

APPENDIX 7: PHYTOPHTHORA DIEBACK ASSESSMENT – KUNDIP – TERRATREE (2013)

Kundip Mining Centre and Proposed Kundip -Rav8 Haul Road

***Phytophthora* Dieback Assessment**

Prepared for Silverlake Resources

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Terratree Pty Ltd
ABN 48 159 6065 005
Unit 10, Level2
Fremantle Prison
Knutsford Street
Fremantle WA 6160
PO Box 1616
Fremantle
WA 6959
Telephone (08)335 4228
Mobile 0400 003 688
Email: joeg@terratree.com.au
www.terratree.com.au

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A handwritten signature in black ink that reads "Joe Grehan".

Author: Joseph Grehan
Principal Ecologist

1 Table of Contents

Executive Summary	5
1 Introduction.....	6
1.1 Background.....	6
1.1.1 Past Land Uses	7
1.1.2 Previous Studies	7
2 Regulatory context	8
3 Existing Environment.....	9
3.1 Regional Setting.....	9
3.2 Soils and Vegetation	9
3.3 Climate	10
4 Methods and Limitations.....	11
4.1 Methods.....	11
4.2 Sampling	11
4.3 Limitations.....	12
5 Results	14
6 Discussion.....	15
6.1 Kundip Mining Centre	15
6.2 Proposed Kundip to Rav 8 Haul Road	16
6.3 <i>Armillaria luteobubalina</i>	16
7 Conclusion and Recommendations.....	17
8 References.....	19
9 Glossary of Terms	20

List of Tables

Table 1 *Phytophthora cinnamomi* occurrence categories as defined by the DEC (2012, draft)

Table 2 Area of each disease occurrence category within the Kundip Mining Centre and the Proposed Kundip to Rav 8 haul road

Table 3 Sample results from the Kundip Mining Centre and proposed Kundip to Rav 8 haul road

List of Figures

Figure 1 Project Location

Figure 2 *Phytophthora* Dieback Occurrence – Kundip Mining Centre

Figure 3 *Phytophthora* Dieback Occurrence – Proposed Kundip to Rav 8 Haul Road

List of Plates

Plate 1 Uninterpretable vegetation

Plate 2 Interpretable Uninfested vegetation (Bl unit) with dominant disease indicator species *Banksia lemanniana*

Plate 3 Interpretable Uninfested vegetation (Bm unit) with dominant disease indicator species *Banksia media*

Plate 4 Sample site in Bl vegetation unit

Plate 5 Uninterpretable area on top of waste dump

Plate 6 Unmappable area (excluded) due to high degree of disturbance

Plate 7 High risk water –gaining site

Plate 8 High risk water –gaining site

Executive Summary

Silverlake Resources (Silverlake) engaged Terratree Pty Ltd (Terratree) to undertake a *Phytophthora* Dieback (Dieback) assessment of the Kundip Mining Centre and proposed Kundip to Rav 8 haul road (hereafter referred to as 'the project area'). The Dieback assessment was undertaken by Department of Environment and Conservation (DEC) accredited Dieback Interpreters Joseph Grehan and Ian Moore between November 13th-18th, 2012 in accordance with the survey methodology stipulated in '*Phytophthora cinnamomi* and the diseases caused by it - Volume 2: Interpreters Guidelines for Detection, Diagnosis and Mapping' (CALM 2001).

It is estimated that the Kundip Mining Centre project area is 627.6ha. Of this approximately 103.6ha (16.5%) is Uninfested, 393.1ha is Uninterpretable (62.6 %) and 130.1 ha is Unmappable (20.7%) (see Glossary of Terms). The proposed Kundip to Rav 8 haul road corridor that was assessed is 155.1 ha, of which 14.9ha (9.6%) is Uninfested, 82.6 ha (53.2%) is Uninterpretable and 57.6 ha (37.1%) is Unmappable.

Nine soil and tissue samples were taken from recently dead and dying disease indicator species. The samples were lodged with the Department of Environment and Conservation's Vegetation Health Services (VHS) laboratory where diagnostic baiting was conducted. Eight of the nine samples returned negative results for *Phytophthora*. The VHS has advised that the remaining sample, which was taken from along the entrance road to the Kundip Mining Centre, is likely to be *Phytophthora cryptogea*, however this cannot be confirmed until DNA analysis is carried out in February. This is the second positive result for *Phytophthora* along the site entrance road with a 2006 sample taken by Glevan Consulting returning a positive result for a new species which is similar to *P. arenaria*, *P. aff arenaria*. Therefore the entrance road to the Kundip Mining Centre presents a risk in terms of spreading *Phytophthora* into Protectable Uninfested and Uninterpretable areas.

The majority of the proposed Kundip to Rav 8 haul road corridor is Uninterpretable and Unmappable for the presence of Dieback. There is 4.9 ha (9.1% of the assessed 100 m wide corridor) of Uninfested vegetation within the Bm and Bl vegetation units which occurs at the start of the proposed haul road as it leaves the boundary of the Kundip Mining Centre.

The Jerdacuttup River and some lower order streams dissect the proposed Kundip to Rav 8 haul road. These water-gaining sites pose the greatest risk along the proposed route in terms of vehicle hygiene and ensuring that Dieback is not transported into the Uninfested section of the proposed haul road and other Protectable areas within the Kundip Mining Centre.

While it is unlikely that *Phytophthora* is currently present in the areas that have returned negative results, the recovery of two positive results along the entrance road to the Kundip Mining Centre presents a risk in terms of spreading of the pathogen into Protectable areas.

1 Introduction

Silverlake Resources (Silverlake) engaged Terratree Pty Ltd (Terratree) to undertake a *Phytophthora* Dieback (Dieback) assessment of the Kundip Mining Centre and proposed Kundip to Rav 8 haul road (hereafter referred to as 'the project area'). The Dieback assessment was undertaken by Department of Environment and Conservation (DEC) accredited Dieback Interpreters Joseph Grehan and Ian Moore between November 13th-18th, 2012

The Kundip Mining Centre is located approximately 17 km south-east of Ravensthorpe along the Ravensthorpe to Hopetoun Road. The Rav 8 site is located approximately 25 km east of Ravensthorpe. The proposed haul road is approximately 16 km long heading in a north-easterly direction from the Kundip Mining Centre to the Rav 8 site (**Figure 1**).

1.1 Background

Phytophthora Dieback ('Dieback') is a soil borne pathogen with a range of hosts in the southwest of Western Australia. These predominantly come from the Proteaceae, Ericaceae, Myrtaceae, Xanthorrhoeaceae and Fabaceae plant families. While some plant species are resistant, others are susceptible to the disease caused by the pathogen resulting in chlorosis, dieback and usually death.

According to the most recent State of the Environment Report (Environmental Protection Authority 2007) *Phytophthora* Dieback, which is listed as a Priority 1 threat, is the third biggest threat to biodiversity after salinity and climate change. It is a more serious threat than weeds, clearing of native vegetation, acid sulphate soils and soil erosion.

- Over 40% (2,300) of the native plant species and half of the endangered plant species in the south-west of WA are susceptible to the pathogen
- Change in plant community composition and structure causes impacts throughout the whole ecosystem, including impacts on the local fauna
- Dieback can lead to significant soil erosion as a result of the loss of susceptible vegetation.

The Dieback pathogen is widespread in areas with greater than 800 mm of annual rainfall, not so extensive in areas that receive between 600-800 mm and mainly restricted to water-gaining sites in areas that receive 400-600 mm. The pathogen does not occur in areas that receive less than 400 mm of annual rainfall. In Western Australia Dieback is a significant environmental issue for projects between Geraldton in the Midwest and Esperance on the South Coast and is widespread in the Southwest region.

The introduction of *Phytophthora* Dieback into the South Coast regions has had a significant impact on many plant communities. Conservation reserves such as the Stirling Range National Park have been severely impacted with 60-80% of the park being infested. The disease has also impacted coastal heath communities that are dominated by highly susceptible Proteaceous genera such as *Banksia* and *Hakea*.

The pathogen has been spread as far east as Cape Le Grand National Park east of Esperance, and in the Fitzgerald River National Park within the United Nations Biosphere region. *Phytophthora cinnamomi* has been recorded in the Ravensthorpe area; however it is generally restricted to water-gaining sites.

1.1.1 Past Land Uses

The Kundip Mining Leases M74/41, 51, 53 & 135 comprise approximately 664 ha has been mined intermittently for over 100 years. There are large areas of disturbance within the Kundip Mining leases including tracks, open pits, old mine shafts, costeans and exploration disturbance.

1.1.2 Previous Studies

The Kundip Mining Centre and proposed Kundip to Rav 8 haul road were previously assessed for Dieback occurrence by Glevan Consulting in 2006. The assessment found that the Kundip Mining Centre was mostly Uninterpretable due to the absence of disease indicator species. The remainder of the Kundip Mining Centre was found to be Unmappable for disease occurrence due to past disturbances including pits, shafts, costeans, stockpiles, tracks and drill lines. The majority of the 16 km proposed Kundip to Rav 8 haul road was found to be Uninterpretable with approximately 1.5 km of Uninfested vegetation at the start of the route from the Kundip Mining Centre. All ten soil and tissue samples taken during the assessment returned negative results for *Phytophthora cinnamomi*. One sample returned a positive result for *Phytophthora arenaria* which is thought to be a less pathogenic and destructive species than *P.cinnamomi*.

2. Regulatory Context

Ministerial conditions relating to the management of Dieback for the Philip River Gold Project are detailed in *Bulletin 1213 for the Philip River Gold Project, Ravensthorpe* (EPA January 2006). The following conditions and procedures were recommended in relation to Dieback management:

9-1 "Within one month following the issuing of the notice to the decision-making authorities under section 45(7) of the *Environmental Protection Act 1986* and in consultation with the Department of Conservation and Land Management, the proponent shall prepare a Dieback Management plan to the requirements of the Minister for the Environment on advice of the Environmental Protection Authority.

The objective of the Dieback Management Plan is to prevent the introduction of Dieback to the Kundip mine site and haul road area.

The Plan should include the procedures and/or measures for:

1. hygiene and wash-down for all plant and equipment;
2. restriction of use of the haul road to vehicles which are dieback-free only;
3. monitoring of vegetation condition along the haul road and within the Kundip site for signs of Dieback;
4. training of personnel; and
5. contingency plans for the management of Dieback if introduced.

9-2 Within two months following the issuing of the notice of decision-making authorities under Section 45(7) of the *Environmental Protection Act 1986*, the proponent shall implement the Dieback management Plan for all activities on the Kundip site and the haul road."

9-3 The proponent shall make the Dieback management Plan required by condition 9-1 publically available, in manner approved by the Department of Environment.

A person or entity intentionally or unintentionally spreading Dieback could be prosecuted under the "Serious Environmental Harm" provisions *Environmental Protection Act* (1986) Part V S.50A. Projects located within Dieback prone areas which are formally assessed under Part IV of the *EP Act* are usually required to map and manage *Phytophthora* Dieback as part of ministerial conditions associated with environmental approval for project in these areas.

3. Existing Environment

3.1 Regional Setting

The Kundip mining leases M74/41, 51 & 135 and P74/153 together comprise approximately 664 ha and are surrounded by the Ravensthorpe Range which is a Proposed Nature Reserve as a result of EPA Red Book Recommendation (Recommendation 3.8). The Ravensthorpe Range is a significant landform in the region with Mt Desmond, which is 9 km north of Kundip, being the highest point at 330 m above sea level.

While most of the region is underlain by the Yilgarn Craton made up of gneissic and granitic rocks of the Archaean era 2500-3000 Ma, the Ravensthorpe Range overlays a greenstone belt dating back between 2600 to 3000 Ma, which runs through the Yilgarn Craton. The Kundip mining leases are part of the central Ravensthorpe Terrane, a calcareous-alkaline complex that has been dated at 2990-2970 Ma (Craig 2004).

Kundip is located in the eastern part of the Fitzgerald Biosphere region which includes a *core area* of 329,000 ha (Fitzgerald River National park (FRNP)), a *buffer zone* of 130,000 ha (comprised of Crown land and some unvested reserves) and a *zone of cooperation* (comprised of private freehold farmland of which 557,000 ha is cleared and 166,000ha is uncleared). The biosphere is one of only two biosphere reserves in Australia and is recognised as a one of the Earth's 25 biodiversity hotspots (Craig 2004).

The Kundip Nature Reserve (Reserve No. 31128) is located between 0.4-1 km south of the mining leases with a proposed nature reserve continuing west of the Ravensthorpe to Hopetoun road. The FRNP is located south of the proposed nature reserve and south-west of the Kundip mining leases. It is envisaged by the DEC that the Kundip Nature Reserve Proposed and Nature Reserve will continue to provide a regional linkage between the Ravensthorpe Range and the FRNP.

The Kundip mining leases are located between two river catchments with the Steere River passing through the western portion of the leases and the Jerdacuttup River passing through the eastern portion of the leases. The Jerdacuttup River dissects the proposed Kundip to Rav 8 haul road.

3.2 Soils and Vegetation

The soils along the greenstone belt of the Ravensthorpe Range are shallow, skeletal and rocky on the upper slopes with deeper red loamy soils on the lower slopes. The rocky upper slopes and steep valley sides are dominated by Mallee and Mallee-heath vegetation, while the lower slopes are mostly woodlands (Craig 2004). Flatter areas are mostly laterised with white sand overlying lateritic gravel which is underlain by a mottled zone of clay or loam. Deeper soil profiles greater than 1 m occur on the more moderate slopes with a 10 cm deep A horizon comprised of loamy sand to clayey sand overlying a sandy clay B horizon (Chapman and Newbey 1995). It is these deeper sandy soil profiles on moderate slopes that support more Proteaceous species from the *Banksia*, *Isopogon*, *Leucopogon*, *Synaphea* and *Petrophile* genera.

Craig (2004) mapped eighteen vegetation units within the Kundip Mining Centre. Only two of these units, *Banksia lemanniana* (Bl) and *Banksia media* (Bm) were determined to be interpretable for the presence of Dieback due to absence of disease indicator species in the other units. Many of the Uninterpretable vegetation units are dominated by Mallee species including *Eucalyptus cernua*, *E. pileata*, *E. plurocarpa*, *E. suggrandis* and *E. incierata*, or myrtaceous heath species including *Melaleuca hamata*, *M. pauperiflora*, *M. cucullata*. The Mh vegetation unit is the most

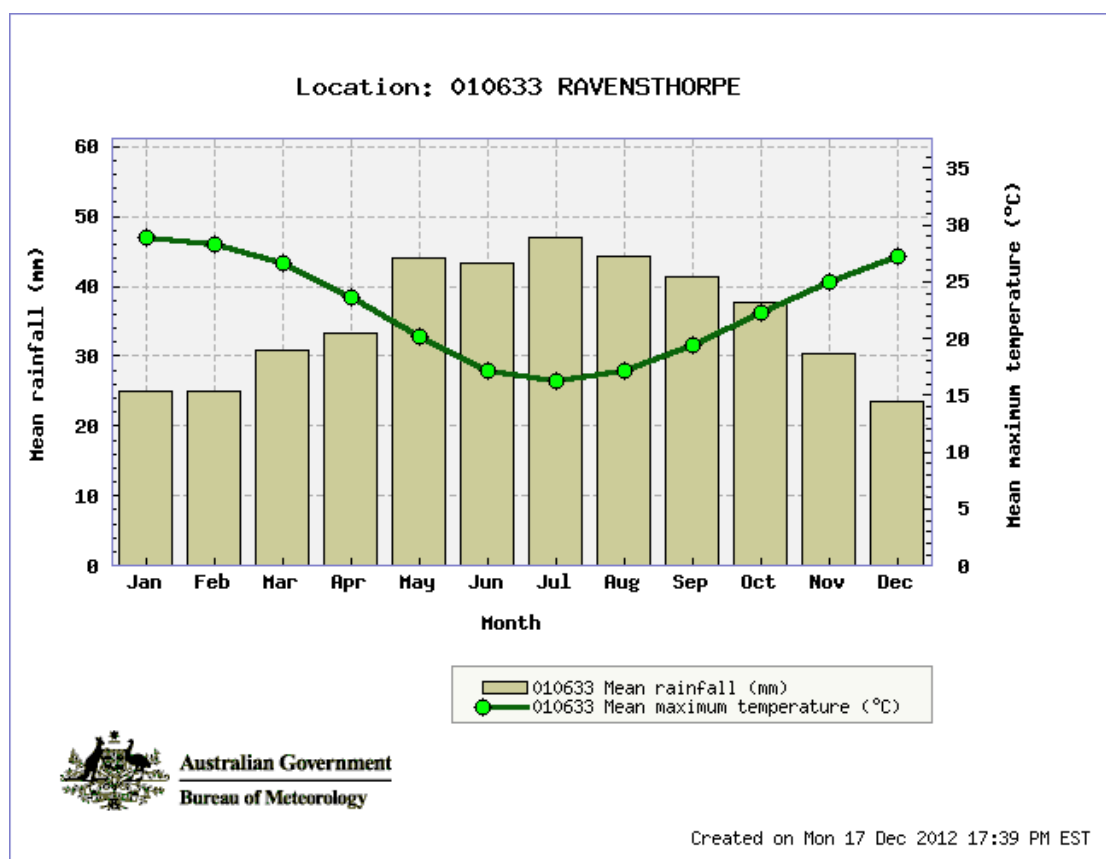
widespread within the Kundip mining lease and is dominated by non-susceptible species including mallees in the overstorey with a dense *Melaleuca* dominated understorey.

Proteaceous vegetation which is highly susceptible to Dieback is more widespread towards the coast on the sandplain. The FRNP has several *Phytophthora cinnamomi* infestations most notably the Bell Track infestation which runs through the park.

3.3 Climate

The climate of the south coast region is typically Mediterranean with cool, wet winters and hot, dry summers. Seasonal variation in rainfall and temperature strongly influences temporal changes in activity of *Phytophthora cinnamomi* in south Western Australia (Shearer and Tippett 1989).

The average annual rainfall for Ravensthorpe is 426 mm with two-thirds of this occurring over six months between May and October. Significant rainfall in springtime results in warm moist soil conditions around water-gaining site which is optimum for pathogen sporulation. The maximum daily temperature at Ravensthorpe is 29°C in January to 16°C in July with a minimum temperatures average 14°C in January-February and 7°C in July-September.



Graph 1: Mean monthly rainfall and temperature for Ravensthorpe (Bureau of Meteorology 2012)

4 Methods and Limitations

4.1 Methods

The Dieback assessment of the Kundip mining centre and Kundip-Rav 8 haul road, was undertaken, in accordance with the survey methodology stipulated in 'Phytophthora cinnamomi and the diseases caused by it - Volume 2: Interpreters Guidelines for Detection, Diagnosis and Mapping' (CALM 2001).

The DEC is currently developing new guidelines for undertaking Dieback surveys. A draft of the new survey guidelines was received from the Disease Standards Officer of the DEC and was applied during the recently completed survey. The main changes in methodology relate to evidence collection and application of the Unmappable (excluded) category which is used for highly disturbed areas. **Table 1** presents the updated *Phytophthora cinnamomi* occurrence categories (DEC 2012, draft) which includes the Unmappable category.

A search of the DEC's Vegetation Health Services (VHS) database was undertaken to obtain all the sample results taken from the Ravensthorpe area since 2006. This included samples taken by Glevan Consulting for Tectonic Resources within the Kundip mining leases. The sample waypoints and results, along with the previous occurrence mapping produced by Glevan were then overlaid onto a vegetation map of the project area to produce a field map.

The first step of the field assessment was to undertake reconnaissance of the project area to determine the following:

- Access - all tracks within the project area were mapped
- Identify interpretable vegetation and disease expression if present
- Identify possible disease vectors e.g. tracks, ground disturbance, feral animals
- Determine the location of high risk areas e.g. areas of high disturbance and water-gaining sites
- Identify other impacts to vegetation e.g. drought, herbivory, *Armillaria luteobubalina*, fire

Following the reconnaissance, interpretable areas were mapped before being traversed at 50 m intervals recording evidence of the presence or absence of Dieback, and taking soil and tissue samples of recently dead or dying disease indicator species.

A linear survey was undertaken of the proposed Kundip-Trilogy Haul Road in accordance with guidelines for undertaking linear surveys (CALM 2001). The survey involved assessing a corridor 50 m on both side of the proposed haul road recording evidence of presence or absence of Dieback and taking samples according to the strategy described in Section 4.2.

4.2 Sampling

Soil and tissue samples from recently dead or dying indicator species were taken to confirm the presence or absence of *Phytophthora* Dieback and inform interpretation of the area. The samples were lodged with the DEC's Vegetation Health Services (VHS) laboratory where diagnostic baiting is conducted. All sample point locations were recorded with a hand-held GPS (**Plate4**).

The following sampling strategy was applied when determining sample locations:

Initial standards sampling

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

Sampling to support Infested diagnosis

Recently dead and dying indicator species are sampled to support an Infested diagnosis.

Sampling to supporting an Uninfested diagnosis

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

All sampling was undertaken in strict adherence to the following procedures:

- All tools used in sampling are thoroughly sterilised before samples are taken with a 70:30 mixture of methylated spirits and water. It must be ensured that the tools are dry prior to sampling so that the results are not compromised.
- The area around the base of the plant being sampled is cleared of leaf litter and debris so that this material is not included in the sample.
- The plant sampled is excavated to a depth which ensures that adequate plant tissue material can be obtained from the roots and cambium layer around the collar of the plant being sampled.
- Material from all around the plant is taken in addition to any obvious lesions so as to avoid missing any infected material. All the plant tissue material and a few handfuls of soil from around the roots and other places in the soil profile are placed in a polythene bag.
- An amount of distilled water enough to moisten the soil is poured into the bag to assist with the survival of any inoculum that may be present in the sample.
- All relevant information pertaining to the plant sampled and sample location is recorded on the Sample Information Sheet.
- Two aluminium tags which provide the date, project name, sample number, species sampled and the name of the interpreter are written. One tag is placed in the sample bag and the other is tied near the sample site which is also flagged with a Day-Glo orange flagging banner.
- The sample hole is backfilled to prevent fauna becoming trapped and all tools have excess soil brushed off and are sterilised to prevent contamination of the next sample site and sample.

4.3 Limitations

The following limitations were encountered during the assessment:

- The widespread impact of drought on the vegetation made interpretation more difficult. Low levels of inoculum have previously produced false negative results in low rainfall areas (400-600 mm).
- The majority of the project area is Unintrepretable or Unmappable for *Phytophthora* Dieback.
- The likely presence of *Armillaria luteobubalina* or Australian Honey Fungus complicates interpretation of disease symptoms as it affects many of the same species as Dieback.

Table 1 *Phytophthora cinnamomi* occurrence categories as defined by the DEC (2012, draft)

P.c. occurrence Assessability	Interpretability	Impact Rating	Syndrome	Comment
Included assessable (undisturbed natural areas)	Interpretable Impacts of Phytophthora dieback disease are visible on infested sites	High	Extremely Destructive Epidemic, or Endemic	
		Moderate	Commonly a Variable Epidemic but may also exist as an Extremely Destructive Epidemic	This syndrome may yet to have reached full destructive potential of the pathogen depending on the age of infestation
		Low	Variable Epidemic, where overstorey impact is not present	Although overall impact is low, it is not low enough to be given 'no apparent disease syndrome'
	Uninterpretable Consists of areas of natural vegetation where susceptible plants are too few for interpretation of Phytophthora dieback, These sites are unlikely to change vegetation composition.	None, or none perceptible	No Apparent Disease.	May consist of very low level endemic disease in an environment not favourable to the pathogen
Excluded not assessable (disturbed areas)	May revert to interpretable depending on the level of disturbance (e.g. harvesting or fire)	Predicted impact ratings may be forecasted based on landform and vegetation types. The level of disturbance will determine if impact prediction is possible and/or necessary.	Not applicable	

5 Results

It is estimated that the Kundip Mining Centre project area is 627.6 ha. Table 2 presents a breakdown of the project area into the different disease occurrence categories.

Table 2 Area of each disease occurrence category within the Kundip Mining Centre and the Proposed Kundip to Rav 8 haul road

Category	Kundip Mining Centre	Proposed Kundip to Rav 8 Haul Road
Infested	2 spot infestations along entrance road to minesite	Nil
Uninfested	103.6 ha (16.5%)	14.9 ha (9.6%)
Uninterpretable	393.1 ha (62.6%)	82.6 ha (53.2%)
Unmappable	130.1 ha (20.7%)	57.6 ha (37.1%)
Total Area	627.6 ha	155.1 ha

Eight of the nine soil and tissue samples taken returned negative results for *Phytophthora* (Table 3). The VHS has advised that the remaining sample, which was taken from along the entrance road to the Kundip Mining Centre, is likely to be *Phytophthora cryptogea*, however this cannot be confirmed until DNA analysis is carried out in February.

Table 3 Sample results from the Kundip Mining Centre and proposed Kundip to Rav 8 haul road

Sample No.	Species	Easting GDA 94 Zone 51	Northing GDA 94 Zone 51	Vegetation Health Services Laboratory Results
1.	<i>Petrophile</i> sp.	239274	6270312	<i>P. ?cryptogea</i> *
2.	<i>Banksia lemanniana</i>	241069	6270546	Negative
3.	<i>Banksia lemanniana</i>	241032	6268810	Negative
4.	<i>Banksia lemanniana</i>	239528	6270593	Negative
5.	<i>Leucopogon</i> sp. and <i>Banksia lemanniana</i>	239252	6270702	Negative
6.	<i>Banksia media</i>	240393	6270747	Negative
7.	<i>Banksia media</i>	240127	6270557	Negative
8.	<i>Banksia lemanniana</i>	241002	6270340	Negative
9.	<i>Banksia lemanniana</i>	240484	6271466	Negative

*To be confirmed through DNA analysis

6 Discussion

Eight of the nine samples taken within the project areas have returned negative results for *Phytophthora* with one sample taken along the entrance to the mine site returning a positive result, which is likely to be *P. cryptogea*. Morphological analysis undertaken by the VHS indicates that it is *P. cryptogea* however this cannot be confirmed until DNA analysis is carried out in February. This is the second positive result for *Phytophthora* along the entrance road, with a 2006 sample taken by Glevan Consulting returning a positive result for a new species which is similar to *P. arenaria*, *P. aff arenaria*. Therefore the entrance road to the Kundip Mining Centre presents a risk in terms of spreading the pathogen into Protectable Uninfested and Uninterpretable areas.

6.1 Kundip Mining Centre

Given the past history of soil disturbance without any hygiene management it is surprising that there are no areas infested with Dieback within the Kundip Mining Centre project area. However a large proportion of the areas that have been disturbed by mining and exploration are Unmappable due to this disturbance (**Plate 6**) or Uninterpretable due to the type of vegetation occurring in these areas (**Plate 1**). Most of the vegetation that is susceptible to Dieback occurs in the Bl (**Plate 2**) and Bm (**Plate 3**) vegetation units. The Bl unit is vegetated with dense proteaceous thickets dominated by *Banksia lemanniana* and occurs over laterite and quartzite crests on upper slopes (Craig 2004). The majority of the areas covered by the Bl unit remain undisturbed which indicates that these area may not be prospective for the minerals that have been previously targeted. The Bm unit occurs over duplex soils on lower slopes is open Mallee with low proteaceous and myrtaceous heath (<1 m) with *Bankisa media* being a dominant species. This vegetation unit has high species richness with several susceptible species including *Banksia cirisoides*, *Hakea corymbosa*, *H.marginata* and *H.pandancirpa*. The majority of the Bm unit also remains undisturbed which indicates that these areas may not be prospective for the minerals that have been previously targeted. All the uninfested areas mapped (**Figure 2**) are Protectable from *Phytophthora* Dieback.

Approximately 62% of the Kundip Mining Centre is Uninterpretable due to low abundance of disease indicator species (**Plate 5**). While many species of the Proteaceae, Ericaceae, Fabaceae and Pappilionaceae families are highly susceptible to the pathogen, species from other plant families can act as hosts without succumbing to or expressing symptoms of the disease. Therefore although vegetation in Uninterpretable areas does not express symptoms of the disease, resistant species may be harbouring the pathogen.

The vegetation units that occur on the calcareous clay loams including Ea, Ec and En, while Uninterpretable, are at a low risk of becoming infested as alkaline soils are antagonistic to *P.cinnamomi*. However other *Phytophthora*, species such as *P.multivora* are known to subsist in alkaline soils.

Two positive sample results of *Phytophthora* have been recorded along the entrance road to the Kundip Mining Centre. The 2012 assessment recovered *P.cryptogea* while the 2006 assessment recovered a relatively new species, *P. aff arenaria*.

The entrance road poses the main risk in terms of spreading Dieback into Protectable areas within the Kundip Mining Centre, therefore vehicle and machinery hygiene along this stretch of road will need to be managed and monitored.

6.2 Proposed Kundip to Rav 8 Haul Road

The majority of the proposed Kundip to Rav 8 haul road corridor that was assessed 50 m either side of the proposed route is Uninterpretable and Unmappable for the presence of Dieback. There is 4.9 ha (9.1% of the assessed corridor) of Uninfested Protectable vegetation within the Bm and Bl vegetation units which occurs at the start of the proposed haul road as it leaves the boundary of the Kundip Mining Centre (Figure 3).

The Jerdacuttup River and some lower order streams dissect the proposed Kundip to Rav 8 haul road. These water-gaining sites (Plates 7 & 8) pose the greatest risk along the proposed route in terms of vehicle hygiene and ensuring that Dieback is not transported into the Uninfested section of the proposed haul road and other Protectable areas within the Kundip Mining Centre.

6.3 *Armillaria luteobubalina*

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

- Clusters of fruiting bodies around or near the base of the plant
- A pungent mushroom smell
- An inverted V shaped scar at the base of the plant
- Yellow-white stringy rot under the bark in the roots and base of affected plants (DEC 2012)

Yellow-white stringy mycelium was observed in two of the *Banksia* plants sampled; therefore it is likely that *Armillaria luteobubalina* is present within the project areas. However it is unlikely that *Armillaria luteobubalina* is having a significant impact on the vegetation within the project areas due to the low rainfall and small amount decaying biomass when compared to the Jarrah and Marri forests of the southwest where it is abundant.

7 Conclusion and Recommendations

While it is unlikely that *Phytophthora* is currently present in the areas that have returned negative results, the recovery of two positive results along the entrance road to the Kundip Mining Centre presents a risk in terms of spreading of the pathogen into Protectable areas. The majority of the proposed Kundip to Rav 8 haul road is Uninterpretable with Protectable Uninfested vegetation at the beginning of the proposed route from the Kundip Mining Centre. The route crosses the Jerdacuttup River and associated lower order watercourses which increases the likelihood of the pathogen being present in the Uninterpretable vegetation. Although there is a low likelihood of the pathogen being present in Uninterpretable and Unmappable areas within the Kundip Mining Centre the low risk of the pathogen being present and possibly spread into Protectable areas will require management and on-going monitoring. The following recommendations are presented to inform management and minimise the risk of non-autonomous spread of the pathogen within the project area:

1. The current Dieback Management Plan will require updating to address the risk of spreading or introducing *Phytophthora* into Protectable areas including both Uninfested and Uninterpretable areas within both the Kundip Mining Centre and the proposed Kundip to Rav 8 haul road.
2. A risk assessment should be undertaken of all the Uninterpretable and Unmappable areas within the Kundip Mining Centre areas to identify 'Disease Risk Area', or areas where there is a Moderate to High risk of the pathogen being present and to ensure that vehicles and machinery are 'clean on exit' from these areas.
3. Ensure access management is addressed in the Dieback Management Plan to identify tracks that can be closed and manage vehicle movement throughout the Kundip Mining Centre project area to minimise the risk of introducing and/or spreading Dieback into Protectable areas.
4. Protectable Uninfested areas will need to be identified through appropriate signage and should also be demarcated in the field.
5. All basic raw materials required for the construction of the haul road will need to be sourced from and stockpiled on Uninfested land.
6. All vehicles, plant and machinery entering the site should be clean of soil and vegetative material prior to entering the site. Vehicles and machinery that do not meet the appropriate standard should be refused entry to the site until the condition of vehicles and/or machinery is attended to.
7. The section of the proposed haul road that passes through Uninfested vegetation should be designed to prevent run-off from draining into the adjacent vegetation.
8. The haul road should be designed to prevent vehicles from picking up soil as they cross water gaining areas along the proposed route.
9. All minesite personnel should be trained to ensure that all the necessary hygiene measures are understood and implemented correctly; particularly in relation to vehicle wash-down procedures.
10. Under Section 9.6 in "*Phytophthora cinnamomi* and disease caused by it-Volume II interpreters guidelines for Detection, diagnosis and mapping titled" "Age limit for maps" it states that "The maximum time allowed for a recheck is 12 months from the field completion date as shown in the map legend. After three years the area must be

completely re-interpreted.” The guidelines then go on to say “Note: If an area is rechecked more than once, the expiry date is taken from the original interpretation date not the recheck date” (Pages 52-52). Therefore it is recommended that Dieback occurrence be rechecked annually and the project areas be re-interpreted triennially.

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9 Glossary of Terms

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

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

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

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

Landscape Unit - the area used in the analysis of the need for, and the determination of the boundaries of, areas to be mapped for *Phytophthora* Occurrence, for determining 'protectable' areas and their appropriate boundaries, and for preparing *Phytophthora* Dieback Management Plans. A landscape unit

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

***Phytophthora* Dieback Management Map** - the map prepared as part of 'protectable' areas *Phytophthora* Dieback management planning process. It records details of planned management actions.

***Phytophthora* Dieback Management Plan** - the document (includes appended maps) that describes and controls how human access to uninfested 'protectable' areas is to be managed so that the role of humans as vectors in establishing new centres of infestation will be reduced to the lowest possible level.

***Phytophthora* Dieback Occurrence Map** - the main map produced by Interpreters. It shows *Phytophthora* Dieback occurrence, *Phytophthora* Dieback free areas; Uninterpretable and Unmappable areas and may show Unprotectable areas.

Protectable Area -areas, including areas of high conservation and/or socioeconomic value (E.g. a small uninfested area which contains a known population of a susceptible species of threatened flora) within the vulnerable zone that:

- Are situated in zones receiving > 600 mm per annum rainfall or are water gaining sites (E.g. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600 mm per annum rainfall zone
- Have been determined to be free of the pathogen *P. cinnamomi* by a qualified Disease Interpreter (all susceptible indicator plant species are healthy, no plant disease symptoms normally attributed to *P. cinnamomi* are evident)
- Are positioned in the landscape and are of sufficient size. (E.g. > 4 ha with axis >100m) such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term (a period of a few decades)
- Consists of areas where human vectors are controllable (E.g. not an open road, private property)

Phosphite - an aqueous solution of mono- and di-potassium phosphite

Precaution means an action(s) taken beforehand to avoid environmental degradation or to ensure a good environmental outcome.

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

Precautionary Principle- has the meaning as stated in the Intergovernmental Agreement on the Environment (1992): "Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

(a) careful evaluation to avoid, where-ever practicable, serious or irreversible damage to the environment;
and,

(b) an assessment of the risk-weighted consequences of various options.”

Principles of Sustainability- has the same meaning as Section 19(2) of the *Conservation and Land Management Act 1984*. Risk means the chance of uninfested area becoming infested through the autonomous actions of the pathogen or the actions of people and animals or a combination of these factors, measured in terms of the magnitude of consequences of that event should it occur and the likelihood of the event and its consequences occurring, assessed in the context of existing controls.

Risk Analysis - s a systematic use of available information to determine how often specified events may occur and the magnitude of their consequences.

Risk Control - part of risk management that involves the implementation of policies, standards, procedures and physical changes to eliminate or minimise adverse risks.

Risk Evaluation - the process used to determine risk management priorities.

Risk Management - the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects

Risk Treatment - selection and implementation of appropriate options for dealing with risk

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

Threat - indication that serious or irreversible environmental damage may occur.

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

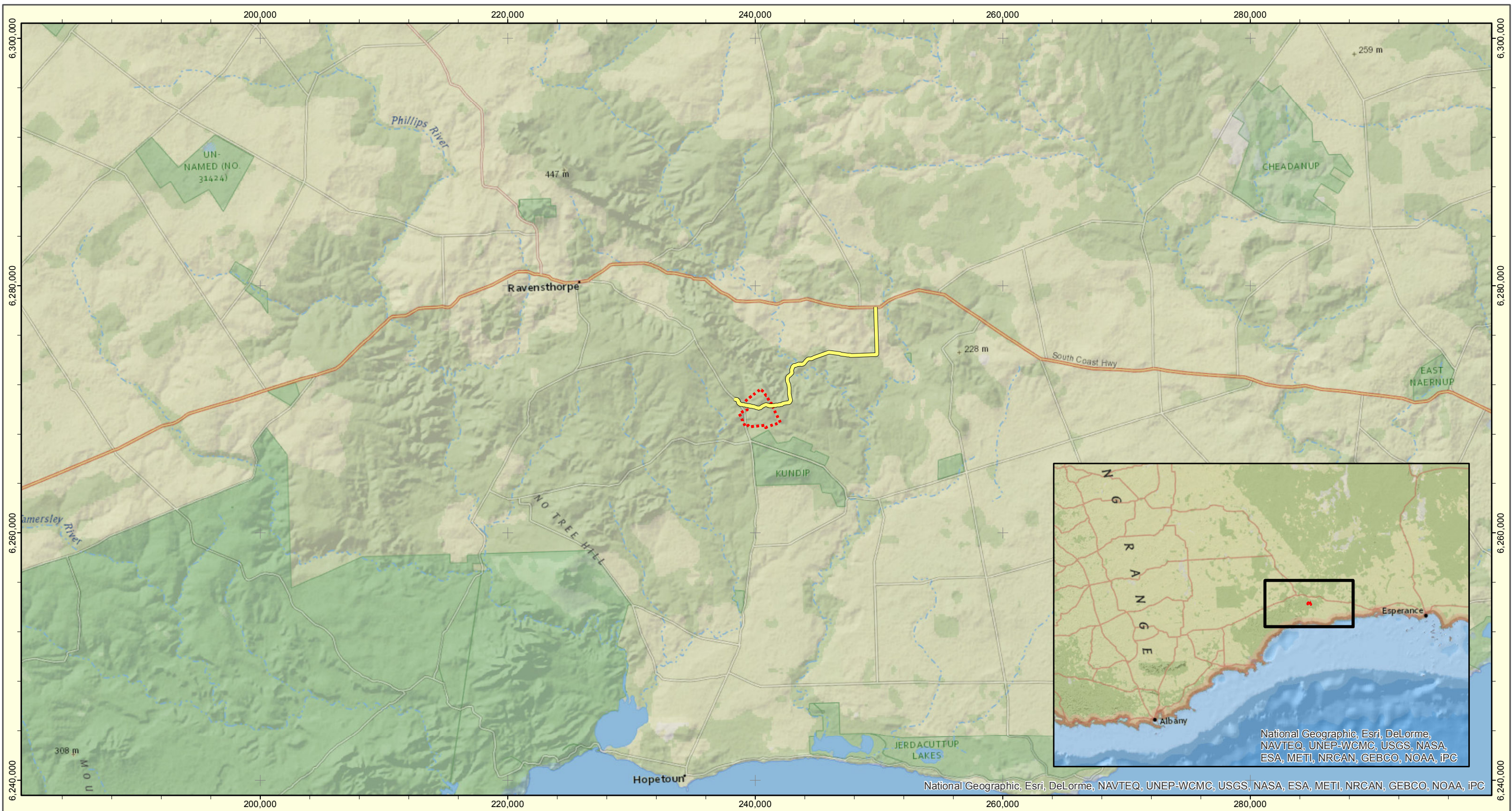
Uninterpretable Areas - areas situated in areas receiving > 600+ mm per annum rainfall or are water gaining sites (e.g. granite outcrops, impeded drainage or engineering works which aggregate rainfall) in the 400-600mm per annum rainfall zone where indicator plants are absent or too few to determine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

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



Vulnerable - susceptible to physical injury

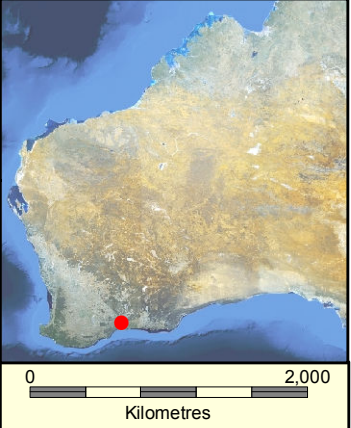
Vulnerable Zone - that part of the South West Land Division and the areas adjoining it to the north west and the south east that receive greater than 400 mm per annum rainfall and in which susceptible native plants occur in conjunction with the environmental factors required for the pathogen *P. cinnamomi* to establish and persist.

Figures


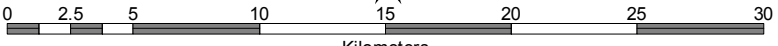


LEGEND

-  Haul Road
-  Assessment Area




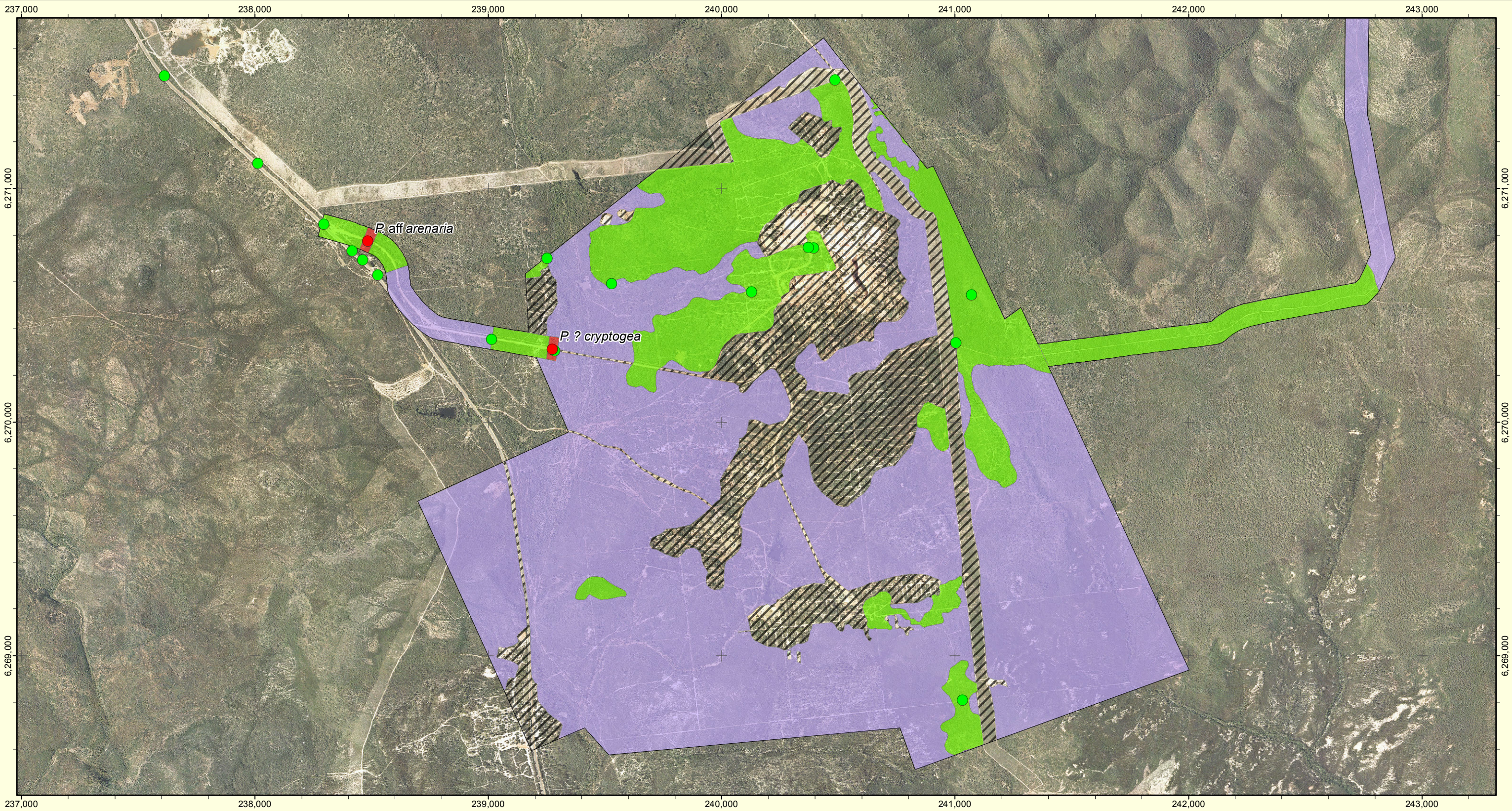
PROJECT LOCATION
Kundip Mining Centre *Phytophthora* Dieback Assessment



 Kilometers








Coordinate System: GDA 1994 MGA Zone 51
 Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:300,000	Prepared: N King	Project No: TS12001	Figure 1
Date: 09/01/2013	Checked: R Cullen		
Revision: Rev A	Reviewed: J Grehan		

Terratree 

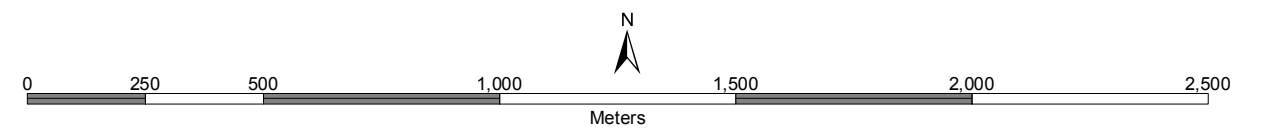


LEGEND


- | | | | |
|---|-----------------|---|------------------|
|  | Assessment Area |  | Sample Locations |
|  | Unmappable |  | Negative |
|  | Infested | | Positive |
|  | Uninfested | | |
|  | Uninterpretable | | |



Phytophthora Dieback Occurrence - Kundip Mining Centre



Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:16,000	Prepared: N King	Project No: TS12001	
Date: 09/01/2013	Checked: R Cullen	Figure 2	
Revision: Rev A	Reviewed: J Grehan		



LEGEND	
	Assessment Area
	Unmappable
	Infested
	Uninfested
	Uninterpretable
	Negative
	Positive
	Sample Locations



Phytophthora Dieback Occurrence - Proposed Haul Road

Coordinate System: GDA 1994 MGA Zone 51
Projection: Transverse Mercator, Datum: GDA 1994, Units: Meter

Scale @ A3: 1:40,000	Prepared: N King	Project No: TS12001	Figure 3	
Date: 09/01/2013	Checked: R Cullen			
Revision: Rev A	Reviewed: J Grehan			

Plates



Plate 1 Uninterpretable vegetation



Plate 2 Interpretable Uninfested vegetation (Bl unit) with dominant disease indicator species *Banksia lemanniana*



Plate 3 Interpretable Uninfested vegetation (Bm unit) with dominant disease indicator species *Banksia media*



Plate 4 Sample site in Bl vegetation unit



Plate 5 Uninterpretable area on top of waste dump



Plate 6 Unmappable area (excluded) due to high degree of disturbance



Plate 7 High risk water-gaining site



Plate 8 High risk water-gaining site