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Phytophthora Dieback Occurrence Survey

Turner Road, Sheoak Drive and Heritage Rail Trail reserves

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Phytophthora Dieback Occurrence Survey

Turner Road, Sheoak Drive and the Heritage Rail Trail Reserves

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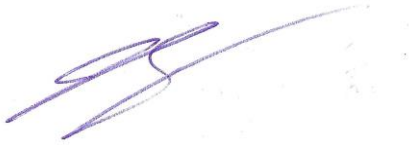

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EXECUTIVE SUMMARY

Since 2008, the Shire of Denmark have been undertaking Phytophthora Dieback assessments of Shire Reserves, with the aim of understanding the distribution of the introduced plant pathogen Phytophthora Dieback across the lands managed by the Shire. This report presents the results of three reserves assessed during the 2016/17 financial year. The project was supported by funding from the Western Australian Government's State NRM Program, supported by Royalties for Regions.

The project area for the 2017 Shire of Denmark Phytophthora Dieback surveys included Turner Road reserve, Sheoak Drive reserve, and the Denmark/Nornalup Heritage Rail Trail from Springdale Beach to Ocean Beach Road. Both Turner Road and Sheoak Drive reserves are large broad area reserves located beyond the extent of Denmark's residential area, while the Heritage Rail Trail is a narrow, linear area following an old rail alignment and experiences unrestricted high use.

In accordance with the agreed project scope of works, the field survey was undertaken using a methodology referred to as a broad scale survey. The broad scale survey method is defined in the Department of Parks and Wildlife (DPaW) guideline, Phytophthora Dieback Interpreters Manual for lands managed by the Department (2015) and provides planning level disease occurrence information.

Phytophthora Dieback is widespread across the Turner Road reserve, most likely due to the influence of long term gravel extraction activities. The extent of the infested category has been extended to the lower edges of the currently disturbed gravel pit areas on the basis of active disease expression that was identified on the edge of the central disturbance area. All vegetation downslope of active disease expression has also been classified as infested.

The Karri forest vegetation within the Turner Road Reserve has been classified as uninterpretable due to the lack of susceptible species within the vegetation. Due to the proximity to the recently disturbed gravel extraction sites which are upslope of some of the Karri vegetation type, these uninterpretable areas have been classified as unprotectable and it is considered likely that the disease is present in some of these areas but cannot be detected due to the vegetation type.

Phytophthora Dieback is widely distributed across Sheoak Reserve. There is fresh evidence of the disease on the edges of all trafficable boundary tracks and Phytophthora Dieback has spread along the entire length of the western boundary track, extending along the full length of the track north of the cadastral boundary. There is a very small area of uninfested vegetation located in the northern most area of the reserve. While the area of uninfested vegetation within the reserve is very small, it was determined during the survey that the uninfested category extends upslope beyond the cadastral boundary of the reserve and continues until the vegetation becomes uninterpretable Karri forest. It is likely that the full extent of the uninfested area is significant and would be considered to be protectable.

The entire surveyed alignment of the Denmark Nornalup Heritage Rail Trail was classified as uninterpretable due to the nearly complete absence of indicator species within the vegetation. However, due to the confirmed presence of the disease, achieved through the collection of two samples that returned positive results for the pathogen, all uninterpretable areas are also considered to be unprotectable. There is a high probability that the disease is present through at least some of the uninterpretable category.

A series of recommendations have been provided however the basis of Phytophthora management, specific to the three reserves discussed in this report, must be to mitigate risks of transporting the pathogen from these areas to other Shire reserves that may be currently uninfested and protectable from the disease.

1 INTRODUCTION

1.1 Background

Since 2008, the Shire of Denmark have been undertaking Phytophthora Dieback assessments of Shire Reserves, with the aim of understanding the distribution of the introduced plant pathogen Phytophthora Dieback across the lands managed by the Shire. This report presents the results of three reserves assessed during the 2016/17 financial year. The project was supported by funding from the Western Australian Government's State NRM Program, supported by Royalties for Regions.

Phytophthora Dieback is an introduced soil borne plant pathogen that affects up to 50% of native plant species within Western Australia. Most commonly the disease is caused by the species *Phytophthora cinnamomi,* however, other species such as *P. multivora* can also have significant impact under specific environmental conditions. Phytophthora Dieback is commonly introduced to an area through infested soils carried as basic raw materials or as soil on vehicles, plant and machinery. In favourable conditions the pathogen can result in the collapse of entire vegetation communities. Once introduced to an area, Phytophthora Dieback will spread through further human vectoring and also via water movement and root to root contact, resulting in extensive infestations which may cause significant impact to native vegetation communities. There is currently no practical method of eradication of the pathogen.

1.2 Objectives

The objectives of the 2017 assessment were to survey the Turner Road reserve (R13255), Sheoak Drive reserve (R29561), and the Denmark-Nornalup Heritage Rail Trail from Springdale Beach to Ocean Beach Road (Heritage Rail Trail) (Reserves 30277,41815 and 42507) for the presence of Phytophthora Dieback to:

- Validate the existing disease distribution information through a soil and tissue sampling program.
- Identify and map the extent of disease occurrence using a broad scale survey methodology.
- Review existing hygiene management within the reserves and provide recommendations to update the current hygiene management procedures.

1.3 Scope of Works

In order to achieve the objectives defined above, the following scope of works was undertaken:

- A detailed desktop assessment of the three reserves involving an analysis of known infestations, topography, geology, land use and access.
- Completion of a field based, broad scale disease occurrence survey across the reserves. The broad scale survey involved:
    - A linear survey of all internal tracks, walk trails and other potential vectoring infrastructure; and
    - Extrapolation of linear survey results to remaining areas to estimate the extent of uninfested areas.
- Mapping of disease fronts using a hand held GPS unit and demarcation of disease boundaries only where they intersected surveyed roads, tracks, access points and other site specific management areas.
- A soil and tissue sampling program to verify field interpretation decisions.

- Application of protectable area criteria to the surveyed areas to identify areas that are considered protectable from future infestation by *Phytophthora* species; and
- Development of this report detailing project methodology, results and providing recommendations for hygienic management.

1.4 Site Characteristics

The project area for the 2017 Shire of Denmark Phytophthora Dieback surveys included Turner Road reserve, Sheoak Drive reserve, and the Denmark/Nornalup Heritage Rail Trail from Springdale Beach to Ocean Beach Road. All reserves are managed by the Shire of Denmark and are shown on Figure 1.

Both Turner Road and Sheoak Drive reserves are large broad area reserves located beyond the extent of Denmark's residential area, while the Heritage Rail Trail is a narrow, linear area following an old rail alignment and experiences unrestricted high use.

1.4.1 Climate

The nearest Bureau of Meteorology (BoM) recording station is listed as Denmark, Western Australia. Data from this station shows an average annual rainfall of 1093.6mm with the wettest month being July (170.9mm) and February is recorded as the driest month (26.8mm). The online temperature data for this site was particularly limited, however, it did indicate that January was the warmest month and May was the coldest.

As *Phytophthora* distribution is closely aligned with climatic conditions these are important statistics. *Phytophthora* requires warm moist conditions and is limited to areas where average annual rainfall exceeds 400mm. From the available BoM data it can be seen that the project area falls within the accepted rainfall zone for *Phytophthora* occurrence.

2 METHOD

In accordance with the agreed project scope of works, the field survey was undertaken using a methodology referred to as a broad scale survey. The broad scale survey method is defined in the Department of Parks and Wildlife (DPaW) guideline, *Phytophthora Dieback Interpreters Manual for lands managed by the Department* (2015). A summary of key survey activities is provided below.

2.1 Desktop Interpretation

The survey areas were subject to an initial desktop assessment involving a review of the Vegetation Health Service (VHS) *Phytophthora* sample database and examination of available aerial imagery to assess:

- the known occurrence of Phytophthora Dieback on or near the subject areas;
- the occurrence of site specific vectors including but not limited to roads, creek lines, gravel pits and other potentially threatening features; and
- evidence of existing disease signatures such as areas of obvious vegetation decline.

2.2 Field Survey

The broad scale survey was undertaken by a Department of Parks and Wildlife (Parks and Wildlife) registered disease interpreter and involved mapping of all disease boundaries and limited ground coverage of all potentially uninfested areas upslope of infestations to confirm the uninfested status. Uninfested areas were not surveyed by walking transect lines spaced at a maximum distance of 50m apart, as required for an operational scale survey.

Field data including disease presence and vegetation information was collected using a hand held GPS unit and converted to ArcGIS™ shapefiles. Collected field data included all sample locations, a point file of all identified individual plant deaths attributed to *Phytophthora* and track files of the area covered during survey.

The survey method provides planning scale disease occurrence information. Due to the limited ground coverage in uninfested areas there is a possibility of small upslope infestations being present that do not intersect the assessed disease vectors and were not detected during survey. For this reason an operational scale assessment will be required prior to the commencement of any on-ground soil disturbance works.

2.3 Sampling Program

Sampling for Phytophthora Dieback involves the collection of soil and tissue samples from fresh deaths of plants considered to be reliable indicator species of *Phytophthora* expression. Where suspicious deaths were identified, soil and root tissue material was collected into heavy duty plastic bags and forwarded to the VHS laboratory for analysis.

All sampling undertaken was performed in accordance with the methods described in the *Phytophthora Dieback Interpreters Manual for lands managed by the Department* (Parks and Wildlife, 2015).

3 ASSESSMENT CRITERIA

Parks and Wildlife (2015) guidelines identify six potential disease hygiene categories based on presence/absence of the disease, or the unknown disease status of an area. An area can have an unknown disease status if the vegetation at the site is not susceptible to the disease or it cannot be assessed because of disturbance, eg fire. As a result, even if the pathogen is present, there may be no interpretable signs.

Only areas with suitable remnant native vegetation can be assessed. Areas that have been cleared or significantly altered are excluded from survey. In some cases small excluded areas may be afforded a hygiene category if they are small enough to be influenced by adjacent surveyed vegetation or situated such that topographical influences can be used to determine disease presence or absence.

The six possible disease categories are listed and described below:

1. **Infested –** Areas a registered interpreter determines to have plant disease symptoms consistent with the presence of *Phytophthora cinnamomi*.
2. **Uninfested –** Areas determined by a registered interpreter to be free of plant disease symptoms that indicate the presence of *P. cinnamomi*.
3. **Uninterpretable –** Natural, undisturbed areas where susceptible plants are absent, or are too few to make a determination of the presence or absence of *P. cinnamomi*.
4. **Temporarily uninterpretable –** Areas where disease presence or absence cannot be determined due to a level and type of site disturbance that will recover within the short to medium term, eg fire, rehabilitation.
5. **Not yet resolved –** *Phytophthora* occurrence diagnosis cannot be made because of inconsistent or incomplete evidence (including sample results). The category is only to be used in low interpretability zones (400mm to 600mm rainfall range).
6. **Disease risk roads (DRR) –** Interpreters will use the DRR category to show the disease status is unknown because of suspected or apparent recent use under unknown hygiene conditions.

Following the determination of disease categories, protectable areas are identified to determine areas that are likely to remain free from the disease with the application of appropriate disease hygiene as required.

Protectable areas are defined in the *Phytophthora Dieback Interpreters Manual for lands managed by the Department* (2015) as areas that:

- Have greater than 600mm of annual rainfall or are water gaining sites in the 400mm -600mm rainfall zone;
- Are determined to be free from *Phytophthora cinnamomi* by a DPaW registered disease interpreter;
- Are positioned in the landscape and are of sufficient size that they will not be engulfed by *Phytophthora* via autonomous spread. Such an area is defined as being greater than 4ha with a minimum axis of 100m, and not down slope of an infested area;
- Have controllable human vectors; and
- Include high conservation and/or socio economic values.

4 RESULTS AND DISCUSSION

The disease occurrence and location of protectable vegetation across the surveyed areas is shown in Figures 2 - 4. Appendix A presents the VHS laboratory certificates for all samples collected during the survey. A single desktop assessment was conducted for all reserves and is discussed below, while the detailed results from the survey of each reserve are discussed independently following.

4.1 Desktop assessment

4.1.1 Previous interpretation data

In 2008, Green Skills was commissioned by South Coast Natural Resource Management to conduct an assessment of the presence of the pathogen Phytophthora Dieback within ten peri-urban reserves in the Shire of Denmark. Assessments were designed to identify healthy and infested reserves and to prioritise reserves for hygienic management.

The resulting report, *A Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark* (Green Skills, 2008), incorporates basic Phytophthora Dieback information, the results of on-ground surveys and disease management recommendations. These serve as a generic disease management plan with specific priority outcomes relating to Mount Hallowell (R46618), Peace Street Reserve (R46688), a portion of the Denmark-Nornalup Heritage Rail Trail, a portion of the Rudyard Place road reserve and Redgum Lane Reserve (R41224) compiled in later studies in 2014 and 2016. The Turner Road, Sheoak Drive and Heritage Rail Trail reserves are listed in the 2008 report but were only subject to a preliminary assessment and no disease occurrence information is included.

4.1.2 VHS positive sample database

A review of the VHS positive sample database from 2015 indicates that there are no historic positive sample recoveries from within the project area. There is, however, a single positive historic sample point approximately 1.5km to the east of the surveyed section of the Heritage Rail Trail, collected in 1994.

4.2 Broad Scale Assessments

4.2.1 Turner Road Reserve

Turner Road Reserve is approximately 42 ha in size and located approximately 5km to the north east of the Denmark CBD on the corner of Turner and Glenrowan Roads. All adjoining lands are privately owned and predominantly cleared, however, small pockets of adjoining remnant vegetation do exist.

Access to the reserve is either via a locked gate off Turner Road, the Rural Fire Brigade (RFB) access driveway off Turner Road or the southern boundary fire break track. All access from Glenrowan Rd has been closed. The gated access from Turner Road leads to a central internal track that traverses the reserve from east to west terminating approximately 200m east of the western boundary.

The reserve is positioned on the northern flanks of a locally significant elevation, with the highest point being along the southern boundary fire break. The reserve appears to have been used extensively for the extraction of gravels with observable disturbances across nearly the entire reserve. There are currently three obvious major disturbance areas, all located along the southern boundary.

4.2.1.1 Vegetation

The vegetation across the Turner road consists of a mixed closed forest of Karri, Jarrah and Marri with Karri dominant on the upper slopes and creek lines, while the Jarrah and Marri species become dominant across the mid-slopes. On the upper slopes the vegetation is largely uninterpretable due to an understorey dominated by *Bossiaea linophylla*, *Hakea* and *Taxandria* species. Further down slope the

understorey opens up but is still dominated by *B. linophylla,* however, some indicator species become common. Indicator species used for disease interpretation across the reserve included:

- *Banksia grandis;*
- *Leucopogon verticillatus;*
- *Patersonia umbrosa;*
- *Xanthorrhoea gracilis;* and
- *X. platyphylla*

4.2.1.2 Disease Expression

Very limited active disease expression was identified across the vegetation and was limited to fresh deaths of *P. umbrosa* and occasional *Xanthorrhoea spp*. The vegetation associated with the lower slopes in particular showed very limited evidence of disease presence, however, as described above those areas were associated with Karri forest occurring on the more fertile soils where disease impact is often limited.

The most obvious disease expression was identified on the mid to upper slopes where the Jarrah dominated forest occurred on lateritic gravel soils. In these areas there were large areas of high impact infestation with expression through historic deaths of the overstorey and a general absence of indicator species within the understorey. The highly susceptible species *Banksia grandis* was completely absent in these areas. The disease expression in these areas is consistent with expression of disease that has been present in the landscape for an extended period of time.

4.2.1.3 Disease Occurrence

The disease occurrence and associated disease hygiene categories are shown on Figure 2 and have also been provided in associated spatial files. In summary, the disease is widespread across the reserve, most likely due to the influence of long term gravel extraction activities. The extent of the infested category has been extended to the lower edges of the currently disturbed gravel pit areas on the basis of active disease expression that was identified on the edge of the central disturbance area. All vegetation downslope of active disease expression has also been classified as infested.

The Karri forest vegetation situated on the upper slopes has been classified as uninterpretable due to the lack of susceptible species within the vegetation. Due to the proximity to the recently disturbed gravel extraction sites which are upslope of some of the Karri vegetation type, these uninterpretable areas have been classified as unprotectable and it is considered likely that the disease is present in some of these areas but cannot be detected due to the vegetation type.

4.2.1.4 Soil and tissue sample program

The results of the soil and tissue sampling program from Turner Road Reserve are shown on Figure 3 and the VHS sample analysis report is presented in Appendix A. There were two samples collected from Turner Road Reserve and both returned positive results for *Phytophthora cinnamomi.* These results confirm that the identified disease expression and extent as shown on Figure 2 can be attributed to impact from *P. cinnamomi*.

4.2.2 Sheoak Drive Reserve

Sheoak Drive Reserve is approximately 12 ha in size and located approximately 5km to the north east of the Denmark CBD, on the eastern side of the Denmark River. It is adjoined by private property on all sides except the north where it is adjoined by Crown Land (R29560). With the exception of private property to the east, all adjoining lands are vegetated with remnant native vegetation. The reserve appears to have been recently burnt, however, the Shire of Denmark records show the reserve was burnt approximately 5 years prior to the current survey.

There are established fire breaks along all boundaries except the northern boundary which is formed by a cadastral line that does not appear to represent any physical feature in the field. There is, however, an

established firebreak approximately 450m to the north. Access to the reserve is via a small entrance gate located off Sheoak Drive in the south eastern corner of the reserve which is otherwise fenced on all sides except the northern boundary. There are no internal tracks.

The reserve is positioned on the southern flanks of a locally significant elevation and there is a small creek that flows across the south east corner and another minor rise, with a north westerly aspect, on the southern side of the minor creek.

4.2.2.1 Vegetation

The local vegetation transitions from a closed *Eucalyptus diversicolor* (Karri) forest situated on the upper slopes and largely outside of the cadastral boundary of the reserve, to a mixed forest of Karri and *Allocasuarina fraseriana* (Sheoak) on the mid slopes then into a forest of *E. marginata* (Jarrah) and *Corymbia calophylla* (Marri) on the lower slopes and creek line. The understorey is largely dominated by *Acacia pentadenia,* however, multiple disease indicator species are present and include:

- *Banksia grandis;*
- *Leucopogon capitellatus;*
- *L. verticillatus;*
- *Patersonia umbrosa;*
- *Persoonia longifolia;*
- *Podocarpus drouynianus;*
- *Xanthorrhoea gracilis;* and
- *X. preissii.*

4.2.2.2 Disease Expression

Active fresh disease expression was limited through the majority of the reserve however, extensive historic evidence was apparent. This included areas of high disease impact along the western boundary, with deaths of overstorey Jarrah trees supported by occasional fresh deaths of indicator species along the western boundary track.

Small pockets of fresh disease activity impacting *P. drouynianus* and *X. preissii* were apparent in vegetation fringing the creek line and these were used to identify the upslope extent of the disease away from boundary tracks. There were also pockets of active disease activity impacting *P. umbrosa* and *X. gracilis* in vegetation on the small rise south of the minor creek.

The vegetation along the western and southern edges of the reserve appeared to be more recently impacted by fire than the remainder of the reserve. In these areas there was very vibrant re-growth which can often limit the impact of the disease, however, there were some scattered roadside deaths in these areas.

4.2.2.3 Disease Occurrence

As shown in Figure 3, Phytophthora Dieback is widely distributed across Sheoak Reserve. There is fresh evidence of the disease on the edges of all trafficable boundary tracks and Phytophthora Dieback has spread along the entire length of the western boundary track, extending along the full length of the track north of the cadastral boundary. There is a very small area of uninfested vegetation located in the northern most area of the reserve. While the area of uninfested vegetation within the reserve is very small, it was determined during the survey that the uninfested category extends upslope beyond the cadastral boundary of the reserve and continues until the vegetation becomes uninterpretable Karri forest. It is likely that the full extent of the uninfested area is significant and would be considered to be protectable.

4.2.2.4 Soil and Tissue Sampling Program

The results of the soil and tissue sampling program from Sheoak Drive Reserve are shown on Figure 3 and the VHS sample analysis report is presented in Appendix A. There were two samples collected from Sheoak Drive Reserve and one returned a positive result for *Phytophthora cinnamomi.* The positive

result was collected from a *X. gracilis* located on the mid to upper slope of the small rise in the south east corner of the reserve. This result confirms that presence of the disease in this area and supports the classification of the area as infested.

The negative result was collected from a fresh *B. grandis* death located to the north of the reserve's cadastral boundary but in a position that was considered influential to the majority of vegetation within the reserve. The death was consistent with multiple scattered *B. grandis* deaths observed within the higher areas of the reserve which were not believed to be associated with impact caused by Phytophthora Dieback.

4.2.3 Denmark-Nornalup Heritage Rail Trail

The surveyed section of the Denmark-Nornalup Heritage Rail Trail extends from Springdale Beach to Ocean Beach Road and follows an historic rail formation through low lying wetland areas. It is approximately 4km in length. At the very eastern end the trail alignment is adjoined by native remnant vegetation in excellent condition, extending to the eastern bank of the Denmark River. From the river's western bank the alignment is adjoined by private property for a distance of approximately 800m and there is extensive evidence of disturbance and impact by exotic weed species. To the west of the private property the trail alignment adjoins remnant native vegetation communities within the Water Corporation Reserve.

The trail is used extensively for recreational activities including walking and cycling. It also appears to be a cycle access way for cyclists accessing town from outer lying residential areas.

4.2.3.1 Vegetation

The vegetation along the surveyed portion of the Heritage Rail Trail alignment can be described as predominantly very open woodland of *Melaleuca preissiana* and *Callistachys lanceolata* over dense wetland vegetation dominated by *Taxandria* and *Melaleuca* species. Immediately west of the Denmark River is a small patch of Karri forest with an altered understorey that has been impacted by several weed species. Susceptible species within the vegetation that occurs along the alignment were limited to:

- *Adenanthos obovatus*
- *Leucopogon obovatus*; and
- *Xanthorrhoea platyphylla*.

4.2.3.2 Disease Expression

Due to the lack of indicator species within the vegetation, disease expression was extremely limited. Occasional scattered deaths of *Xanthorrhoea* were noted but due to the time since death and a lack of supporting evidence it was not possible to confidently attribute the death to Phytophthora Dieback. A single location with two fresh *Xanthorrhoea* deaths supported by some long dead *Xanthorrhoea* stumps was identified to the west of the Denmark River.

4.2.3.3 Disease Occurrence and Hygiene categories

With the exception of the two positive sample sites (discussed below) the entire alignment has been classified as uninterpretable. This category has been applied due to the nearly complete absence of indicator species within the vegetation. However, due to the confirmed presence of the disease and the low lying nature of the entire alignment, all uninterpretable areas are also considered to be unprotectable. There is a high probability that the disease is present through at least some of the uninterpretable category.

4.2.3.4 Sample Program

The results of the soil and tissue sampling program from the Heritage Rail Trail survey area are shown on Figure 4 and the VHS sample analysis report is presented in Appendix A. There were two samples

collected from along the alignment and both returned positive results for *Phytophthora cinnamomi.* These results confirm the presence of *P. cinnamomi* along the Heritage Rail Trail alignment.

5 RECOMMENDATIONS

A series of management recommendations for application across all Shire of Denmark Reserves are presented in the 2008 Green Skills document *A Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark.* Specific recommendations for each reserve are presented in Section 7 of the Green Skills document and generic hygiene recommendations for application across the Shire are presented in tabular format in Section 8. A summary of the key recommendations to be applied across all Shire of Denmark reserves is provided in the Executive Summary of the Green Skills report and presented below.

1. *All works within and around priority reserves to strictly adhere to **Town Planning Scheme Policy No. 1 for Dieback Disease Management** (Shire of Denmark, 1997) hygiene controls including but not limited to:*
    - *No soil movement or extraction within priority reserves*
    - *No operations (firebreaks, earthworks, fencing etc) within or around the vicinity of the Phytophthora Dieback free protection areas unless extremely dry soil conditions*
    - *No unauthorized vehicular access to priority reserves (closure of vehicular access where applicable)*
2. *Installation of Project Dieback signage at Phytophthora Dieback free protection areas and at Phytophthora Dieback infested areas*
3. *Installation of Project Dieback signage at entry to priority reserves to inform users of how to reduce risk of Phytophthora Dieback spread*
4. *Treatment of disease frontlines to stabilize disease movement (once points 1 – 3 have been implemented)*
5. *Develop annual monitoring and treatment program in Phytophthora Dieback free protection areas*
6. *Host Phytophthora Dieback awareness forum (compulsory attendance by Shire works staff and open invitation to community members)*
7. *Assess and develop Phytophthora Dieback management recommendations for remaining Shire of Denmark reserves which were not assessed within this study (Green Skills, 2008)*

Great Southern Bio Logic has reviewed the Green Skills recommendations and believes that if applied, the generic hygiene recommendations are suitable for effective mitigation of the risk of further non-autonomous vectoring of the disease. It is however noted, that Green Skills recommendations 4 and 5 are associated with treatment and monitoring programs, designed to protect uninfested areas from all mechanisms of disease movement. Due to the extensive nature of disease occurrence through the three reserves detailed in this report, it is considered that phosphite treatments are not appropriate.

It is further noted that the Green Skills report was produced 7-8 years ago. Since that time knowledge regarding *Phytophthora* Dieback management has improved and its specific applicability to Denmark reserves may have altered. Consideration should be given to undertaking a full review of the document for all reserves. Great Southern Bio Logic is aware that the current standards for operational hygiene management as defined in *Phytophthora cinnamomi and disease caused by it, Volume 1, management guidelines* (CALM, 2003) is scheduled for review. It is therefore recommended that the 2008 *Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark* and the *Town Planning Scheme Policy No. 1 for Dieback Disease Management,* be reviewed following the issue of the amended management guidelines.

The following recommendations are provided by Great Southern Bio Logic for implementation within the Turner Road, Sheoak Drive and Denmark Nornalup Heritage Rail Trail reserves specifically. It is intended that these recommendations will replace any previous disease management recommendations for these reserves.

1. Operational Hygiene
    a. All vehicles, machinery, equipment and footwear are to be effectively cleaned down (See Section 5.1) upon completion of works and before re-locating to other Shire Reserves or areas with uninfested vegetation or unknown disease status. Effective cleandown should be performed on the reserve perimeter, preferably on sealed ground that drains into infested areas of the reserves.
    b. Any gravels or other basic raw materials excavated from the Turner Road reserve or other reserves must be considered to be infested. Such materials must not be used in areas that have been assessed to be protectable from Phytophthora Dieback.
    c. All earthworks, road verge works and street sweeping conducted in any residential area adjoining the reserves is to be undertaken in accordance with *Town Planning Scheme Policy 1* hygiene guidelines. These areas are also considered likely to be infested through the mechanisms of autonomous spread; therefore the movement of soil and vegetable matter from these areas presents a potential risk of disease vectoring. Private residents and contractors undertaking works should also be urged to comply with this standard.
2. Project Dieback Signage
    a. No existing dieback demarcation signage was within the reserves. Due to access restrictions, it is considered that signage within the Turner Rad reserve is not warranted however the Shire should consider signage within the Sheoak Drive reserve and along the Heritage Rail Trail to highlight the presence of the disease.
    b. General disease information signage should be considered at reserve entry points in residential areas. Signage should highlight the issues associated with *Phytophthora* and the management actions required to minimise the spread. Signage may assist with communication of these messages but should not be relied on as a stand-alone communication strategy.
3. *Community Awareness and Education*
    a. The current distribution of Phytophthora is likely to impact the adjoining residential and commercial developments of all reserves. Movement of infested soil from these areas poses a significant threat of disease vectoring to other areas within the Shire of Denmark. Consistent with the solutions to address the threat identified in *A Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark, Section 8, Limited Education and Awareness in the Community* (Green Skills, 2008), a public communication strategy is recommended for the immediate local communities.
4. *Re-Survey*
    a. Due to the movement of disease boundaries through autonomous spread and human vectoring, operational disease hygiene information is not to be used for operational purposes after 12 months from the date of interpretation. In accordance with DPaW guidelines (2015), operational disease boundaries must be re-checked every 12 months and a full re-interpretation must be undertaken after three years of the original survey. Re-survey will only be required across the Sheoak Drive reserve, associated with soil movement activities that require internal access to the reserve.

5.1 Effective Clean Down Standards

The management solutions identified in Section 8 of *A Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark* also identify requirements for the clean down of vehicles when entering and exiting infested and uninfested sites. It is further recommended that

requirements for cleandown be expanded to include all vehicles, machinery, equipment and footwear. Table 1 below has been provided as a guide for the requirement for cleandown when crossing disease hygiene category boundaries.

Table 1: Requirement to undertake effective cleandown when crossing disease category boundaries

Exiting Category	Entering Category	Cleandown Required
Uninfested	Infested	No
	Uninterpretable	No
	Excluded	No
Infested	Uninfested	Yes
	Uninterpretable	Yes
	Excluded	No
Uninterpretable	Uninfested	Yes
	Infested	No
	Excluded	No
Excluded	Uninfested	Yes
	Infested	No
	Uninterpretable	Yes

Effective clean down involves the removal of all soil and plant material from machinery, vehicles, equipment, tools and footwear so it cannot be transported. Attention needs to be given to removing soil and plant material from under vehicles and machinery, especially from running boards, belly plates, spare tyres and wheels.

If operations are conducted in dry soil conditions the requirements for clean down are reduced as the soil material does not readily adhere, and clean down can be performed using a stiff brush or compressed air.

Drainage from clean down areas needs to be controlled so that effluent from clean down operations does not drain into uninfested or uninterpretable areas.

Hand held equipment, tools and footwear can be sterilised using methylated spirits. Place methylated spirits into a suitably labelled spray bottle, spray to cover all surfaces and allow a few minutes to soak in. Other equipment can be sterilised by soaking in a disinfectant such as bleach (active ingredient sodium hypochlorite). Dilute the bleach (1 part bleach to 10 parts water), soak tools for a few minutes then rinse, following the manufacturer's safety instructions.

Water can be sterilised by adding 6ml of sodium hypochlorite (bleach or pool chlorine) to every 10L of water. Safety instruction should be followed.

5.2 Dry Soil Conditions

Dry soil conditions are when soil moisture content of open ground or on unsealed roads is not high enough to allow soil material to adhere to vehicles, machinery, equipment and footwear. The level of soil moisture required for soils to be classified as dry soil varies between soil types, however, a general rule commonly applied is that greater than 5mm of rainfall over a 24 hour period will result in moist soil conditions.

6 REFERENCES

Bureau of Meteorology (BoM) (2015): http://www.bom.gov.au/climate/data/

Department of Parks and Wildlife (Parks and Wildlife) (2015), *Phytophthora Dieback Interpreters Manual for lands managed by the department*, Perth

Department of Environment and Conservation (CALM) (2003): *Phytophthora cinnamomi and disease caused by it, Volume 1, management guidelines,* **Department of Conservation and Land Management, Perth**

Green Skills (2008): *A Study into the Risk of Phytophthora Dieback in Ten Peri-Urban Reserves within the Shire of Denmark,* Unpublished report

7 LIMITATIONS

This report was prepared for the Shire of Denmark, solely for the purposes set out in the scope of works and it is not intended that any other person use or rely on the contents of this report.

Whilst the information contained in the Report is accurate to the best of our knowledge and belief, Great Southern Bio Logic and its agents cannot guarantee the completeness or accuracy of any of the descriptions or conclusions based on the information supplied to it or obtained during the site investigations, site surveys, visits and interviews. Furthermore, field and / or regulatory conditions are subject to change over time, and this should be considered if this report is to be used after any significant time period after its issue.

Great Southern Bio Logic and its agents have exercised reasonable care, skill and diligence in the conduct of project activities and preparation of this report. However, except for any non-excludable statutory provision, Great Southern Bio Logic and its agents provided no warranty in relation to its services or the report, and is not liable for any loss, damage, injury or death suffered by any party (whether caused by negligence or otherwise) arising from or relating to the services or the use or otherwise of this Report.

This report must be read, copied, distributed and referred in its entirety.

Figures

Phytophthora Dieback Occurrence Survey-*Turner Road, Sheoak Drive and the Heritage Rail Trail Reserves*

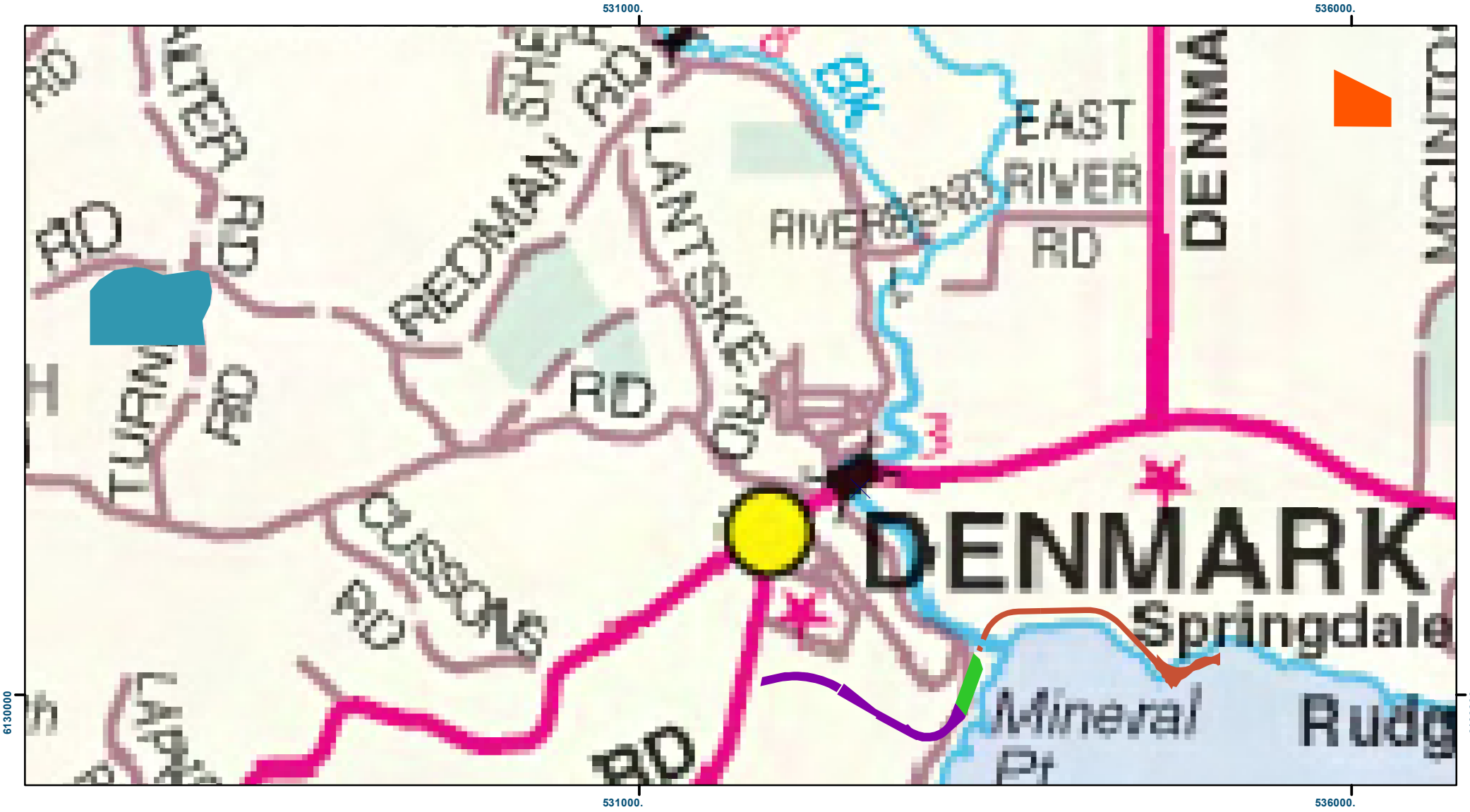

Figure 1: Regional Location and Project Areas

GREAT SOUTHERN BIO LOGIC

Ref: GSBL255
Date: 28-Apr-17

Broadscale survey of Phytophthora Dieback occurrence and Reserve Hygiene Management Plan for Turner and Sheoak Reserves and a portion of of the Denmark-Nornalup Heritage Rail Trail prepared for Shire of Denmak, May 2017

LEGEND

- Turner Reserve 13255
- Sheoak Reserve 29561
- Denmark-Nornalup Rail Trail Reserve 30277
- Denmark-Nornalup Rail Trail Reserve 41815
- Denmark-Nornalup Rail Trail Reserve 42507

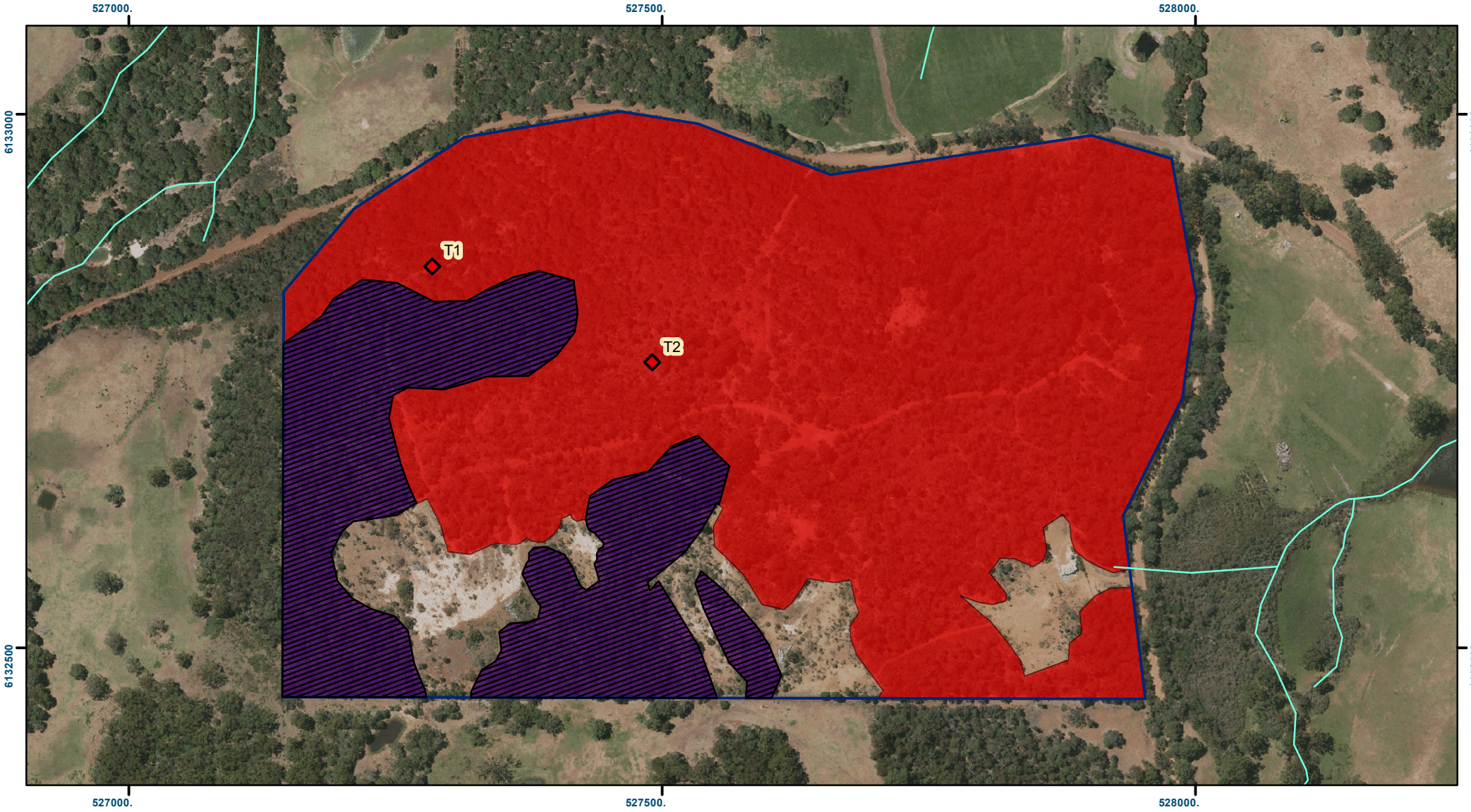

Figure 2: Turner Reserve 13255 Phytophthora Dieback occurrence with sample locations and unprotectable areas

GREAT SOUTHERN BIO LOGIC

Ref: GSBL255
Date: 21-Jun-17

Broadscale survey of Phytophthora Dieback occurrence and Reserve Hygiene Management Plan for Turner and Sheoak Reserves and a portion of of the Denmark-Nornalup Heritage Rail Trail prepared for Shire of Denmak, May 2017

N

0 50 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

1:5,000

LEGEND

STATUS
- Infested
- Uninfested
- Uninterpretable
- Excluded
- Unprotectable

RESULT
- Phytophthora cinnamomi
- Negative
- Historic VHS Pc 2015
- Hydrography
- Reserve project area

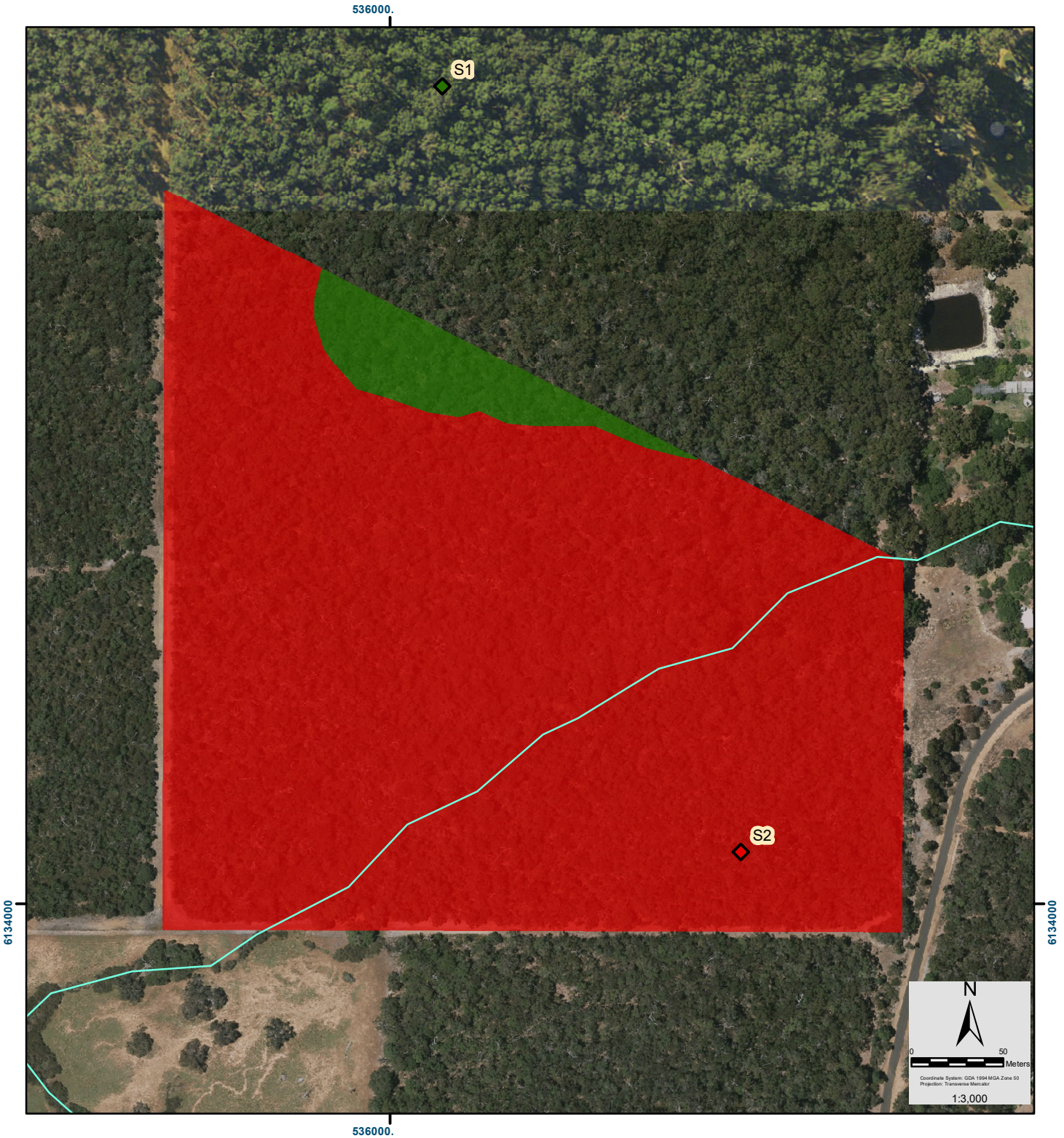

Figure 3: Sheoak Reserve 29561 Phytophthora Dieback occurrence with sample locations and unprotectable areas

GREAT SOUTHERN BIO LOGIC

Ref: GSBL255
Date: 31-May-17
Image: Landgate SLIP

Broadscale survey of Phytophthora Dieback occurrence and Reserve Hygiene Management Plan for Turner and Sheoak Reserves and a portion of of the Denmark-Nornalup Heritage Rail Trail prepared for Shire of Denmak, May 2017

LEGEND

STATUS
- Infested
- Uninfested
- Uninterpretable
- Excluded
- Unprotectable

RESULT
- Phytophthora cinnamomi
- Negative
- Historic VHS Pc 2015
- Hydrography

Figure 4: Phytophthora Dieback occurrence with sample locations and unprotectable areas across a portion of the Denmark-Nornalup Heritage Rail Trail

GREAT SOUTHERN BIO LOGIC

Ref: GSBL255
Date: 21-Jun-17

Broadscale survey of Phytophthora Dieback occurrence and Reserve Hygiene Management Plan for Turner and Sheoak Reserves and a portion of of the Denmark-Nornalup Heritage Rail Trail prepared for Shire of Denmak, May 2017

N

0 100 Meters

Coordinate System: GDA 1994 MGA Zone 50
Projection: Transverse Mercator

1:13,000

LEGEND

STATUS
- Infested
- Uninfested
- Uninterpretable
- Excluded
- Unprotectable

RESULT
- Phytophthora cinnamomi
- Negative
- Historic VHS Pc 2015
- Hydrography
- Reserve project area

Appendix A

VHS Sample Analysis Report

Department of Parks and Wildlife

Vegetation Health Service – Phytophthora sample information

FORM FEM046

CONTACT DETAILS of sender
Name Jeremy Spencer
Fax No._____ Phone No. 0400 113 093
DPW Office or Company Name GS Bio Logic

Job Type (Please indicate)
private

VHA use only
Date received 19.4.17
Date faxed 26.4.17

GDA(1) GDA 94

SEND TO: Vegetation Health Service, Ecosystem Health Branch – Dept. Parks & Wildlife, 17 Dick Perry Ave, KENSINGTON 6151
Phone: (08) 9334 0317
Fax: (08) 9334 0114

VHS Identification Number (VHS USE ONLY)	Sample Date	*Sample label (Give location, eg. Forest Block or Shire, etc. and sample number)*	Plant species sampled	Site Impact (2)	Zone 50 or 51	Map Reference (3)	Land Tenure (4)	RESULT s/s root (5)	RESULT bait (5)
VHS 36377	13-04-17	Turner Rd Reserve Sample 1	*X. preissii/P. umbrosa*	L	50	E 527284 N 6132857	R		CIN
VHS 36378	13-04-17	Turner Rd Reserve Sample 2	*X. gracillis*	H	50	E 527490 N 6132767	R		CIN

NOTES:
1. Please tick this box if your map references are supplied in the **GDA 94** standard. If not, please specify the datum used.
2. Site impact - Low, Moderate, or High (as in the Dieback Interpreter's Manual).
3. An MGA map reference with prefixes **must** be supplied for all samples.
4. Land tenure - State Forest (SF), National Park (NP), Reserve (R), Westrail (W), Private (P), Gravel Pit (GP), or other. (Other - describe in comments below).
5. Result codes used – CIN = *Phytophthora cinnamomi*, MUL = *P. multivora*, CRY = *P. cryptogea*, PI = *P. inundata*, ARE = *P. arenaria*, ELO = *P. elongata*, THE = *P. thermophila*, PM = *P. megasperma*, PN = *P. nicotianae*, CON = *P. constricta*, NEG = negative, SUB = subcultured for further tests

Please Note: a). NEG results cannot be used to represent a total absence of *Phytophthora* in the sampled area. b). Information from your samples will be incorporated into the VHS database and map products, which may be made available to the public and third parties to be used for research and other purposes.

COMMENTS:

Department of Parks and Wildlife

Vegetation Health Service – Phytophthora sample information

FORM FEM046

CONTACT DETAILS of sender
Name Jeremy Spencer
Fax No. _____ Phone No. 0400 113 093
DPW Office or Company Name GS Bio Logic

Job Type (Please indicate)
private

VHA use only
Date received 28.4.17
Date faxed 3.5.17
GDA(1) GDA 94 11.5.17

SEND TO: Vegetation Health Service, Ecosystem Health Branch – Dept. Parks & Wildlife, 17 Dick Perry Ave, KENSINGTON 6151
Phone: (08) 9334 0317
Fax: (08) 9334 0114

VHS Identification Number (VHS USE ONLY)	Sample Date	*Sample label (Give location, eg. Forest Block or Shire, etc. and sample number)*	Plant species sampled	Site Impact (2)	Zone 50 or 51	Map Reference (3)	Land Tenure (4)	RESULT s/s root (5)	RESULT bait (5)
VHS 36397	21-04-17	Sheoak Reserve Sample 1	*B. grandis*	M	50	E 536028 N 6134445	R		NEG
VHS 36398	21-04-17	Sheoak Reserve Sample 2	*X. gracilis*	M	50	E 536191 N 6134028	R		CIN

NOTES:
1. Please tick this box if your map references are supplied in the **GDA 94** standard. If not, please specify the datum used.
2. Site impact - Low, Moderate, or High (as in the Dieback Interpreter's Manual).
3. An MGA map reference with prefixes **must** be supplied for all samples.
4. Land tenure - State Forest (SF), National Park (NP), Reserve (R), Westrail (W), Private (P), Gravel Pit (GP), or other. (Other - describe in comments below).
5. Result codes used – CIN = *Phytophthora cinnamomi*, MUL = *P. multivora*, CRY = *P. cryptogea*, PI = *P. inundata*, ARE = *P. arenaria*, ELO = *P. elongata*, THE = *P. thermophila*, PM = *P. megasperma*, PN = *P. nicotianae*, CON = *P. constricta*, NEG = negative, SUB = subcultured for further tests

Please Note: a). NEG results cannot be used to represent a total absence of *Phytophthora* in the sampled area. b). Information from your samples will be incorporated into the VHS database and map products, which may be made available to the public and third parties to be used for research and other purposes.

COMMENTS:

Department of Parks and Wildlife

Vegetation Health Service – Phytophthora sample information

FORM FEM046

CONTACT DETAILS of sender
Name Jeremy Spencer
Fax No. _____ Phone No. 0400 113 093
DPW Office or Company Name GS Bio Logic

Job Type (Please indicate)
private

VHA use only
Date received 10.4.17
Date faxed 24.4.17

GDA(1) GDA 94

SEND TO: Vegetation Health Service, Ecosystem Health Branch – Dept. Parks & Wildlife, 17 Dick Perry Ave, KENSINGTON 6151
Phone: (08) 9334 0317
Fax: (08) 9334 0114

VHS Identification Number (VHS USE ONLY)	Sample Date	*Sample label (Give location, eg. Forest Block or Shire, etc. and sample number)*	Plant species sampled	Site Impact (2)	Zone 50 or 51	Map Reference (3)	Land Tenure (4)	RESULT s/s root (5)	RESULT bait (5)
VHS 36350	06-04-17	Denmark Nornalup Heritage Trail Sample 1	*X. preissii*	L	50	E 532641 N 6129896	R		CIN
VHS 36351	06-04-17	Denmark Nornalup Heritage Trail Sample 2	*X. preissii/A. obovatus*	L	50	E 533675 N 6130583	R		CIN

NOTES:
1. Please tick this box if your map references are supplied in the **GDA 94** standard. If not, please specify the datum used.
2. Site impact - Low, Moderate, or High (as in the Dieback Interpreter's Manual).
3. An MGA map reference with prefixes **must** be supplied for all samples.
4. Land tenure - State Forest (SF), National Park (NP), Reserve (R), Westrail (W), Private (P), Gravel Pit (GP), or other. (Other - describe in comments below).
5. Result codes used – CIN = *Phytophthora cinnamomi*, MUL = *P. multivora*, CRY = *P. cryptogea*, PI = *P. inundata*, ARE = *P. arenaria*, ELO = *P. elongata*, THE = *P. thermophila*, PM = *P. megasperma*, PN = *P. nicotianae*, CON = *P. constricta*, NEG = negative, SUB = subcultured for further tests

Please Note: a). NEG results cannot be used to represent a total absence of *Phytophthora* in the sampled area. b). Information from your samples will be incorporated into the VHS database and map products, which may be made available to the public and third parties to be used for research and other purposes.

COMMENTS: