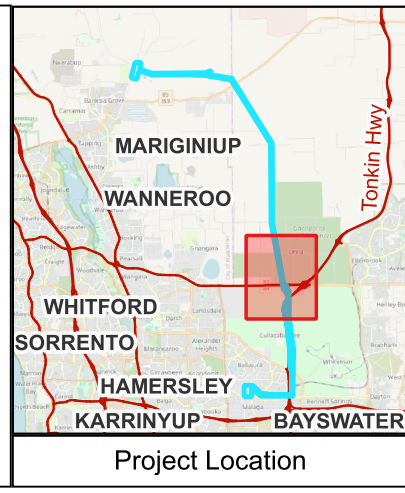
- Legend**
- Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area
 - NT-NBT Centreline
 - Gngangara-Moore River State Forest
 - Watercourse Line
 - Contour (10 m)
 - Miscellaneous Road
 - Local Road
 - State Road

Sample Location and Result

- ◆ *P. cinnamomi* (Historical)

Phytophthora Occurrence

- Infested
- Excluded



Phytophthora Occurrence Map
2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project

0 250 500 750 1,000 m

N

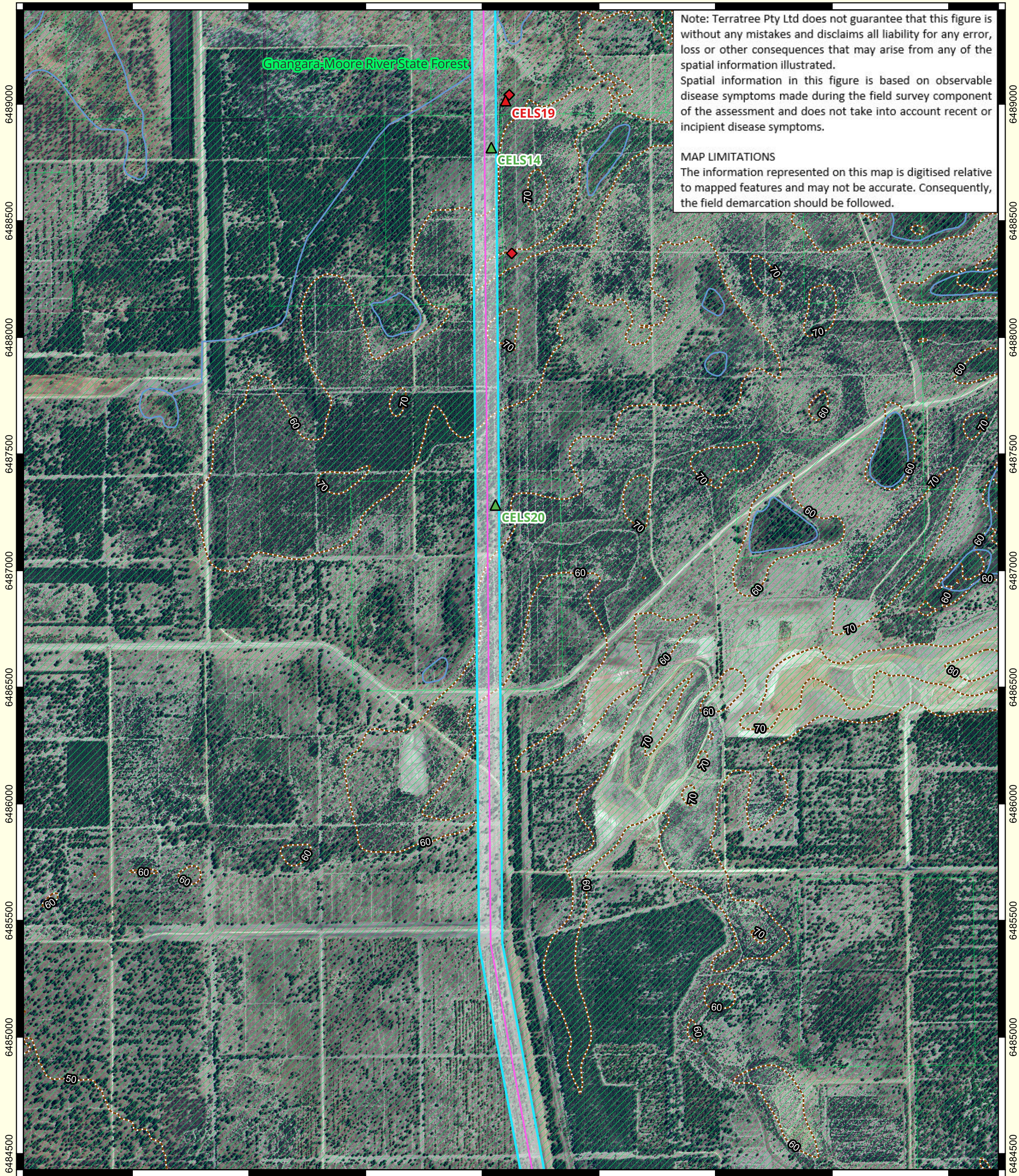
Datum: GDA 1994 Scale: 1:15,000 at A3
Projection: MGA Zone 50

Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002
Expiry: 11/07/2026	Prepared: N.L	
	Review: J.G	
	Revision:	

Figure 3

Terratree

395000 395500 396000 396500 397000 397500 398000 398500



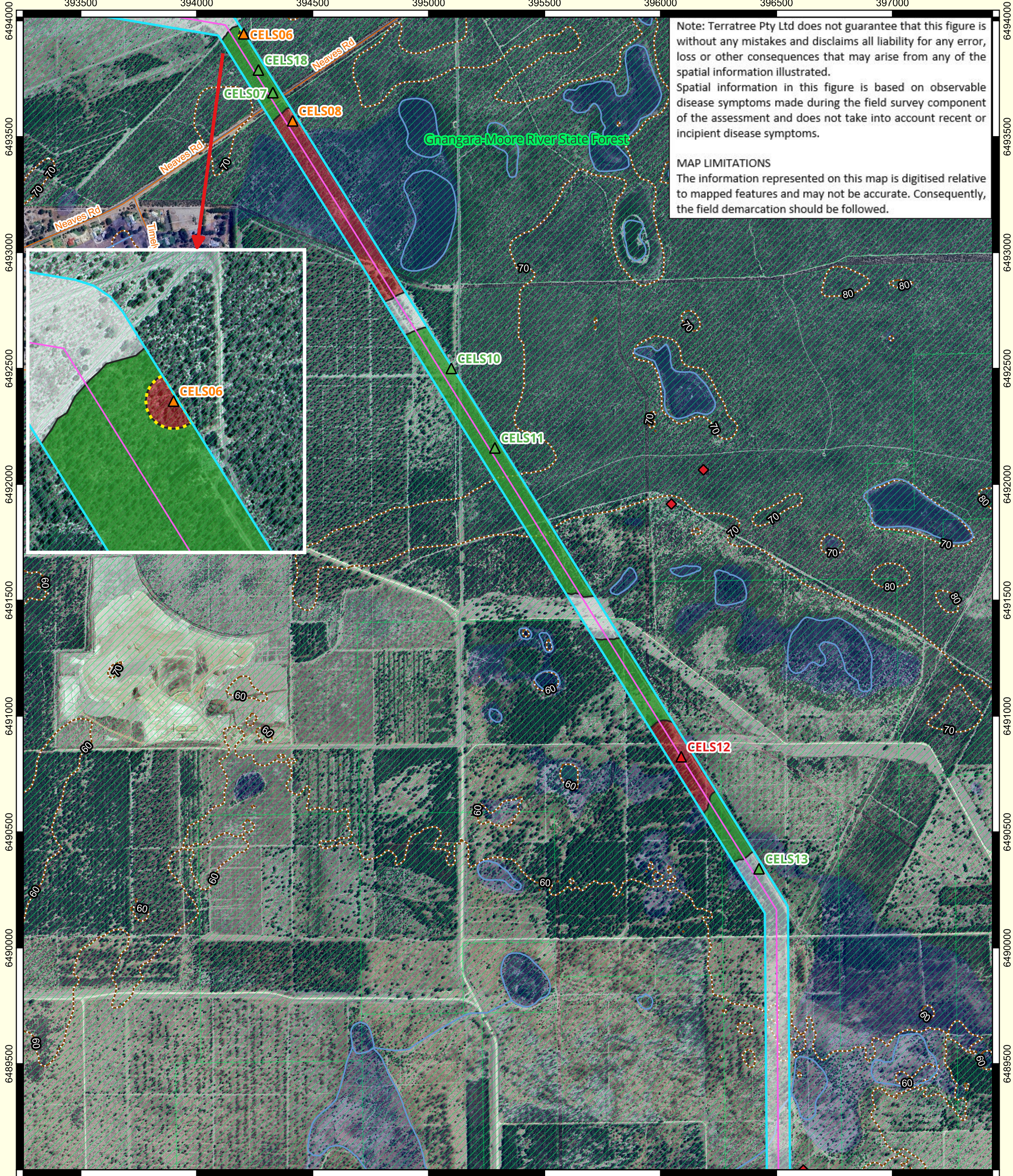
Note: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any error, loss or other consequences that may arise from any of the spatial information illustrated. Spatial information in this figure is based on observable disease symptoms made during the field survey component of the assessment and does not take into account recent or incipient disease symptoms.

MAP LIMITATIONS
The information represented on this map is digitised relative to mapped features and may not be accurate. Consequently, the field demarcation should be followed.

395000 395500 396000 396500 397000 397500 398000 398500

Legend	Sample Location and Result	Phytophthora Occurrence	<p>Project Location</p>	<p>Phytophthora Occurrence Map 2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project</p> <p>0 250 500 750 1,000 m</p> <p>Datum: GDA 1994 Scale: 1:15,000 at Projection: MGA Zone 50 A3</p>											
<ul style="list-style-type: none"> Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area NT-NBT Centreline Gngangara-Moore River State Forest Watercourse Line Contour (10 m) Miscellaneous Road Local Road State Road 	<ul style="list-style-type: none"> ▲ <i>P. cinnamomi</i> ▲ Negative ◆ <i>P. cinnamomi</i> (Historical) 	<ul style="list-style-type: none"> Excluded 			<table border="1"> <tr> <td>Date: 11/07/2025</td> <td>Interpreter: J.G, N.L</td> <td>Project #: T25002</td> </tr> <tr> <td>Expiry: 11/07/2026</td> <td>Prepared: N.L</td> <td></td> </tr> <tr> <td>Figure 4</td> <td>Review: J.G</td> <td></td> </tr> <tr> <td></td> <td>Revision:</td> <td></td> </tr> </table>	Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002	Expiry: 11/07/2026	Prepared: N.L		Figure 4	Review: J.G		
Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002													
Expiry: 11/07/2026	Prepared: N.L														
Figure 4	Review: J.G														
	Revision:														





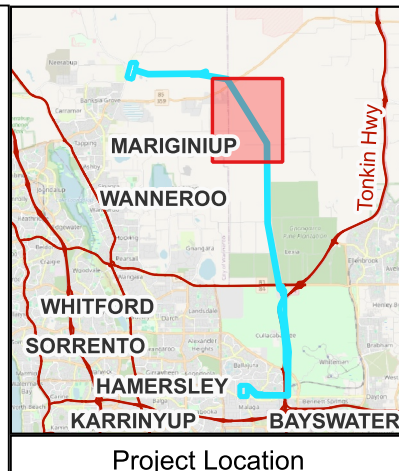
- Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area
- NT-NBT Centreline
- Watercourse Line
- Gnaragara-Moore River State Forest
- Geomorphic Wetland
- Contour (10 m)
- Miscellaneous Road
- Local Road
- State Road

Sample Location and Result

- P. cinnamomi*
- P. arenaria*
- Negative
- P. cinnamomi* (Historical)

Phytophthora Occurrence

- Infested
- Uninfested
- Excluded
- Not Demarcated



Phytophthora Occurrence Map
2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project

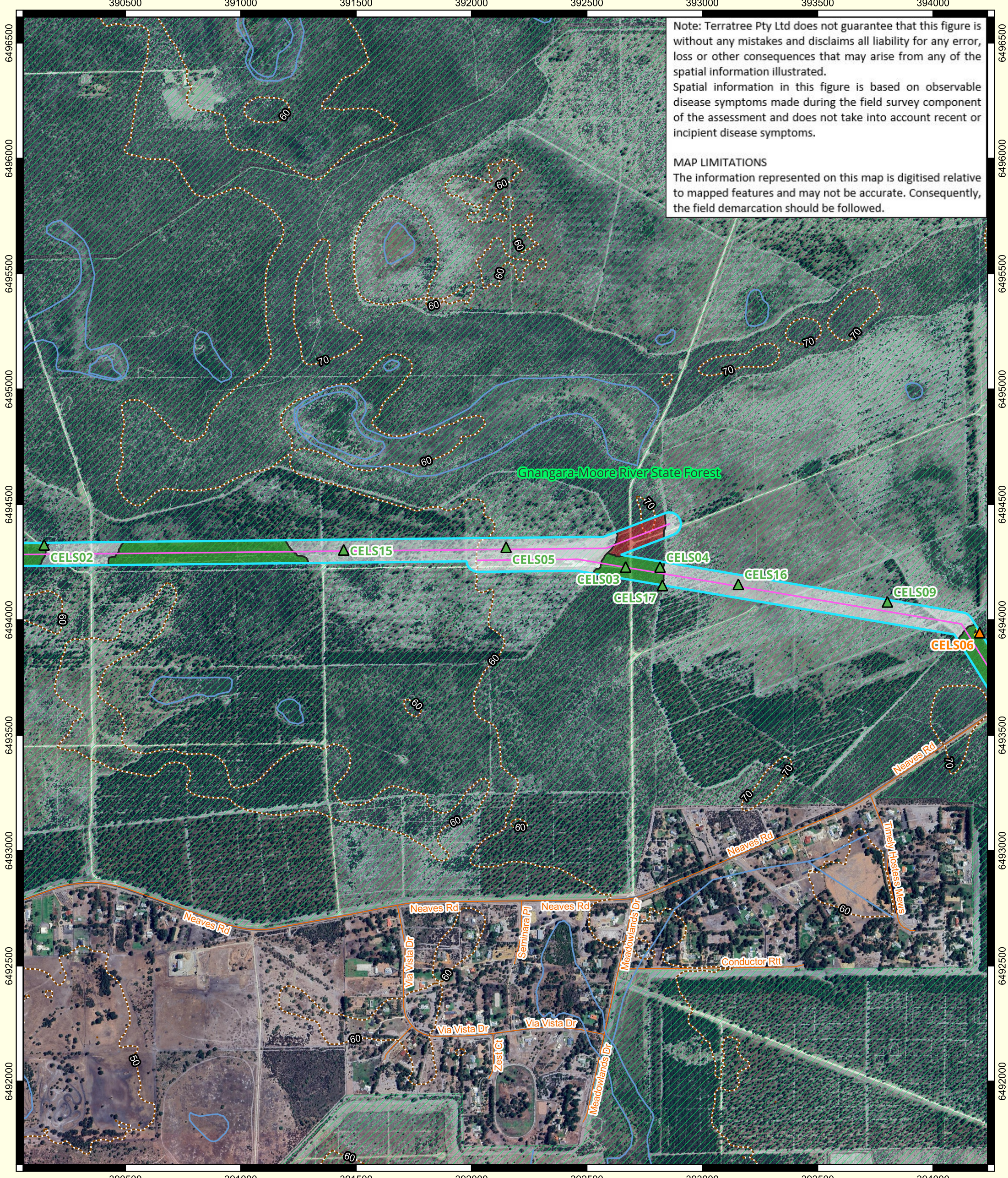
0 250 500 750 1,000 m

N

Datum: GDA 1994 Scale: 1:15,000 at
Projection: MGA Zone 50 A3

Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002
Expiry: 11/07/2026	Prepared: N.L	
Figure 5	Review: J.G	
	Revision:	

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Note: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any error, loss or other consequences that may arise from any of the spatial information illustrated.

Spatial information in this figure is based on observable disease symptoms made during the field survey component of the assessment and does not take into account recent or incipient disease symptoms.

MAP LIMITATIONS
 The information represented on this map is digitised relative to mapped features and may not be accurate. Consequently, the field demarcation should be followed.

Legend

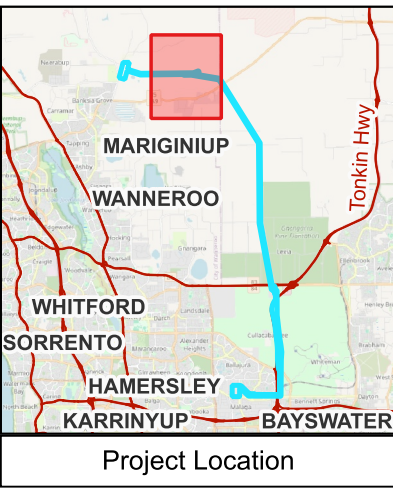
- Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area
- NT-NBT Centreline
- Gngangara-Moore River State Forest
- Watercourse Line
- Contour (10 m)
- Miscellaneous Road
- Local Road
- State Road

Sample Location and Result

- P. arenaria*
- Negative

Phytophthora Occurrence

- Infested
- Uninfested
- Excluded
- Not Demarcated



Phytophthora Occurrence Map
2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project

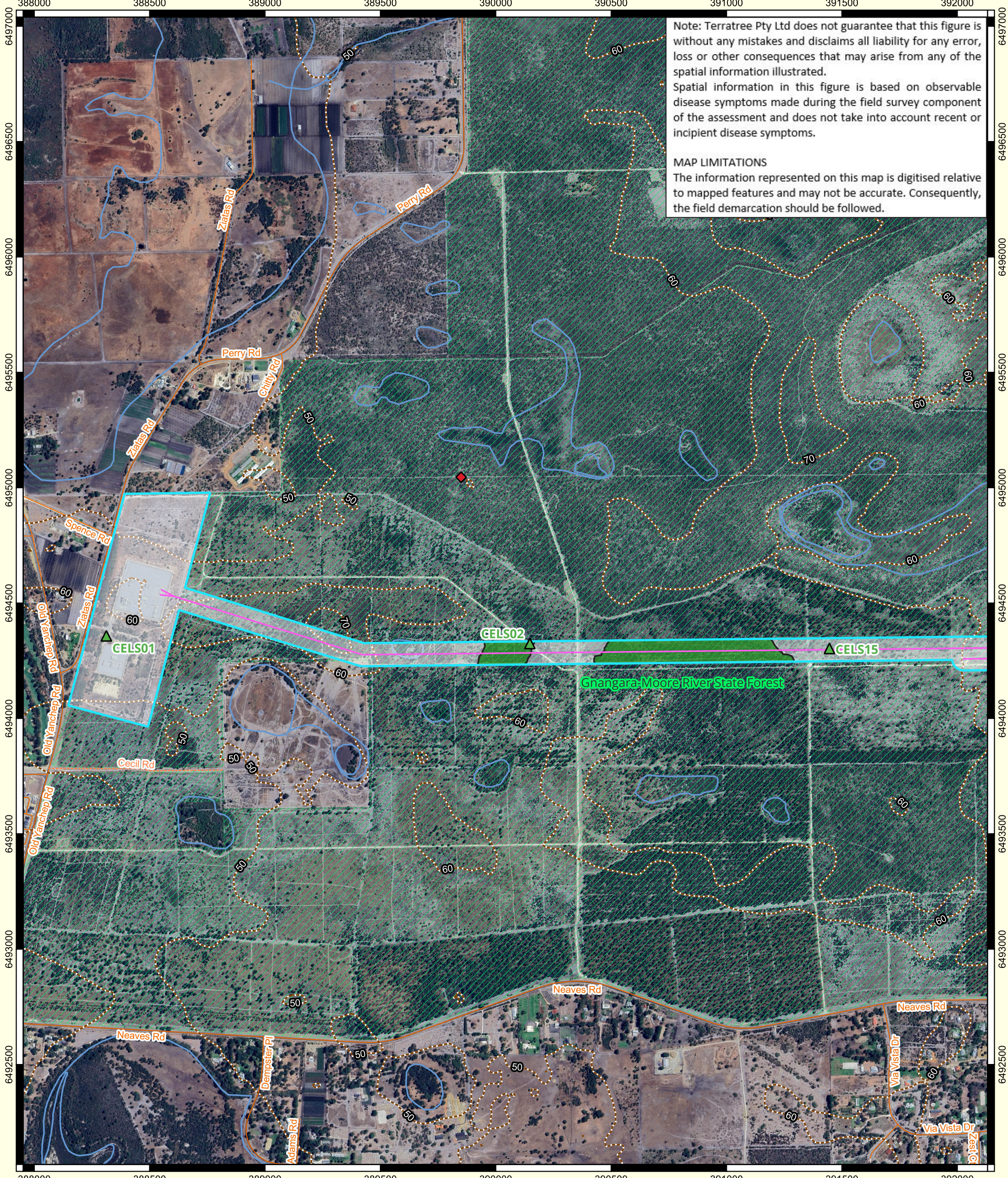
0 250 500 750 1,000 m

N

Datum: GDA 1994 Scale: 1:15,000 at
 Projection: MGA Zone 50 A3

Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002
Expiry: 11/07/2026	Prepared: N.L	
Figure 6	Review: J.G	
	Revision:	

Terratree



Note: Terratree Pty Ltd does not guarantee that this figure is without any mistakes and disclaims all liability for any error, loss or other consequences that may arise from any of the spatial information illustrated.

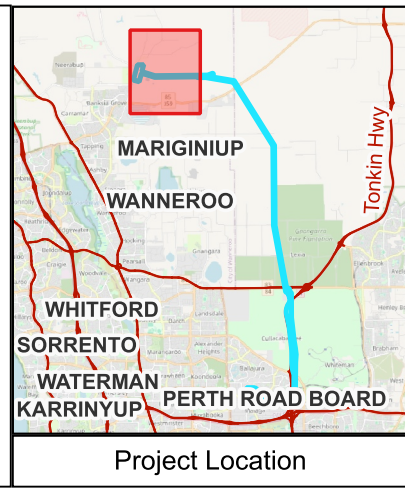
Spatial information in this figure is based on observable disease symptoms made during the field survey component of the assessment and does not take into account recent or incipient disease symptoms.

MAP LIMITATIONS
The information represented on this map is digitised relative to mapped features and may not be accurate. Consequently, the field demarcation should be followed.

- Legend**
- Northern Terminal (NT) to Neerabup Terminal (NBT) Assessment Area
 - NT-NBT Centreline
 - Watercourse Line
 - Gnangara-Moore River State Forest
 - Contour (10 m)
 - Miscellaneous Road
 - Local Road
 - State Road

- Sample Location and Result**
- ▲ Negative
 - ◆ *P. cinnamomi* (Historical)

- Phytophthora Occurrence**
- Uninfested
 - Excluded



Phytophthora Occurrence Map
2025 Comprehensive Linear Dieback Assessment - Clean Energy Link North Project

0 250 500 750 1,000 m

N

Datum: GDA 1994 Scale: 1:10,000 at
Projection: MGA Zone 50 A3

Date: 11/07/2025	Interpreter: J.G, N.L	Project #: T25002
Expiry: 11/07/2026	Prepared: N.L	
	Review: J.G	
	Revision:	

Figure 7

Terratree

Appendix

Appendix A: CPSM Laboratory Sample Result Sheet

Batch Details

Analysis Fee
Delivery date
Registered by Joe Grehan
Organisation Terratree Pty Ltd

Address :3/42 Victoria Street, Midland
Phone Number: 08 92501163/0400 003 688
Email Address: joeg@terratree.com.au

Sample Information						
Sample	Sample Label	Date Collected	Plant Species Sampled	Species of Interest	Sample Type	Species Isolated
1	CELS01	27/02/2025	<i>Banksia grandis</i>	Phytophthora species	Soil and root	Negative
2	CELS02	7/03/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
3	CELS03	7/03/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Negative
4	CELS04	7/03/2025	<i>Adenanthos cygnorum</i>	Phytophthora species	Soil and root	Negative

Plant Health Laboratories

Biological Science and Biotechnology
Contact: Diane White 0419943382
E-mail d.white@murdoch.edu.au
Web www.cpsm-phytophthora.org

5	CELS05	7/03/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
6	CELS06	12/03/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Phytophthora arenaria
7	CELS07	12/03/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Negative
8	CELS08	12/03/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Phytophthora arenaria
9	CELS09	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
10	CELS10	2/04/2025	<i>Xanthorrhoea preissii</i> <i>Banksia attenuata</i>	Phytophthora species	Soil and root	Negative
11	CELS11	2/04/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Negative
12	CELS12	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Phytophthora cinnamomi
13	CELS13	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative

14	CELS14	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
15	CELS15	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
16	CELS16	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
17	CELS17	2/04/2025	<i>Banksia menziesii</i>	Phytophthora species	Soil and root	Negative
18	CELS18	2/04/2025	<i>Banksia ilicifolia</i>	Phytophthora species	Soil and root	Negative
19	CELS19	2/04/2025	<i>Banksia attenuata</i>	Phytophthora species	Soil and root	Phytophthora cinnamomi
20	CELS20	2/04/2025	<i>Xanthorrhoea preissii</i>	Phytophthora species	Soil and root	Negative
21	CELS21	29/5/2025	<i>Banksia menziesii</i>	Phytophthora species	Soil and root	Phytophthora nicotianae