ASSESSMENT OF GUIDELINES FOR BEST PRACTICE MANAGEMENT OF *Phytophthora cinnamomi* IN PARKS AND RESERVES ACROSS VICTORIA

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EXECUTIVE SUMMARY

Introduction and literature review

The plant pathogen *Phytophthora cinnamomi* has been identified as a "key threatening process" in the Australian environment (Environment Australia 2001). The threatening process is the lethal epidemic of '*Phytophthora* dieback' which leads to further consequences such as the extinction of populations of some flora species, a reduction in primary productivity within affected ecosystems and the loss and degradation of flora and fauna habitat (Environment Australia 2001).

In Victoria, the potential for devastating environmental damage is recognised and the use of infested gravel is listed as a threatening process under the *Flora and Fauna Guarantee Act 1988*. The pathogen is present in over 20% of Victoria's National, Wilderness, State and Metropolitan Parks (Parks Victoria 2000). Parks Victoria has instigated this identification of best practice relating to the management of *P. cinnamomi*.

This report reviews the current methods of control, hygiene and quarantine for *P. cinnamomi* and assesses best practice procedures. It is part of a larger preliminary review of dieback caused by *P. cinnamomi* across the park estate in Victoria being undertaken for Parks Victoria by the Centre for Environmental Management, University of Ballarat, assisted by Deakin University. It complements the *Threat Abatement Plan for Dieback caused by the root - rot fungus Phytophthora cinnamomi*, (NTAP, Environment Australia 2001).

Guidelines for best practice management of *P. cinnamomi*

Internationally, disease caused by *P. cinnamomi* in native vegetation is limited in distribution and the scale is much reduced compared with that in Australia. A review of guidelines for best practice management for *P. cinnamomi* in Australia found that the most advanced plans and procedures are those developed for Victoria, Western Australia and Tasmania. In general there is a need to develop better, more comprehensive processes and guidelines for management of *P. cinnamomi*.

Planning and policy objectives

In Victoria, statewide objectives and strategic planning are poorly developed. Best practices include:

- Adoption of *a* cross-tenure, integrated approach to policy and planning, including establishment of a Consultative Committee;
- Development of a clear pathway of responsibility for *P. cinnamomi* management; and
- Establishment of a Steering Committee and working groups to develop policy, guidelines and documentation.

Mapping, prevention of spread and protection of uninfested areas

In Victoria, mapping of the distribution of *P. cinnamomi* has been undertaken in few parks or reserves and in most cases only to a limited extent. Best practices include:

- Comprehensive mapping in parks and reserves where the pathogen is known to occur;
- Development of a standard method for recording and reporting *P. cinnamomi* outbreaks;

- Identifying and mapping *P. cinnamomi* free areas for parks and reserves with extensive infestations; and
- Development and expansion of a risk identification system for individual areas (e.g. Parks) at a statewide level.

Research and Monitoring

There is clearly scope for a greater research effort into a number of aspects of the biology, ecology, control and management of *P. cinnamomi.* Best practices include:

- The establishment of a complete database of susceptible communities, including flora and fauna species;
- The evaluation of the effectiveness of management programs;
- An investigation into the use of chemical control agents;
- Research to assess the effect of the pathogen on animal habitats, threatened species and populations;
- Support of such research programs by land management agencies in collaboration with other states, research institutes and universities;
- Monitoring the spread of the pathogen; and
- Review of monitoring protocols.

Containment and hygiene

Procedures for containment and hygiene for management of *P. cinnamomi* in native vegetation in Australia have been developed over a number of years. Best practices include:

- Enhancement of existing Victorian guidelines based on those developed in Western Australia;
- Rigorous application of containment and hygiene measures and implementation of these measures;
- Implementation of containment and hygiene programs to maintain *P. cinnamomi* free areas, with an emphasis on parks and reserves that are identified as a high risk, are currently uninfested and in areas amenable to protection in the long term; and
- Accredited assessors used to develop hygiene plans, and document and implement strategies.

Restoration

Procedures for restoration of *P. cinnamomi* damaged vegetation are undeveloped, however it is an active area of research. Best practices include:

- Liaison between Parks Victoria and researchers to develop appropriate restoration protocols based on current research.

Recreation

A wide range of recreational activities are potential sources of spread for *P.cinnamomi*. In Victoria there are brief guidelines for managing these activities. Best practices include:

- Development of more specific guidelines based on the current Victorian and Western Australian guidelines;

- Rigorous application of containment and hygiene measure for recreation users; and
- Appointment of accredited assessors to assess and implement hygiene measures.

Treatment of existing infestations

Currently phosphite is a major component of control strategies in Western Australia. Best practices include:

- Investigation of the use of phosphite as a major component of control strategies; and
- The use of qualified assessors to implement phosphite application.

Staff training

P. cinnamomi management processes in Western Australia are extensive and integrated, with responsibilities undertaken by senior staff such as Dieback Coordinator and Senior *P. cinnamomi* interpreters. Currently in Victoria responsibility for *P. cinnamomi* control lies with rangers. Best practices include:

- The use of qualified staff to be responsible for *P. cinnamomi* assessment and management; and
- Staff training based on nationally accredited programs.

Community education and information

Public education is a central component of *P. cinnamomi* dieback management. Currently in Victoria community education applicable to the effects of *P. cinnamomi* on public land is minimal. Best practices include:

- Development and monitoring of a public education program in collaboration with other states, local government and universities.

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1. INTRODUCTION

1.1 General introduction

The plant pathogen *Phytophthora cinnamomi* has been identified as a 'key threatening process' in the Australian environment (Environment Australia 2001). The threatening process is the lethal epidemic of '*Phytophthora* dieback' that occurs when a combination of plant species susceptibility, presence of the fungal pathogen and vulnerability due to favourable environments, leads to a major disruption of plant community structure. Further consequences of the threatening process include:

- The extinction of populations of some flora species;
- A reduction in primary productivity within affected ecosystems; and
- The loss and degradation of flora and fauna habitat

(Environment Australia 2001).

In Victoria the potential for devastating environmental damage is recognised and the use of infested gravel is listed as a threatening process under the *Flora and Fauna Guarantee Act 1988*. The pathogen is present in over 20% of Victoria's National, Wilderness, State and Metropolitan Parks (Parks Victoria 2000). Parks Victoria has instigated this identification of best practice relating to the management of *P. cinnamomi*.

1.2 Objectives

This report complements the preliminary review of dieback caused by *P. cinnamomi* across the park estate in Victoria, undertaken for Parks Victoria by the Centre for Environmental Management, University of Ballarat assisted by Deakin University. The review of *Phytophthora* dieback provides park managers with consistent and comparable information on the actual and potential extent of the disease throughout the state and on Parks Victoria land. This will assist in the development of management strategies to abate the threat to environmental values, and should be valuable for programs aimed at improving vegetation condition and providing services to park visitors. The preliminary review provides information to assist in attaining a number of objectives of the National Threat Abatement Plan (NTAP, Environment Australia 2001, see section 3.1.1 below).

The objective of this report is to review current methods of control, hygiene and quarantine to provide an assessment of best practice procedures in relation to *P. cinnamomi* in Victoria.

This report provides guidelines for best practice management of *P. cinnamomi* in protected area management. In particular it provides:

- Collation of current quarantine and hygiene procedures as applicable to protected area management; and
- Identification and analysis of best practice management of *P. cinnamomi* in protected area management.

It should be considered in conjunction with the *Threat Abatement Plan for Dieback caused by the root - rot fungus Phytophthora cinnamomi*, (NTAP, Environment Australia 2001) and will assist Parks Victoria in contributing to a State *P. cinnamomi* Threat Abatement Plan Implementation Team.

2. LITERATURE REVIEW

2.1 Terminology

Phytophthora cinnamomi is a soil-inhabiting 'water mold' or Oomycete that is pathogenic to many plant species (Environment Australia 2001; Lewis & Colquhoun 2000). It was originally classified as a fungus because of its superficial resemblance to this group and common names such as 'Cinnamon Fungus' are still used. This report has adopted the terminology of the *Phytophthora cinnamomi* Threat Abatement Plan (Environment Australia 2001) and uses the scientific binomial *P. cinnamomi* to describe the pathogenic microbe, and the term '*Phytophthora* dieback' to describe the epidemic of plant disease it causes. In the past *Phytophthora* dieback has commonly been called 'dieback' or 'Jarrah dieback', however these terms should be avoided, as they may be confused with other plant diseases or localities.

2.2 Mechanisms of dispersal and spread of *P. cinnamomi*

The dispersal of *P. cinnamomi* in the landscape occurs through autonomous and passive mechanisms that spread an existing infestation, and by the transfer of infective material that results in totally new centres of infestation (Environment Australia 1999). Figure 1 provides an illustration of the life cycle and spread of *P. cinnamomi*.

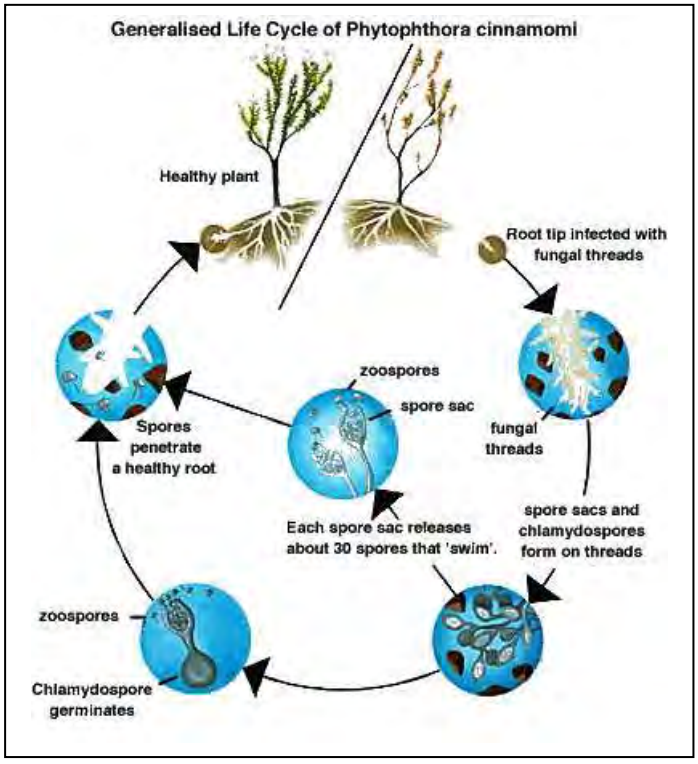

Figure 1 ***P. cinnamomi*** **life cycle and disease symptoms**

(CNR 1994)

2.2.1 Autonomous spread

The autonomous spread of *P. cinnamomi* occurs when the pathogen moves entirely under its own volition, without the aid of other physical processes such as an animal vector (Environment Australia 1999). Autonomous spread results in an expansion of the area of an existing infestation and accounts for the upslope movement of the disease. It may result from the active movement of the microscopic zoospores (Figure 1) through warm wet soils. However, this would only account for a portion of the rate of autonomous spread since zoospores only move approximately 2cm per annum through soil pores, whereas the actual rates of uphill spread in Jarrah forests can be as high as 80 – 100cm per annum (Environment Australia 1999).

2.2.2 Passive spread

Passive spread results in the downslope expansion of an existing infestation due to subsurface and surface water flow.

Subsurface flow

This occurs when zoospores are washed downslope through the soil matrix. The soil probably acts as a filter to the movement of the pathogen spores resulting in quite slow rates of expansion of an existing disease site. For example, in a long-term study in the northern Jarrah forest, Western Australia, the rate of passive spread of the pathogen through subsurface flow has not exceeded 2m per annum (Environment Australia 1999).

Surface flow

This second mechanism of passive spread of an existing infestation occurs when zoospores are transported by surface water runoff. Zoospores may be spread hundreds of metres, particularly in rapidly saturated, non-porous soils that occur on steep slopes. It is believed that the movement of zoospores via surface flow is the most important factor in the expansion of the disease by passive spread (Environment Australia 1999).

2.3 Spread of the pathogen to new areas in Australia

2.3.1 National overview

Human activity causes the most significant, rapid and large-scale spread of *P. cinnamomi* (Environment Australia 1999; Lewis & Colquhoun 2000). Movement of soils during road construction and maintenance, earthmoving, timber harvesting, mineral exploration and the use of infested nursery stock can spread the pathogen (Environment Australia 1999, Marks & Smith 1991). Spread can also occur by recreational activities such as bushwalking and the use of off road vehicles such as motorbikes and four wheel drives (Lewis & Colquhoun 2000). Scientists and others studying rare flora and fauna can also act as vectors (Environment Australia 2001). If human activity is going to spread the pathogen to a new site then it must involve the transfer of infested soil or plants. Clearly, any human activity that can move infested material, either soil or plant material or both, has the potential to spread the disease to an entirely new location. Animals such as domestic stock, feral species such as pigs and some native species can also potentially move infested material to a new site (Lewis and Colquhoun 2000)

2.3.2 Victorian perspective

The vectors for the spread of infestation to new areas in Victoria are the same as those that occur at a national level. These include the use of infested gravel for road construction, and infested soil adhering to vehicles, trail bikes and other machinery (Niewand *et al.* 1995). A major vector for spread of the disease recognised in Victoria is infested nursery stock (Marks & Smith 1991, Niewand *et al.* 1995). Other vectors include footwear, native animals such as wombats and domestic animals such as horses (Niewand *et al*. 1995).

2.4 Hygiene and management protocols

2.4.1 Current quarantine and hygiene protocols

Currently quarantine and hygiene protocols vary between states.

Victoria

In Victoria protocols for hygiene and quarantine procedures are developed through management plans and through operational guides for those parks and reserves that have identified *Phytophthora* dieback as a management issue within their management plans.

General guidelines for the control of *Phytophthora* dieback in parks are provided in Niewand *et al.* (1995). These general guidelines suggest that each park is broadly classified as potentially susceptible or not, based on the presence of susceptible plant communities, that disease risk ratings are applied and that protectable areas are identified. Hygiene procedures for operational and maintenance activities, including work practice and management of equipment between and within infested and uninfested areas are also recommended. Hygiene may also include the testing of raw materials to be imported into uninfested high-risk areas and proper wash-down of vehicles.

The general guidelines by Niewand *et al*. (1995) also detail protocols for the identification of infested areas within high-risk areas, containment measures within high-risk parks recognised as substantially infested, management planning and monitoring. Details of *P. cinnamomi* management; planning (road placement, movement of gravel etc.); road grading operations, drainage, gravel sources; management of vehicle tracks and fire operations are also provided in an operational guide by Peters (1995).

An Operational Guide to Minimise the Spread of P. cinnamomi in the Brisbane Ranges National Park and Steiglitz Historic Park (Peters 1995) and the *Brisbane Ranges National Park Management Plan* (Parks Victoria 1997) have been used as a guide for the development of management plans for *P. cinnamomi* in other parks. The operational guide in particular is an excellent source document.

Current knowledge of the Brisbane Ranges National Park, Angahook-Lorne State Park, Otway National Park, Wilson's Promontory National Park and Grampians National Park indicates that the general guidelines by Niewand *et al.* (1995) have in general (the notable exception being Brisbane Ranges National Park) not been brought into action. Strategies to control *P. cinnamomi* in management plans for many of these parks are extremely limited.

Forest management plans in Victoria contain some actions for management of *P. cinnamomi*. For example the potential for threats from the pathogen in heath woodlands and coastal forests is identified in the Otways Forest Management Plan (DCE 1990) and actions to apply hygiene and quarantine measures such as washing machinery and limiting access are given high priority. Brief guidelines are also outlined in management plans for Central Highlands (NRE 1999), Midlands (NRE 2000) and Gippsland (NRE 2001) Forest regions.

Recently Shire Councils have recognised the problems with *P. cinnamomi* on lands under their management (e.g. Surf Coast Shire). However the extent of the development of guidelines is very limited or has not been undertaken.

Western Australia

Quarantine and hygiene measures in Western Australia have been implemented for over a decade. These measures are documented extensively in recent Western Australian Department of Conservation and Land Management publications entitled *Phytophthora cinnamomi and disease caused by it* (Volume 1: Management Guidelines) and Volume 2 *Detection, Diagnosis and Mapping Guidelines*(CALM 2000). They apply across state authorities.

These management guidelines provide two separate strategies when dealing with 'protectable' and 'infested/unprotectable' areas. CALM's objective in uninfested 'protectable' areas is to manage hygiene by planning, implementing and enforcing the rule, for all human activities, of being clean on entry to the area and, having entered clean, to avoid cross contamination from infested to uninfested areas. The hygiene measures available to land managers preparing *P. cinnamomi* management plans include temporary seasonal closure of roads and walking trails, signage, permanent closures, and establishment of hygienic entry and cleandown points.

In the management of 'infested/unprotectable' areas, CALM adopts management strategies that include development of a priority management system, the application of phosphite (see section 2.4.2 below) and management guidelines and training programs. These strategies are covered in detail in CALM (2000) Volume 3 *Phosphite Operations* and Volume 4 *Training Curriculum and Syllab*i.

Guidelines for determining resource use have been developed, which direct resources to those areas most likely to remain free of infection in the long term:

> The areas should have the following characteristics:
>
> - They are currently free of infection.
> - They are of significance for conservation, either as single purpose reserves or for other, multiple land uses.
> - They are topographically located in such a way that they are unlikely to be entirely colonised by autonomous spread of the pathogen within some definable medium-term time frame.
> - The physical location is amenable to restricting human access, and this is publicly acceptable and financially affordable.
> - They are unlikely to be vulnerable to infection resulting from the presence of other, uncontrollable vectors.
>
> (Environment Australia 2001)

Tasmania

In Tasmania management of *P. cinnamomi*, including quarantine and hygiene measures, is covered in the Parks and Wildlife Service (PWS 1993) *Phytophthora cinnamomi Hygiene Manual*. The protocols within this document are currently under review to conform to the National Threat Abatement Plan (Environment Australia 2001). Currently parks within Tasmania are managed for *P. cinnamomi* on a district by district basis (R. Schahinger PWS Tasmania, *pers. comm*.), with management protocols to control *P. cinnamomi* implemented prior to maintenance or development activities taking place. *The Pest Disease Management Plan* for state forests in Tasmania includes guidelines for hygienic access. Reference to management of *P. cinnamomi* is also made in each Forest District Management Plan (Environment Australia 1999).

2.4.2 Treatment of existing infestations

Biological control of *P. cinnamomi* in native vegetation communities has had limited testing, and has not been accepted as a useful option for control (Cahill 1993). Investigation has

included applications of fertilisers, organic matter and maintenance of ground litter. The effectiveness of fire for the control of *P. cinnamomi* has also been considered but has not been proven (Environment Australia 2001). There is current research into the effectiveness of fire underway in the Brisbane Ranges National Park (D. Peters, Parks Victoria, *pers. comm.*). Improved soil drainage has proved successful in some plantation situations, but this has limited application in the management of conservation reserves (Environment Australia 2001). There have been various attempts at developing chemical controls, which have been ineffective or have had undesirable environmental impact, e.g. methyl bromide (Hardy, Barret & Shearer 2001).

In horticulture the most successful approach to *P. cinnamomi* control has been the use of the systemic fungicide phosphite (Irwin *et al*. 1995, note that we refer to the chemical used in the control of *P. cinnamomi* in this report as 'phosphite', which is the active form of potassium phosphonate and is also referred to as 'phosphonate' by some sources). It is taken up actively or passively through the stem, leaves roots and flowers and is highly selective against the *P. cinnamomi* pathogen.

Phosphite has been used extensively in native forests, *Banksia* woodlands and heathlands in Western Australia (Hardy, Dell & Colquhoun 2001, Komorek *et al.* 1997, Shearer & Fairman 1997, G. Hardy *pers. comm.*, Murdoch Uni. WA). CALM Western Australia has recognised phosphite as a major strategy for management of *P. cinnamomi* in native *vegetation* (CALM 2000 Vol 1, Podger *et al*. 1996). Over the past decade research has been carried out on the potential of phosphite for the control of *P. cinnamomi* in selected native forests and heathlands of Western Australia (Hardy, Barret & Shearer 2001) and also to a limited extent in Victoria (Peters & Weste 1997). Research has shown that there can be phytotoxic effects for some species and at some levels of application, thus phosphite cannot be used indiscriminately.

Recent studies in the laboratory and field (in heathland, heathy woodland, coastal heathland and heathy open forest) found that *Xanthorrhoea australis* plants exhibiting the early decline stages of disease were protected by phosphite at a concentration of 4g a.i./L. Plants did not lose their disease symptoms but were able to survive for at least 12 months. Plants showing severe symptoms died (Aberton *et al.* 1999; Aberton *et al.* 2001a). Upon removal and dissection of *Xanthorrhoea australis* plants, it is evident that not all roots are infested, nor are all of the areas of an individual root. However, once symptoms (chlorosis) occur there is significant damage to the stem. Laboratory analysis of isolates of *P. cinnamomi* from the field showed inhibition of hyphal growth at phosphite concentrations > 1 g a./L. These field studies have only been undertaken at Wilsons Promontory (Aberton *et al.* 2001a) and at Anglesea (Aberton *et al.* 1999).

In further research High Performance Ion Chromatography is being used to study the level of phosphite held within the plant tissue. So far, it is evident that the fungicide stays within the leaf tissue for at least a month when sprayed at high concentrations (25g a.i./L). At operational concentrations that are used in field plots (4g a.i/L) phosphite cannot be detected after one month (Aberton *et al.* 2001a). Clearly phosphite is effective in native vegetation and will probably become a major control strategy.

3. GUIDELINES FOR BEST PRACTICE MANAGEMENT OF *P. cinnamomi*

All current procedures and methods for managing *P. cinnamomi* in Australia have recently been reviewed on a state-by-state basis in the National Threat Abatement Plan, (NTAP, Environment Australia 2001) and associated 'Supplementary Information' (Environment Australia 1999). The National Threat Abatement Plan (NTAP) is intended to apply nationally, however it also gives broad direction to management at a regional and local level. The supplementary document provided with the NTAP contains state-by-state analysis of the *P. cinnamomi* problem.

Internationally, disease caused by *P. cinnamomi* in native vegetation is generally limited in distribution (Aberton *et al.* 2001c, Brasier & Jung 2001, Hansen 2001), and the scale of infestation is small compared to affected areas in Australia. In addition the effects of *P. cinnamomi* on plant and fauna diversity in other countries is not as extensive, nor is the resulting environmental damage as significant as in Australia. The area of native vegetation affected by *P. cinnamomi* exceeds many hundreds of thousands of hectares in Western Australia, Victoria and Tasmania, and tens of thousands of hectares in South Australia (Environment Australia 2001). It has been predicted that 'the epidemic invasion of Australia's native vegetation is likely to continue until *P. cinnamomi* occupies all of the habitats which are suited to its establishment and maintenance' (Environment Australia 1999). The NTAP states that: 'While eradication is not possible at present, well developed management plans based on current knowledge can assist in restricting the intensification and spread of known infestations and limit spread to new sites' (Environment Australia 2001).

From this review of the management guidelines for *P. cinnamomi* in Australia it is clear that the plans and procedures developed from Victoria, Western Australia and Tasmania are most advanced. The depth of information contained in the four-volume set of guidelines produced in Western Australia (CALM 2000) provide a comprehensive resource for guidelines elsewhere. Procedures that are already in place in Western Australia (all lands under CALM management) and Victoria (Parks Victoria land) have been used as a guide for the development of best practice guidelines. These are relatively comprehensive guidelines created under similar environmental conditions and therefore could be applied throughout Victoria.

It is acknowledged that there are many other useful sources of information. Incomplete guidelines from Tasmania (T. Wardlaw, Tasmanian PWS, *pers. comm*.), Queensland (Gadek 1999) and those currently available electronically on the Internet were investigated. Documents dealing with land administered by local government and, in Victoria, land set aside for forestry purposes, were also reviewed to provide a guide for the development of best practice guidelines for Victorian parks and reserves.

3.1 Planning and policy

3.1.1 Overview

The National Threat Abatement Plan (Environment Australia 2001) has two broad goals:

- To protect nationally listed threatened species and ecological communities from *P. cinnamomi*;
- To prevent further species and ecological communities from becoming endangered by reducing the chance of exposure to the pathogen.

Five primary objectives are included within the NTAP:

- To promote the recovery of nationally listed threatened species and ecological communities that are known or perceived to be threatened by *Phytophthora cinnamomi*;
- To limit the spread of *Phytophthora cinnamomi* into areas where it may threaten threatened species and ecological communities or into areas where it may lead to further species or ecological communities becoming threatened;
- To improve the effectiveness and efficiency of the management of *Phytophthora cinnamomi* through appropriate research and monitoring programs;
- To inform Commonwealth, State and Territory management agencies, landholders and the public about the Threat Abatement Plan's actions and their outcomes; and
- To effectively coordinate management activities.

The NTAP includes the establishment of National and State *P. cinnamomi* Threat Abatement Plan Implementation Teams to oversee implementation of the plan and actions at a national, regional and local level, including the development of codes of practice.

Western Australia

The management of *Phytophthora* dieback in Western Australia is overseen at the Ministerial level of Government, reflecting the significance of the disease. Western Australia has a clear set of objectives for public and private land. A Dieback Consultative Council (DCC) was formed as an independent body appointed by the Minister to advise on *P. cinnamomi* dieback in native vegetation within Western Australia. The DCC was established in response to a Ministerial Review Panel (Podger *et al.* 1996) and has a current membership of 14-16 individuals from interest groups and agencies including: industry; state government; local government; and the Western Australia conservation movement (Environment Australia 1999). A policy statement was developed based on a review in 1998 and a clear set of management objectives was established.

A series of task forces have been formed including the Dieback Working Group to implement improvements in practices, and the publication of four volumes of guidelines for management of *P. cinnamomi* (CALM 2000). In addition, there are numerous prescriptions and compliance audits (examples: Forest Management Plans; Regional and Park Management Plans; 10 year Forest Management Plan 1994-2003; and Regional Management Plans for conservation areas) (Environment Australia 1999). Objectives and guidelines have also been developed for local government by the Dieback Working Group (Lewis & Colquhoun 2000).

Management and research has been assisted in Western Australia by a high level of co-ordination between management authorities (CALM), researchers (Murdoch University) and industry (e.g. Alcoa). This is demonstrated by the extent of collaborative projects, research grants and management progress in the state.

In Western Australia CALM staff are involved in *P. cinnamomi* management at many levels and their roles are clearly defined (CALM 2000). These range from senior staff members to on-ground personnel including:

- A Dieback Coordinator who assists with policy development, develops and maintains management systems and guidelines, and delivers accredited training programs;
- A senior *P. cinnamomi* Interpreter who assists and advises on all aspects of the disease to staff; and
- Staff who have specific roles such as a dedicated Phosphite Action officer (CALM 2000).

Victoria

In Victoria, no strategic planning or statewide objectives have been formulated that apply across state jurisdictions. However there is a broad strategy for Parks and Reserves (Niewand *et al.* 1995).

The *Flora and Fauna Guarantee Act 1988* (Vic) has listed the use of *P. cinnamomi* infested gravel as a threatening process.

Current park management plans have a section briefly describing the occurrence of the pathogen and its threats, where appropriate. The Brisbane Ranges National Park Management Plan has extensive sections on *P. cinnamomi* management, dealing with the impacts of *P. cinnamomi* dieback on vegetation, guidelines for walking track management and lists of management options for track closures (Parks Victoria 1997). Specific objectives and operational guidelines relating to *P. cinnamomi* management practices have also been developed for the Brisbane Ranges National Park (Peters 1995). Management strategies relating to *P. cinnamomi* in Victoria can also be found in NRE Forest Management Plans (examples include NRE 1999, NRE 2000 & NRE 2001), which provide brief guidelines for best practice.

3.1.2 Best practice

- Support for development of an integrated approach to policy and planning, across all jurisdictions and land tenures, consistent with the NTAP.
- Development of a clear pathway of responsibility for *P. cinnamomi* management (from policy creation to implementation).
- Support for the development of a set of policies and objectives that applies to the state as a whole (freehold and public land); based on the Western Australian approach outlined in appendix one (The Management Objectives, CALM 2000).
- Support for the establishment of a Steering Committee (consistent with the NTAP State-based *P. cinnamomi* Threat Abatement Plan Implementation Team) to oversee policy and appoint working groups. This could comprise representatives of Parks Victoria, Department of Natural Resources and Environment (NRE), local government, universities, Alcoa and other industries.
- Appointment of working groups to develop guidelines and documents for implementation at state and local government levels.
- Development of an accreditation mechanism for assessors of *P. cinnamomi* based on the Western Australian approach.

3.2 Mapping, risk assessment and zoning

3.2.1 Overview

A key component for any strategy for management of *Phytophthora* dieback is to know where it occurs and which species and communities are threatened by the introduction of the pathogen.

3.2.2 Mapping

The distribution of *P. cinnamomi* in Australia has been assessed as locality points of infestation (Environment Australia 1999). Mapping the extent of disease caused by *P. cinnamomi* in Australia is considered to be a difficult goal to achieve. Autonomous and passive spread are constant processes that would make large-scale mapping inaccurate after a period of time (Environment Australia 1999). This is particularly the case in Western

Australia where large tracts of land are infested. Mapping is usually undertaken in Western Australia within 12 months of any operational activity (CALM 2000).

In Tasmania *P. cinnamomi* mapping has been limited to a broad scale distribution as points of infestation. Few detailed maps of an individual area have been created (Environment Australia 2001).

In Victoria, distribution mapping of *P. cinnamomi* has been undertaken in few parks or reserves, and in most cases only to a limited extent. Such mapping has been undertaken in the Brisbane Ranges National Park (Peters 1995) and initiated at Wilson's Promontory, Otway and Angahook-Lorne National Parks (Bluett 2001; Cahill *et al.* 2001a, b, c). Compared to Western Australia, the land area affected by *P. cinnamomi* in parks is currently restricted. Mapping *P. cinnamomi* distribution in individual parks and reserves is thus likely to be achievable if required for management purposes.

There have been a number of recent developments in the application of remote sensing to the analysis of forest health and of vegetation structure that may prove useful for mapping *P. cinnamomi* infestations over a broad scale. For example, high resolution videography obtained using low flying aircraft (Coops and Catling 1997) and the Compact Airborne Spectrographic Imager (CASI, Old and Stone 2002) that utilise multispectral imaging can resolve features on the ground less than one metre in size. Videography at two metre resolution and digital image analysis are being used to examine and map the distribution of *P. cinnamomi* in open forests and heathlands at Anglesea, Victoria (L. Gibson, Deakin University, *pers. comm*.). Global Information System (GIS) has been used with success to develop predictive models for *P. cinnamomi* distribution and to produce digital maps of occurrence (Environment Australia 1999, Wilson *et al*. 1997).

3.2.3 Risk identification and identification of management zones

The Western Australian management guidelines provide two different categories for risk identification, 'protectable' (see 2.4.1 above) and 'infested / unprotectable' (CALM 2000)

The objective in uninfested 'protectable' areas is to manage hygiene so that all humans are clean on entry to the area and avoid cross contamination from infested to uninfested areas. This approach is related to the large areas infested by *P. cinnamomi* in the state. Thus identification of protectable areas is done on a site-by-site basis when works are to be carried out, or entrance required.

In the management of 'infested / unprotectable' areas, CALM adopts management strategies that include development of a priority management system, the application of phosphite and hygiene measures on a case-by-case basis.

In Victoria, recommended risk ratings are based on plant communities (susceptible species) (Niewand *et al.* 1995). Procedures for protection of uninfested high-risk areas are provided in Niewand *et al.* (1995). The actual extent to which risk ratings have been applied in Victoria appears to be limited. Peters (1995) has listed six zones for management of the disease in the Brisbane Ranges.

The preliminary review of *P. cinnamomi,* of which this report is a part, includes identification of parks and reserves at risk across Victoria.

3.2.4 Best practice

- Statewide assessment of the distribution of susceptible values in parks and reserves and the potential distribution of the pathogen. Parks and reserves most at risk Identified.
- Mapping of the distribution of *P. cinnamomi* on a Park-by-Park basis, as has been done for the Brisbane Ranges. Priority given to those parks and reserves most at risk, that have the infestation and where management actions are programmed.

- Where symptoms of *P.cinnamomi* are apparent in high-risk areas, ensuring that tests for the disease are carried out to confirm that the pathogen is present.
- In high risk parks and reserves, identifying and mapping localities of threatened taxa and communities where the risk of infestation by *P. cinnamomi* is likely. Priority given to those parks and reserves where *P. cinnamomi* is known to occur.
- Management zones in high risk parks and reserves identified according to risk and presence of *P.cinnamomi* (appendix two).
- Management zones incorporated into relevant management plans and fire protection plans. Where necessary, access tracks, management activity and visitor use within certain zones changed.
- Focusing containment, planning, regulation, training and education on high risk parks.
- Accredited assessors used to undertake mapping, testing, planning, regulation, training and education work to provide consistency and accuracy across the state (CALM 2000).
- Monitoring the development of remote sensing and mapping technology where applicable to mapping the distribution of *P. cinnamomi.*

3.3 Research and monitoring

3.3.1 Overview

In a review of *Phytophthora* dieback in Western Australia (Podger *et al.* 1996) over half (18 out of 33) of the recommendations dealt with research that was required for *P. cinnamomi* management. In this review, areas of research that have been identified include the susceptibility of flora and fauna to *P. cinnamomi* and the susceptibility of threatened taxa and communities. In addition there is the need to evaluate management procedures to ensure that they are effective. The effectiveness and non-target impacts of phosphite as a treatment has mainly been studied in Western Australia and needs to be assessed in Victorian communities and conditions (Environment Australia 1999).

In Victoria, records are scattered and there is no comprehensive database in place based on a standardised reporting system. Niewand *et al.* (1995) provides guidance on monitoring of *P. cinnamomi,* including a protocol for testing and recording. A recent NRE community information pamphlet on *P. cinnamomi* (Griffith-Jones 2001) identified NRE laboratories at Knoxfield and Heidelberg as locations where testing can be undertaken.

The need for conservation of susceptible species *ex situ* is included in the NTAP (Environment Australia 2001)

3.3.2 Best practice

- Laboratory trials conducted to confirm the susceptibility of species observed to be affected by *P. cinnamomi* in the field. Assess threatened species/taxa as a priority.
- Systematic evaluation and quantitative assessment of the effectiveness of management guidelines and containment and hygiene procedures eg. Brisbane Ranges (see section 3.4.1 below).
- Undertaking research to assess the effect of the pathogen on animal habitats, threatened species and populations.
- Monitoring and mapping the spread of the pathogen, eg. Anglesea and Wilson's Promontory (see section 3.2 above).

- Establishment of a seed bank or tissue culture bank of threatened species susceptible to *P. cinnamomi.*
- Undertaking research to assess the effectiveness and non-target impacts of phosphite eg. continuation of trials at Anglesea and Wilson's Promontory.
- Undertaking research to assess approaches to the restoration or rehabilitation of susceptible species and communities damaged by *P. cinnamomi.*
- Review of the monitoring protocols of Niewand *et al.* (1995) and development of a standard method for recording and reporting *P. cinnamomi* occurrences that is supported across jurisdictions (see section 3.1.2).
- Identification of laboratories and personnel with expertise for identifying the pathogen in soil samples. These personnel should be capable of a high soil sample processing rate and capable of inputting or maintaining statewide records of occurrence.

3.4 Containment and hygiene

3.4.1 Overview

Reducing the spread of the pathogen is central to all existing *P. cinnamomi* management prescriptions. Procedures for containment and hygiene for management of *P. cinnamomi* in Australian native vegetation have been extensively developed over a number of years. It is believed that these have been effective, although there is no known information on systematic evaluation or quantitative assessment of the effectiveness of the procedures. Procedures are described in detail in all major documents and have been implemented to varying degrees across the states (CALM 2000; Lewis & Colquhoun 2000; Environment Australia 1999; DWG 1999; Niewand *et al.* 1995; Peters 1995).

3.4.2 Containment

Procedures for containment or quarantine of *P. cinnamomi* in Western Australia include a variety of approaches as described in detail in CALM (2000), Lewis & Colquhoun (2000) and Environment Australia (1999). These include: permanent or temporary seasonal closure of roads and walking trails with barriers; removal and rehabilitation of roads and walking trails where necessary; installation of board-walks or fences to control access; installation of adequate signage to alert road and track users and other visitors to the quarantine measures in place and education and information programs. Entry points are established and maintained to ensure all human vectors entering 'protectable' areas do so hygienically (CALM 2000). There are also regulations under the *Conservation and Land Management Act* (CALM Act 1984, WA) to control entry of persons into infested areas and to enforce this control (CALM 2000).

In Victoria, general containment or quarantine measures are similar and include closure of roads or walking tracks by installing gates or barriers to prevent vehicular or public access. Attachment of signs to gates is recommended to educate park visitors about quarantine measures in place (Niewand *et al.* 1995; Peters 1995). There is little evidence that these quarantine measures have been implemented in Victorian parks other than for the Brisbane Ranges National Park.

3.4.3 Hygiene

Hygiene measures covering planning and grading operations, drainage, gravel sources cleaning and disinfesting have been well developed over the last 20 years.

Planning and regulation

Regional plans to control *Phytophthora* dieback in Western Australia, South Australia and Tasmania are said to have had some success (Environment Australia 1999). Guidelines for preparing hygiene plans are utilised in Western Australia (CALM 2000). These plans support decisions made at every level of the containment and hygiene process. A district manager in consultation with an accredited assessor prepares the plan for an area. The plan enables managers to identify 'protectable' areas and then to determine for that area practical management boundaries, hygiene measures to minimise human transfer, and the efficacy of providing protection through application of phosphite.

There are also regulations under the CALM Act 1984 on the control of entry of persons into infested areas and the movement of materials around and through such areas (CALM 2000).

In Victoria, Niewand *et al.* (1995) recommends that the Area Parks and Reserves Manager (now District Chief Ranger) ensures that actions are taken to protect areas within a park that contain plant communities susceptible to *P. cinnamomi*. They propose that protection measures be determined in consultation with the Manager, National Parks and Reserves Branch (now Manager National Parks and Conservation Policy) and the Forest Pathologist.

Parks Victoria management plans provide for testing, monitoring and control of access where appropriate. The management plan for Wilsons Promontory National Park recommends the establishment of quarantine and hygiene procedures (Parks Victoria 2002). Peters (1995) provides a detailed operational guide to the management of *P. cinnamomi* in the Brisbane Ranges National Park and Steiglitz Historic Park, including management zones.

Vehicles, trackworks and roadworks

Road and track construction, drain construction and maintenance operations have a high risk of spreading *P.cinnamomi* as they often involve large movement of soil, water and vegetation (Lewis & Colquhoun 2000). In CALM (2000), Lewis & Colquhoun (2000), DWG (1999) and Peters (1995), there is extensive documentation of hygiene methods for grading operations, drainage and gravel sources, cleaning and disinfecting. All would be suitable sources for developing best practice guidelines.

Fire protection

Fire protection activities can lead to the spread of *P.cinnamomi,* such as through the movement of people and vehicles and grading of firebreaks and access tracks. Policies and procedures to manage this risk are identified in Niewand *et al.* (1995), Peters (1995) and CALM 2000.

3.4.4 Best practice

- Accredited assessors used to develop documentation and implementation strategies, in a statewide systematic process, including district, area or park specific hygiene plans (see above and a simplified plan framework in appendix three) or plans similar to Peters (1995).
- Rigorous application of containment and hygiene measures that have been developed in Victoria and Western Australia over the past 20 years (such as those in appendices four, five, six, seven & eight, based on Peters (1995) with additions in areas of cleaning and sterilizing, road closure, recreational use and fire protection from Western Australia (CALM 2000, Lewis & Colquhoun 2000, DWG 1999).

- Containment and hygiene measures in prioritised in parks and reserves that are identified as a high risk, are currently uninfested and in areas amenable to being protected from infestation in the long term (see section 2.4.1 above).
- Planting stock for revegetation programs sourced from *P. cinnamomi* free nurseries.

3.5 Treatment of existing infestations

3.5.1 Overview

The only viable control technique that has been identified for use in native vegetation to date is the chemical phosphite. Phosphite cannot be used indiscriminately as there is emerging evidence that there may be adverse effects on some species, at some concentrations (G. Hardy, Murdoch University, *pers. comm*.). Research in Western Australia and Victoria is continuing to investigate these effects. Phosphite is currently a major component of control strategies only in Western Australia but is not extensively used in Victoria. Strategies for its use, as described in Section 9 of CALM (2000) Vol 1, are as follows:

1. Develop and maintain a set of protocols founded on science and logic which:
    - Guide land managers in identifying threatened flora, threatened ecological communities and the habitat of threatened fauna that may benefit from the protection through phosphite application; and
    - May be used to establish realistic priorities for use of available resources.
2. Implement and monitor a program using scheduled applications of the protective chemical phosphite for protection of threatened flora, threatened ecological communities and the habitat of threatened fauna.
3. Refine and maintain appropriate management guidelines and training programs.

Aerial spraying of phosphite is used extensively particularly in remote parks e.g. Fitzgerald River National Park, located in the southwest of Western Australia. In other parks such as Sterling Ranges National Park, phosphite is used strategically in smaller areas.

At the local Government level in Western Australia commercial operators provide phosphite spraying services and guidelines.

The methodology and procedural guidelines for applying phosphite in the protection of native plants in the wild are described in detail in CALM (2000), Volume 3 'Phosphite Operations'. Detailed examples of its application, which include spraying and injecting methods, are also provided in Lewis & Colquhoun (2000). Phosphite provides only temporary protection and treatment needs to be ongoing (Lewis & Colquhoun 2000).

There is little reference to the use of phosphite for management of *P. cinnamomi* in park management plans or *P. cinnamomi* guidelines in Victoria.

3.5.2 Best practice

- Undertaking further research on the effects of phosphite and appropriate application levels, timing etc., targeting susceptible threatened flora, threatened ecological communities and the habitat of threatened fauna as a priority, to develop effective management techniques for the chemical control of *P. cinnamomi*.
- Development of detailed sets of procedures for application following Lewis & Colquhoun (2000) (appendix nine) and CALM (2000), Volume 3 'Phosphite Operations'.

- For those species or communities where it is confirmed to be safe and effective, phosphite included as a major component of any strategy for controlling *P. cinnamomi*.
- Accredited assessors used to implement phosphite use and application.

3.6 Restoration

3.6.1 Overview

Once the disease has passed through there is an opportunity to rehabilitate and revegetate affected areas. This approach has been applied to a very limited extent in Western Australia and Victoria.

In Victoria, limited revegetation and restoration has been undertaken in south and east Gippsland, where native eucalypts have been planted on severely damaged sites (Environment Australia 1999). There is little evidence that this approach results in reestablishment of susceptible species or is applicable to communities other than those dominated by eucalypts.

There is potential for vegetation restoration in combination with phosphite treatment. There has been little work in this area in either Western Australia or Victoria. Current research is ongoing (Colquohon *pers. comm*., Aberton *et al.* 2001a,b).

3.6.2 Best practice

- Approaches to rehabilitating infested areas are currently limited. Liaison between land managers and researchers should progress this area of management (eg. Alcoa Western Australia, Deakin University, Murdoch University).

3.7 Recreation and other uses

3.7.1 Overview

A wide range of recreation activities such as bushwalking, orienteering, trail bike and four wheel-driving are serious potential sources of *P. cinnamomi* spread and thus have been a focus for management.

In Western Australia, recreational activities are considered under the general guidelines for hygiene and containment (see section 3.4.2 above), with scope for recreational activities to be precluded from protected or quarantine areas. Procedures include temporary seasonal closure of roads and walk trails with barriers and signs; permanent closures and installation of adequate signage to alert road users of changes (CALM 2000, Vol 1; Section 7.5 to 7.7). Entry points are established and maintained to ensure, if human vectors enter 'protectable' areas, it is done hygienically. The number of entry points is minimised.

Sets of guidelines have been prepared for individual activities (e.g. horse riding, bushwalking and bike riding). A good example of a format for these guidelines is found in 'Managing Dieback in Bushland - A guide for landholders and community conservation groups' (DWG 1999, see appendix six) and also in 'Managing *Phytophthora* Dieback - Guidelines for local government' (Lewis & Colquhoun 2000).

Enforcement is an important aspect of control and Western Australia has regulations for its implementation (see 3.4.2 above). In addition, interpretation and education are considered important for management of recreation in *P. cinnamomi* affected areas (see section 3.9 below).

In Victoria there are no similarly targeted enforceable regulations. There are brief general references to recreational activities with limited guidelines provided (Niewand *et al.* 1995; Peters 1995; CNR 1994).

3.7.2 Best practice

- Rigorous application of containment and hygiene measures for recreation and other uses (road, campsite and track closures) based on existing guidelines (appendices five & six).
- Development and installation of appropriate signage.
- Accredited assessors used to develop specific hygiene plans (appendix three) for recreation types, together with educational material (see section 3.9.2 below).
- Accredited assessors used to assess the implementation of hygiene and containment measures associated with recreation.

3.8 Staff training

3.8.1 Overview

In Western Australia CALM staff involved in *P. cinnamomi* management at many levels are involved in interpretation and training (CALM 2000). The Senior Dieback Co-ordinator, who assists with policy development, creates and maintains management systems and guidelines and delivers accredited training programs. The Senior *P. cinnamomi* Interpreter assists and advises on all aspects of the disease and the dedicated Phosphite Action Officer also plays a role (CALM 2000). There has been extensive development of training courses and curricula for staff involved in *P. cinnamomi* management (CALM 2000, Vol 4).

At the local government level a nationally accredited *P. cinnamomi* Dieback course has also been developed. The training course includes specific learning outcomes and assessment criteria, session plans, a three-hour information session and comprehensive course notes (Lewis & Colquhoun 2000).

In Victoria, *P. cinnamomi* management is currently undertaken at a park level by individual rangers under the responsibility of the District Chief Ranger using the general guidelines (Niewand *et al.* 1995). In the Brisbane Ranges National Park specific guidelines have been developed (Peters 1995). There are no formal training procedures.

3.8.2 Best practice

- Staff training based on programs such as the nationally accredited training course used in Western Australia.
- Appropriate staff trained as accredited assessors
- Information, interpretation and staff training disseminated by designated and qualified staff.
- Improved operator and industry training in *Phytophthora* dieback management, especially hygiene and quarantine, as proposed in the NTAP (Environment Australia 2001).
- The issue of *P. cinnamomi* management addressed in fire protection and fire suppression training.

3.9 Community education and information

3.9.1 Overview

Public education is considered essential in all states where *P. cinnamomi* is a problem (Environment Australia 2001). The success of the NTAP will depend on a high level of cooperation between all those with an interest in *P. cinnamomi* dieback including management agencies, landholders, community groups and the public. It is to be noted that use and development of adjacent land, such as the development of roads and tracks, and ploughing of firebreaks along boundaries may contribute to the spread of *P. cinnamomi* in parks and reserves. The NTAP includes the development of community education programs at the state level.

In Tasmania, a public education program has included leaflets, posters, TV and meetings with stakeholder groups. In Western Australia public education has been continuous and thorough over a long period of time through pamphlets, TV and other media exposure. Signage and quarantine measures in place for a decade or more have resulted in many Western Australians being fully aware of the pathogen, its effects and threats.

In Victoria, education for the public has relied on a pamphlet (CNR 1994) based on a Tasmanian example (D. Peters, Parks Victoria, *pers. comm.*) limited signage (Environment Australia 1999) and a recent Land for Wildlife Note (Griffith-Jones 2001).

3.9.2 Best practice

- Development of a *P. cinnamomi* community education plan.
- Production of updated pamphlets, posters, articles, and signage, focussed on high risk parks and reserves and at targeted user groups, landholders, community groups and local government (see section 3.7.2 and appendix six).
- Accredited assessors used to undertake liaison with relevant stakeholders (for example road authorities & neighbouring landholders) for high risk parks.
- Monitoring of the effectiveness of community education programs.
- Development of community education programs in co-operation with local government and universities.

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APPENDIX ONE

Management objectives (CALM 2000)

- Progressively identify uninfested 'protectable' areas and manage human access to them so that the role of humans as vectors in establishing new centres of infestation is reduced to the lowest possible level,
- Manage already infested and 'unprotectable' areas in a manner which sustains an appropriate level of environmental and social benefits,
- Implement, as a component of broader management programs to protect threatened flora, threatened ecological communities and the habitat of threatened fauna, a program for the use of the protective chemical phosphite,
- Implement programs of interagency research and liaison which are closely linked with:
    - management requirements; and
    - other Western Australian, interstate, Commonwealth and international institutions involved in research and management on *Phytophthora.*
- Encourage community interest and participation particularly through support of the Dieback Consultative Council (DCC) and its prospective Regional Coordination Groups.

(CALM 2000, Vol 1; section 5.4).

APPENDIX TWO

Management zones (Peters 1995)

- **Disturbed sites of low conservation value:** represent cleared and disturbed areas.

  Disease control measures are not necessary within area. However, machinery must be washed before moving into uninfested areas.

- **Infested sites:** identified by disease symptoms such as yellow colouring of leaves, browning and dieback of branches, remains of dead vegetation and/or identified through soil and root testing.

  Restrict activities where the movement of soil or gravel is likely to cross into healthy vegetation. Machinery to be washed before moving into uninfested zones. Drainage from these areas to be monitored, controlled or disinfected.

- **Uninfested low-risk sites:** where disease is restricted by relatively fertile soils and the vegetation generally not susceptible to infection.

  No infested gravel may be used. Hygiene measures apply. No need to undertake quarantine measures.

- **Uninfested moderate-risk sites:** where disease severity is limited by soil type and where the vegetation communities are slightly susceptible.

  No infested gravel may be used. Hygiene and quarantine measures are necessary. Minimise the movement of soil or gravel along roads, roadsides and tracks.

- **Uninfested high-risk:** where the vegetation is susceptible and where the disease could have irreversible ecological consequences.

  No infested gravel may be used. Strictly adhere to hygiene and quarantine measures. Avoid new construction works, such as widening the road, and prevent the movement of soil or gravel along roads, roadsides and tracks.

- **Special sites:** including uninfested high-risk sites of unique ecological significance and which are susceptible to infection.

  Manage as for uninfested high-risk sites, but discourage and restrict access to vehicles, machinery and the public at all times. Where practical, adopt alternatives to the use of machinery for fire suppression or develop control lines remote from these sites.

APPENDIX THREE

Outline Hygiene Management Plan (simplified framework from CALM 2000)

PHYTOPHTHORA CINNAMOMI HYGIENE PLAN DISTRICT PLAN IDENTIFICATION NUMBER: _____	
PROJECT TASK NUMBER: _____	District: SF Block: Occurrence Map ID: _____

Prepared by:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

'PROTECTABLE' AREAS AND THEIR BOUNDARIES :		
(PRINT NAME)	**(SIGNED)**	**(DATE)**

APPROVAL OF 'PROTECTABLE' AREAS:			
The 'protectable' areas and their boundaries are approved.			
District Chief Ranger:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

ACCESS CONTROL AND HYGIENE MEASURES:				
a) List the access control and hygiene measures required to minimise human vectoring of *Phytophthora cinnamomi* into the 'protectable' areas, and b) Prepare and attach a *Phytophthora cinnamomi* Hygiene Management Map that records the details specified in this plan.				
HYGIENE MEASURES (What will be done)	MAP LOCATION (Use legend in management guidelines)	WHEN (Target date)	WHO (Name of the accountable person for EACH TASK)	COMPLETED (Date and initials)
1. Hygiene Eg 'protectable' areas where 'clean on entry' rules apply etc.				

2 Roads Eg Roads to be closed permanently before other activities commence etc.				
3. Entry Points 3.1 Gates required 3.2 Daily gate closure 3.3 Signs required 3.4 Turn around point for trucks required 3.5 Cleandown point to be constructed etc.				
5. Briefings Required				
6. Other- Please Specify				

PHYTOPHTHORA CINNAMOMI HYGIENE PLAN RECOMMENDED FOR APPROVAL**:**		
Attachments**:** Tick (✓) the items that have been completed and attached.		
Phytophthora cinnamomi Hygiene Management Map ✓ Sign Management Checklist ✓ Specifications for road closures ✓ Record of entry into 'protectable' area		
District *Phytophthora* Management Coordinator:		
(PRINT NAME)	**(SIGNED)**	**(DATE)**

APPROVAL:			
I certify that this *Phytophthora cinnamomi* hygiene plan adequately protects the nominated areas and that the hygiene measures can be uniformly applied for all activities within the 'protectable' areas. This plan is approved for implementation.			
District Chief Ranger:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

SIGNAGE REQUIREMENTS FOR: (BLOCK NAME)	
1. Sign Type/Name of Sign	**Number Required**
S1 Clean on Entry	
S2 Clean on Entry. Do not pick up and move soil.	
S3 Control and eradication of Forest diseases.	
S4 Gate warning sign.	
S5 Road closed.	
S6 Cleandown point	
S7 Other- Specify. (Eg) Boot clean down point *Phytophthora cinnamomi* information panels	

2. Sign Ordering			
To be ordered by:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

3. Field Details (Sketch details of field placements; add pages as required)

4. Sign Placement and Removal Checklist					
SIGN ID	ERECTED BY	DATE	REMOVAL Yes/No & When	REMOVED BY	DATE

PHYTOPHTHORA CINNAMOMI HYGIENE PLAN—REVIEW CHECKILST			
1. DETAILS			
District		Plan ID's	
Review conducted by:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

2. OFFICE IMPLEMENTATION Tick (✓) the appropriate box when inspection completed		COMPLIES	ACTION REQUIRED	NOT APPLICABL
2.1	Correct version of *Phytophthora cinnamomi* Hygiene Plan form used			
2.2	Map attached to plan			
2.3	All sections signed before access occurred			
2.4	DCR authority issued			
2.5	Original *Phytophthora cinnamomi* Hygiene Plan available at DHQ			
2.6	Copies held all activity managers			
2.7	Amendments recorded and communicated effectively			
2.8	Analysis of 'protectable' areas and their boundaries correct			
2.9	Table 2. Hygiene Guidelines for 'protectable' areas minimised			
2.10	Reason for retaining and/or building roads correct			
2.11	New roads in/into 'protectable' areas minimised			
2.12	Effective road closure specified — standards, timing, responsibility			
2.13	Minimum number of entry points specified			
2.14	Entry points correctly sited on map			
2.15	Entry point details correct— gates, signs, turn-around, cleandown point			
2.16	Accountability for gate closure assigned			
2.17	Culvert, bridge, causeways correctly specified			
2.18	Correct work sequence specified			
2.19	Briefings adequately specified and accountability assigned			
2.20	All hygiene tasks completed on time and initialled as completed			
2.21	Local review adequately specified and completed, results applied			
2.22				
2.23				

3. FIELD IMPLEMENTATION Tick (✓) the appropriate box when inspection completed		COMPLIES	ACTION REQUIRED	NOT APPLICABLE
3.1	Entry point correctly sited for effluent control			
3.2	Vehicles not re-infested before entering 'protectable' areas			
3.3	Gates installed correctly, on time and being closed			
3.4	Signs installed on time			
3.5	Turn around point installed and being correctly used			
3.6	Cleandown point installed on time and to standard			
3.7	Cleandown or inspection occur to standard			
3.8	Effective road and sign track closures completed on time			
3.9	Briefings completed on time, copy of plan provided			
3.10	Split-phase appropriate, barriers effective and correctly located			
3.11	Demarcation tapes/blazes effective and correct colour			
3.12	Hygiene guidelines for 'protectable' areas (Section 7.6) correctly applied			
3.13	Compliance being effectively measured and recorded			

4. ACTIONS				
ITEM	DESCRIPTION OF ACTION TO BE TAKEN	**ACTION BY (Name)**	**DATE ACTION REQUIRED**	**INITIALS & DATE COMPLETED**

5. CLOSE OUT			
5.1 District manager provided with a copy of the review (circle)		YES	No
5.2 District Manager's acknowledgement			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**
5.3 Contractor/Operator/Coup OIC provided with copy of completed checklist (circle)		YES	**No**

RECORD OF ENTRY INTO A PROTECTABLE AREA			
I agree to implement the *Phytophthora cinnamomi* hygiene measures applicable to the activities I manage within the 'protectable' areas described in this plan.			
1. Activity:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

2. Activity:			
	(PRINT NAME)	**(SIGNED)**	**(DATE)**

APPENDIX FOUR

Containment (Niewand *et al.*1995)

- Quarantine the affected area by restricting access either permanently or seasonally or by relocating roads and tracks (including walking tracks and horse trails);
- Install boardwalks or fencing, improve drainage and surface tracks etc. to minimise potential spread;
- Prevent movement of infected plants and infested soil by NRE/Parks Victoria and where possible, other agencies, user groups and adjoining landholders;
- Determine the extent and potential spread of the disease (e.g. map the distribution of infected plants and drainage lines);
- Where feasible, redirect any water source flowing into and out of the diseased area;
- Restrict recreational activities likely to contribute to the spread of the fungus;
- Manipulate fire protection and silviculture measures;
- Erect warning signs to discourage public access;
- Undertake chemical treatment of soils;
- Undertake regeneration procedures applicable to the affected vegetation community; and
- Minimise spread by education/interpretation (e.g. by using brochures, information boards and signs) directed at parks Victoria/NRE staff, other Government agencies, municipalities, user groups (including visitors), adjoining landowners and the general public as appropriate.

Road closures (CALM 2000)

At road closures and access control points vehicle turnarounds should be considered (Figure 7.5.3, CALM 2000).

Temporary road closures are best affected using a system of gates and signs. Gates must be designed to be easily readily visible to oncoming vehicles. Signs that provide clear information and guidance to potential road users must be installed with all gates.

In some bush operations it may be appropriate to place logs over roads as a method of temporary closure. Line off sight and safety aspects must be evaluated when using this method.

APPENDIX FIVE

Hygiene measures for vehicles, trackwork and roadwork (Peters 1995)

Planning operations

- Ensuring no new roads and tracks are constructed along uninfested ridges.
- Minimising the movement of gravel and soil during road works, track maintenance and fire protection. The more soil that is moved, the greater the risk of creating a new site of infection. Operations that do not disturb the soil are preferable. Where practical, roads should not be widened.
- Carrying out operations under dry soil conditions. Wet soil tends to cling to vehicles and transport the fungus. By planning ahead, this can be achieved. Avoid creating wet conditions during operations.
- Segmenting the operation between clean and infested area. Cleaning down machinery is essential when moving into an area that abuts healthy vegetation.
- Using vehicles that can be easily cleaned in operations, for example, rubber tyre machinery are easier to clean than track machines.
- Co-operation between agencies and functions, where necessary, by sharing equipment and resources to ensure hygiene standards are maintained (e.g. Use of CFA fire tanker to wash down machinery)
- Using contract machinery to increase the amount of work that can be achieved during favourable conditions.

Grading operations

- Grading should be kept to the minimum frequency required to maintain the condition of the pavement formation. Gravel roads, tracks and road shoulders should not be graded beyond the pavement formation.
- Grading of batters is to be avoided as it increases movement of contaminated soil along roads, tracks and vegetation boundaries from which disease can spread. Slashing or mowing is a preferred method of maintaining roadside batters and road shoulders because soil disturbance is minimised.
- Remember to segment grading operations between clean and infested areas and to clean down machinery moving into an area that abuts healthy vegetation.
- Avoid creating windows abutting vegetation on the road shoulder during grading and maintenance operations or when cleaning table drains.
- Prevent the spread of spoil over roadside vegetation. Direct the spoil onto or towards the road pavement where it can be removed and transported to a designated disposal site and not used in future operations.

Drainage

- Improve the drainage of the road or track by covering wet areas or filling in puddles with disease free coarse material that will consolidate the surface.
- Regularly maintain or improve drains so that they are less likely to flood and spread infested drainage water.

- Avoid installing or relocating culverts and roadside runoff or 'cutoff' drains where they will direct drainage water into disease free areas.
- Culverts or drains should be cleaned during dry conditions when soil is less likely to cling to tools and machinery.
- When maintaining drainage lines or table drains, direct the spoil onto or towards the road pavement where it can be removed and transported to a designated disposal site and not used in future operations.

Gravel sources

- Only use fungal free material in disease free areas or infested material in infested areas. Test all sources of material for disease if it is to be used in uninfested high-risk and special sites.
- Highlight on a map those stockpiles infested and those that are free of the fungus. Test stockpiles of uninfested material regularly (at least annually) to ensure that they have remained free of the fungus. Every effort should be made to ensure that material remains clean.
- Work quarries and pits from the down slope edge so that any introduction of the fungus does not infest the whole resource.

Management vehicle tracks

- Ensure vehicles are clean before entering management tracks, particularly in special sites or where vegetation along the track is healthy. Wash down vehicles before entering such tracks if necessary.
- Prevent transportation of infested soil and gravel. Where practical management vehicle tracks should not be graded.
- Gravel to be used in track surfacing or maintenance must be free of *P.cinnamomi.*

APPENDIX SIX

Hygiene measures for recreation (Peters 1995, DWG 1999)

Boots, gear such as tents, tent pegs, toilet trowels, recreational vehicle tyres and animals have the potential to carry infested soil that can spread disease. Thus:

- Start a visit with clean equipment and vehicles.
- Prohibit off-track activities such as orienteering in high risk and special sites.
- Orienteering events should be carefully planned and restricted to dry weather and ground conditions. Avoid or cancel events during wet weather or when soils are wet.
- Avoid wet weather and wet areas.
- Leave a campsite with clean gear.
- Encourage park visitors to remain on the tracks; and
- Encourage park visitors to adopt hygiene measures

Guidelines for bushwalkers (DWG 1999)

Unfortunately the enjoyable pastime of bushwalking can contribute to the spread of *P. cinnamomi*. However, responsible bushwalkers can ensure they do not contribute to the spread of the fungus. If you are planning to bushwalk in your local bushland reserve, in state forest or in a National Park, you can minimise the risk of spreading the fungus by following these guidelines.

- Contact CALM or the local Council for suitable bushwalking areas.
- Keep to tracks.
- Avoid muddy areas.
- Make sure your footwear is free of all mud and soil when arriving at a bushwalking site, and try to keep your footwear as clean as possible during the walk.
- Sterilise footwear when entering high value bushland or when leaving dieback infested areas.
- Use footbaths or shoe cleaning facilities when provided.
- Obey 'track closed' signs.
- Make sure your vehicle is clean when arriving at bushwalking sites.
- Park your car in designated car parks.

Regular bushwalkers may find it useful to carry equipment in their packs and/or vehicle to help keep their footwear clean. A 'bushwalking hygiene kit' should contain a bag to collect scraped off soil and mud, large and small brushes and a bottle of water (from Mains supply). Methylated spirits applied using a spray bottle, is an easy way to sterilise the soles of shoes.

Guidelines for cyclists (DWG 1999)

Bike tyres can pick up soil and mud, and therefore contribute to the spread of *P. cinnamomi*. To minimise this risk, cyclists should follow these guidelines.

- Contact CALM or the local Council to find out areas suitable for cycling.
- Stay on tracks.

- Avoid riding your bike following rain and when the soil is wet.
- Avoid muddy areas and puddles.
- Ensure that your bike is free of mud and soil (on the frame and tyres) when you begin your bike ride.
- Do not enter areas that have been closed off to bike riders.
- Do not enter declared CALM Disease Risk Areas and obey 'track closed' signs. (It is illegal for bicycles to enter Disease Risk Areas).

Guidelines for horse riders (DWG 1999)

Horse riding is a popular activity, particularly in rural and bushland areas. Unfortunately, horse riding can contribute to the spread of *P. cinnamomi* by picking up soil in the horses hooves. To minimise the risk, horse riders should follow these guidelines.

- Contact CALM or the local Council to find out areas where horse riding is appropriate.
- Avoid riding in bushland areas, particularly following rain or when the soil is wet.
- Avoid muddy areas and puddles.
- Obey signs that specify no horse riding.
- Stay on tracks.
- Ensure that your horse's hooves are clean before entering bushland.
- Do not enter declared CALM Disease Risk areas and obey 'track closed' signs. (It is illegal for horses to enter 'Disease Risk Areas').

APPENDIX SEVEN

Cleaning and sterilising (CALM 2000, Lewis and Colquhoun 2000, Peters1995)

- Cleaning is easier and more effective if completed at a depot or permanent/designated cleaning area.
- Try to remove soil and mud when it is dry.
- Remove as much mud and soil as possible with a brush and minimise the amount of water used.
- Ensure vehicles, machinery, hand tools, equipment and boots are cleaned and disinfected before entering uninfested high-risk areas.
- Wash vehicles and machinery thoroughly with a high-pressure hose to remove clods of earth, gravel and root material. Pay particular attention to mud flaps and tyres, the underside of machinery, inside sump guards and belly plates, inside tractor wheels and all track gear.
- Wash down on a hard, well-drained surface (for example a road), and on ramps if possible.
- Do not allow mud and wash-down effluent to drain into bushland.
- Do not drive or walk through wash-down effluent.
- Consider the development of a mobile cleaning plant for vehicles (D. Peters, Parks Victoria, *pers. comm*.).

In most cases, removing all mud and soil from vehicles, machinery and equipment is sufficient to minimise the risk of spreading *P. cinnamomi* (DWG 1999). The extra precaution of sterilising tools and equipment is advised when entering high-risk areas. Hot water at 50^0 C will kill *P.cinnamomi* or equipment can be disinfected using 1% solution of 'quarternary ammonium compound' or 'hypochlorite' (household bleach) in water. Methylated spirits in a spray bottle is convenient.

Clean-down specifications

An object (boots, vehicles, plant, or equipment) is judged to be free of soil and plant tissue, which may be infested with *P.cinnamomi*, when a visual inspection by an authorised officer reveals that it is free of a build up of:

- Clods of soil and/or
- Slurry consisting of soil and water.

Dust and grime adhering to the sides of vehicles need not be removed before entering an infested area.

Field clean-down point – construction and location standards

All clean-down points will be inspected and approved by an authorised officer. An approved clean-down point will meet the following minimum standards.

Construction standards

- Provides physical separation between the object being cleaned and the effluent being produced.

- Provides physical separation from the object being cleaned and infested soil and plants.
- Provides easy and safe access for both the placement of the object to be cleaned and for the person conducting the clean-down.

Field Location Standards

- Sited for safe entry and departure of vehicles and plant
- Sited either to allow effluent to fall directly onto infested soil or is constructed to capture effluent for later transport and correct disposal.
- Sited to enable cleaned objects to enter uninfested areas without becoming re-infested.

APPENDIX EIGHT

Fire protection and wildfire (CALM 2000, Peters 1995)

- Use existing tracks, instead of creating new control lines through healthy vegetation, for the purposes of prescribed burning or firefighting where possible.
- Where practical, confine the movement of vehicles and machinery to formed tracks
- Keep vehicle movement to a minimum, use hand tools wherever possible.
- The uses of rubber tyre machines are preferable to machines with tracks, as they are easier to clean and soil disturbance can be minimised.
- Mowing, slashing or herbiciding to maintain control lines should be encouraged in preference to methods that disturb the soil such as dozing or grading.
- Construct firebreaks to shed water and dry quickly.
- Complete construction and maintenance of firebreaks during dry soil conditions.
- Select strategic breaks that are low in the landscape.
- Nominate cleandown points for incoming and outgoing plant and vehicles.
- Treat water or use bore or scheme water for fire suppression whenever possible.
- Training programs should address *P. cinnamomi* issues.
- Post fire rehabilitation should be planned and implemented incorporating *P. cinnamomi* hygiene measures (D. Peters, Parks Victoria, *pers. comm*.).

APPENDIX NINE

Protecting vegetation - phosphite application (Lewis and Colquhoun 2000)

If the location of infestation is known:

Priority 1 - Treatment of listed susceptible flora, or flora of significance to the reserve.

Priority 2 – Treatment of all vegetation within 5 metres downslope of the infestation edge.

Priority 3 – Treatment of all vegetation within 5 metres of the infestation edge.

Priority 4 – Treatment of significant susceptible vegetation.

Priority 5 – Treatment of susceptible vegetation located 5 metres either side of all access tracks located in the uninfested part of the bushland.

Priority 6 – Treatment of all vegetation in the uninfested part of the bushland.

Priority 7 – Treatment of susceptible vegetation in the infested part of the bushland.

If the location of infestation is unknown:

Priority 1 – Treatment of listed susceptible flora, or flora of significant to the reserve.

Priority 2 – Treatment of vegetation within 5 metres downslope of any dead/dying vegetation.

Priority 3 – Treatment of all vegetation within 5 metres of any dead/dying vegetation.

Priority 4 – Treatment of vegetation within 5 metres of the bushland boundary.

Priority 5 – Treatment of all susceptible vegetation located 5 metres either side of all access tracks.

Priority 6 – Treatment of vegetation within 5 metres of tracks/paths which pass through the bushland.

Priority 7 – Treatment of all susceptible vegetation in the bushland.

Spraying will provide 2-3 years protection and injection will provide 3-5 years protection.

See Lewis and Colquhoun (2000 appendix 4) for details of methods and equipment.