City of Joondalup
Pathogen Management Plan
2018-2028

Image: Trees with Suspected *Phytophthora* within Granadilla Park, Duncraig

Acknowledgements

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Please formally acknowledge the City of Joondalup if you choose to use any of the content contained within the *Pathogen Management Plan 2018-2028*.

Suggested citation:

City of Joondalup, 2018, *Pathogen Management Plan 2018-2028*, Joondalup, WA.

Contents

Acronyms

Abbreviation	Definition
Armillaria	*Armillaria luteobubalina*
the City	City of Joondalup
CoJ	City of Joondalup
DBCA	Department of Biodiversity, Conservation and Attractions
DIDMS	Dieback Information and Delivery Management System
DIG	Dieback Information Group
DRF	Declared Rare Flora
GIS	Geographic Information System
KPI	Key Performance Indicator
NAIA	Natural Area Initial Assessment
NIASA	Nursery Industry Accreditation Scheme Australia
P.	*Phytophthora*
PEC	Priority Ecological Community
TEC	Threatened Ecological Community
WA	Western Australia

1.0 Introduction

The City of Joondalup ('the City') is situated along the Swan Coastal Plain, with the Joondalup City Centre being located 30 kilometres from the Perth Central Business District. The City covers an area of 99 square kilometres which encompasses a diverse range of natural areas including 17 kilometres of coastal foreshore, a chain of wetlands and a variety of bushland ecosystems.

The City's southern boundary is located approximately 16 kilometres from the Perth Central Business District, and is bounded by the City of Wanneroo to the east and north, the City of Stirling to the south, and the Indian Ocean to the west.

There are a number of regionally, nationally and internationally significant natural areas located within the City including the Yellagonga Regional Park and a number of Bush Forever sites which contain vegetation communities and species of high conservation value. Significant natural areas adjacent to the City include the Neerabup National Park and the Marmion Marine Park. The City is also located within the south-west of Western Australia (WA), one of 35 international biodiversity hotspots, with over 2,900 endemic plant species occurring in this region.[1]

The City manages over 500 hectares of natural bushland in 108 bushland reserves containing significant flora and fauna species and ecological communities. The City also manages over 260 parks as well as a substantial number of urban landscaping areas such as streetscapes, pedestrian access ways, sumps and swales.

Pathogens are plant diseases caused by organisms such as water moulds, fungi, bacteria and viruses. Whilst some pathogens are naturally occurring within soil populations, others have been introduced to the environment through the movement of plant materials and soils.

The conditions that are favourable for the growth and survival of pathogens are different for each species of pathogen but are related to:

- soil pH
- soil water content
- soil oxygen level
- nutrient levels in soil
- the activities of other soil organisms.[2]

The symptoms produced by plants that are affected by pathogens vary depending upon the species of pathogen, host species, environment and climatic conditions. Some pathogens can cause rapid death of plants whilst others result in a slow, perennial decline in health.

Vegetated areas within the City are at risk from pathogens which poses a serious threat to the biodiversity within the City's parks and bushland areas. Effective pathogen management is required to ensure that measures are taken to mitigate the effects and limit the spread of pathogens within the City.

[1] Conservation International, 2014
[2] Dieback Working Group, 2000

1.1 Purpose of the Plan

The *Pathogen Management Plan 2018-2028* has been developed to protect native vegetation and ecosystems within the City. The Plan identifies pathogen risk factors, prioritises natural areas for pathogen management and identifies key management actions to protect the City's biodiversity values.

The Plan provides guidance on the management of pathogens within the City to minimise the risk of pathogen introduction and spread. Strategies to engage the community and key stakeholders in order to raise the awareness of pathogens within the City of Joondalup are also identified within the Plan.

The *Pathogen Management Plan 2018-2028* builds upon achievements from the *Pathogen Management Plan 2013-2016* (see Section 1.4). A key achievement of the *Pathogen Management Plan 2013-2016* is the extensive research undertaken to identify areas of pathogen infestation within the City. The *Pathogen Management Plan 2018-2028* will utilise this knowledge, with a key focus of on-ground pathogen treatment.

1.2 Objectives

The objective of the *Pathogen Management Plan 2018-2028* is to protect biodiversity values within the City by minimising the risk of introducing and/or spreading pathogens including species of *Phytophthora, Pythium* and *Armillaria luteobubalina (Armillaria)* within landscaped and natural areas.

The *Pathogen Management Plan 2018-2028* includes the following:

- Outline of key activities which may increase the risk of introducing or spreading pathogens, current controls and further management actions required.
- Identification of reserves of high conservation value that are threatened by pathogens and where management actions should be prioritised.
- Details of management actions to be implemented by the City to reduce the introduction or spread of pathogens in natural areas, parks and urban landscaping areas.
- Outline of an education program to raise the awareness of pathogens within the organisation and the community.

1.3 Scope

This Plan focuses on pathogen management within City managed natural areas and parks, rather than urban landscaping areas, as these sites have the highest biodiversity values. The Plan excludes land not managed by the City such as natural areas managed by other government agencies or landholders and private property.

The Plan also focuses on management actions related to City operations on City owned or managed land undertaken by City staff, contractors and volunteers, rather than external parties such as Utilities or private developers. The City recognises that pathogens may be introduced or spread through external party activities.

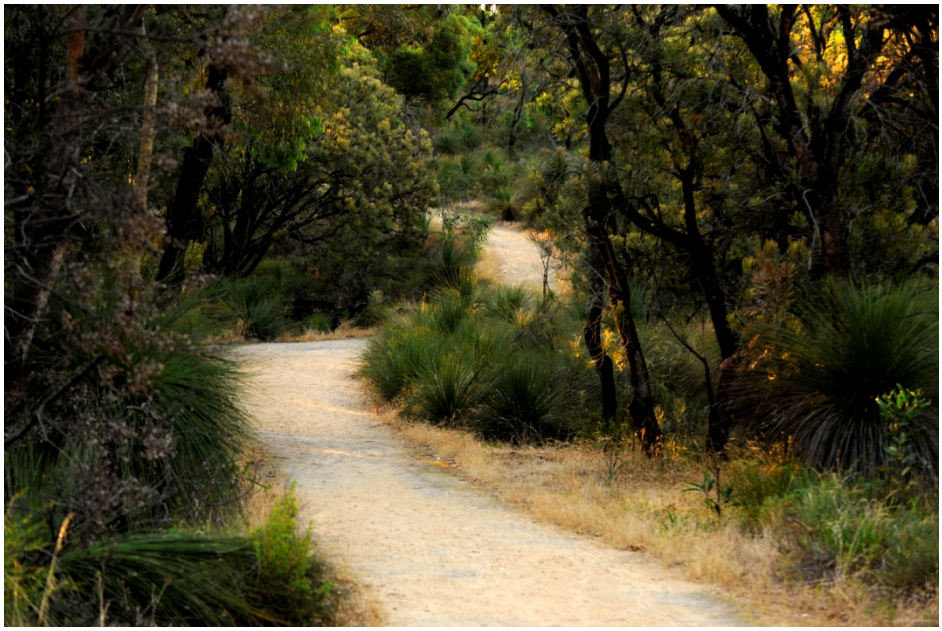

Figure 1: Shepherds Bush Reserve, Kingsley (currently no pathogens have been identified on site)

1.4 Pathogen Management Plan 2013-2016

The *Pathogen Management Plan 2013-2016* was developed to protect biodiversity values within the City from pathogens, establish the level of risk of pathogens within City parks and natural areas and identify areas of high risk where management actions were to be concentrated. The Plan included:

- Desktop assessment of parks and natural areas to establish the level of pathogen risk.
- Development of preventative and management strategies to be implemented.
- Identification of control and treatment measures for infested areas.
- Development of an education program to raise the awareness of pathogens within the organisation and the community.

From 2013 to 2016, the City has implemented recommended projects in the *Pathogen Management Plan 2013-2016* in accordance with the Implementation Schedule. Key achievements are outlined in Appendix 1.

The *Pathogen Management Plan 2013-2016* focussed on establishing the extent of pathogens within the City and provided the management strategies required to prevent pathogen spread. The *Pathogen Management Plan 2018-2028* utilises field results and data obtained through the implementation of the *Pathogen Management Plan 2013-2016* to further progress pathogen management strategies, in particular pathogen prevention actions and the treatment of infected areas.

1.5 Strategic Context

The aim of the Pathogen Management Plan aligns with the City of Joondalup Strategic Environmental Framework outlined in Figure 2. Details of the relevant City plans are included in Appendix 2.

Figure 2: City of Joondalup Strategic Environmental Framework

2.0 Pathogen Descriptions

2.1 *Phytophthora*

Phytophthora is a water mould which attacks the roots of living plants causing them to rot. The rotting weakens and kills the plant by limiting or stopping the uptake of water and nutrients, as detailed in Figure 3. It can be spread in water, soil or plant material and favours soil that is warm or moist.[3]

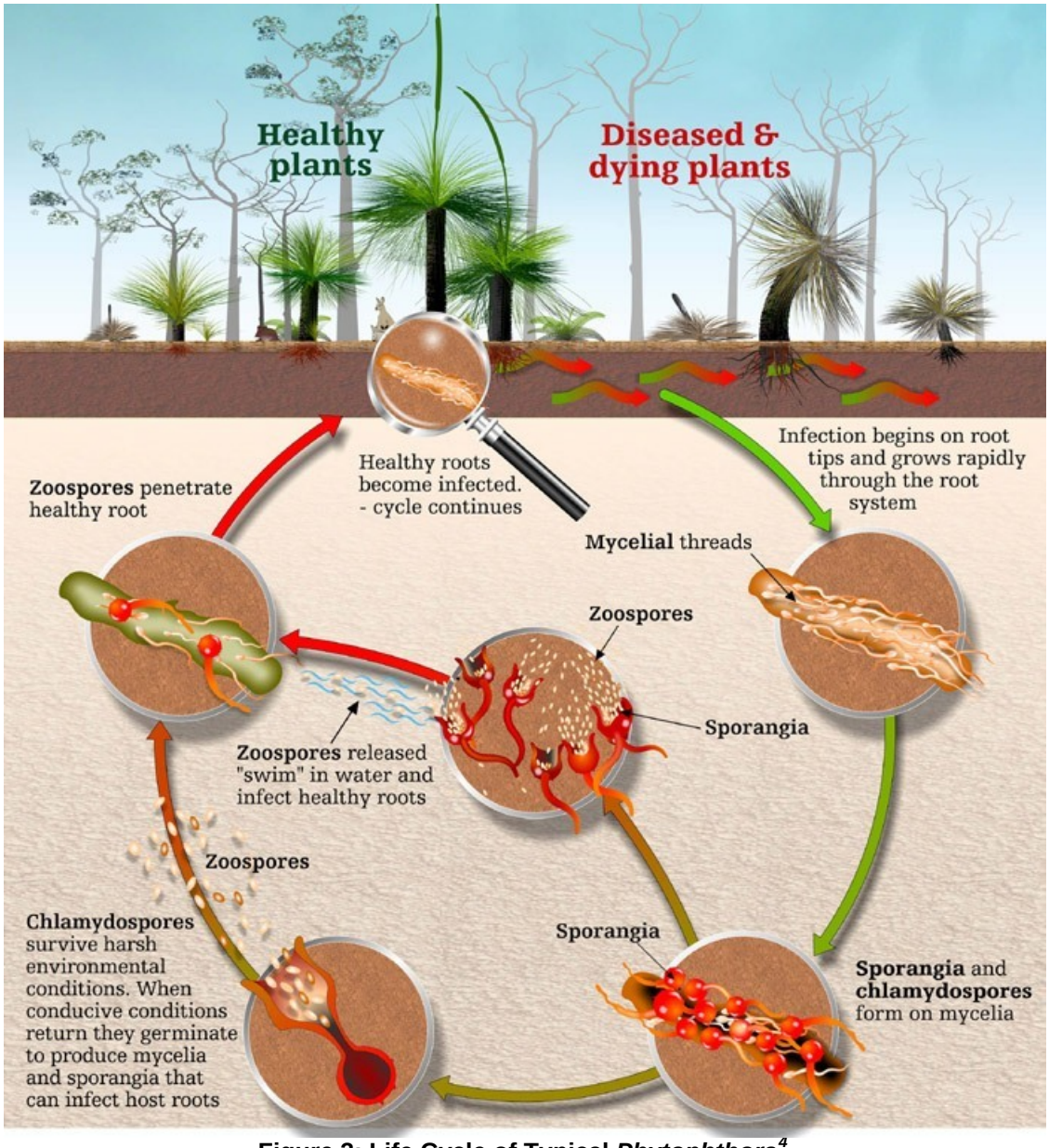

Figure 3: Life Cycle of Typical *Phytophthora*[4]

There are over 140 species of *Phytophthora* and an increasing number of different *Phytophthora* species continue to be identified in WA, some of which have been identified within the City of Joondalup.[4] Figure 4 shows the distribution of *Phytophthora* within the south-west of WA.

[3] Department of the Environment, 2014
[4] Dieback Working Group, n.d.

At present there are no reliable means for the complete eradication of *Phytophthora*. Prevention is more effective and economical than implementing control methods once pathogens have been introduced.

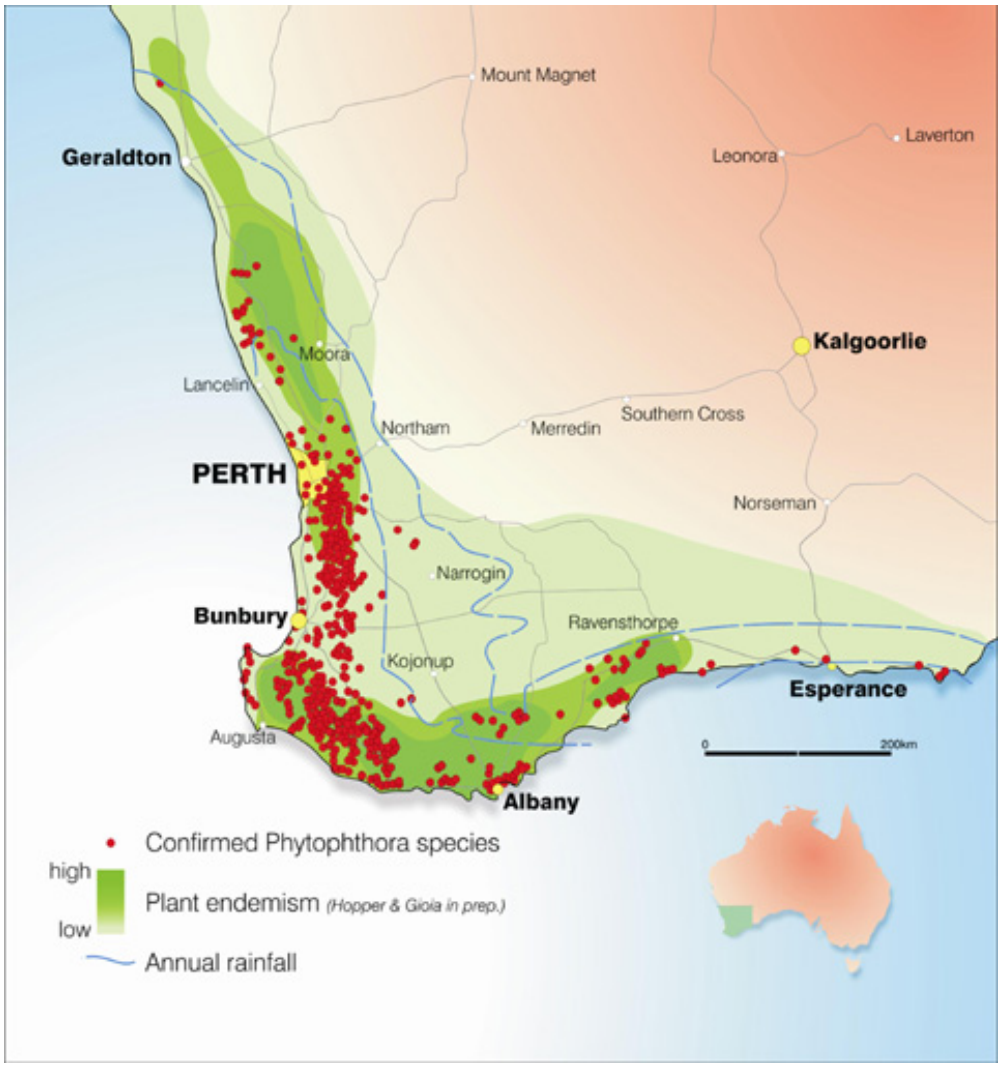

Figure 4: Distribution of *Phytophthora* within the South-west Region of WA[5]

Phytophthora cinnamomi

Phytophthora cinnamomi (P. cinnamomi), also known as *Phytophthora* Dieback, is listed as a key threatening process to biodiversity within Australia under the *Environment Protection and Biodiversity Conservation Act 1999.*[6] More than 40% of native plant species in the south-west of WA are susceptible to *P. cinnamomi.*[7] *P. cinnamomi* has currently not been identified within the City of Joondalup, however it is mentioned in this Plan due to it being the most well known species of *Phytophthora*.

P. cinnamomi occurs widely across southern Australia. In south-west WA it is found in areas which receive above average of 400mm of annual rainfall, however it causes the most impact in areas that receive above average of 600mm of annual rainfall.[7]

P. cinnamomi is not considered to occur commonly in alkaline soils with high pH such as those within the Quindalup complex (found along coastal areas such as within the City of

[5] Department of Biodiversity, Conservation and Attractions, 2017
[6] Commonwealth of Australia, 2014a
[7] Dieback Working Group, 2015

Joondalup as shown in Figure 5).[8] The pathogen is more likely to be found in Bassendean soils. However, research suggests that other species of *Phytophthora* are more commonly associated with vegetation decline in the Spearwood and Quindalup soils, such as *Phytophthora multivora* and *Phytophthora nicotianae.*[9]

[8] Department of Environment and Conservation, no date
[9] Barber, P., 2012

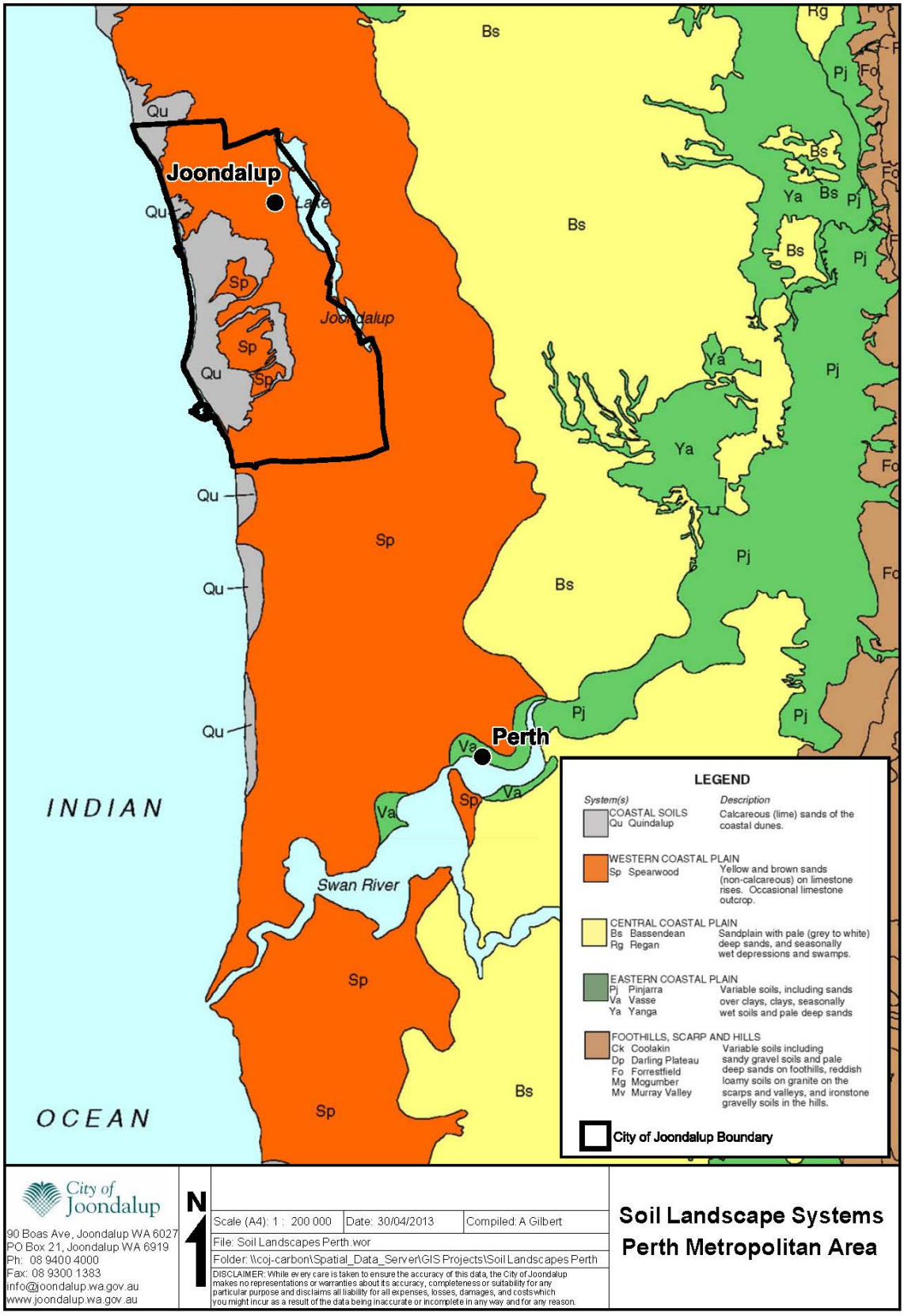

Figure 5: Soil Landscape Systems of Perth Metropolitan Area

Phytophthora alticola

Phytophthora alticola (P. alticola) has only recently been identified in the Perth Metropolitan Region and is associated with *Eucalyptus* and *Acacia* species. *P. alticola* has been identified within one City park to date.

Phytophthora arenaria

Research suggests that *Phytophthora arenaria* (*P. arenaria*) is native to WA.[10] *P. arenaria* causes episodic disease, particularly in areas where localised flooding occurs, and is associated with *Banksia* and *Eucalyptus* species.[11] *P. arenaria* has been identified within one City park to date.

Phytophthora asparagi

Phytophthora asparagi (*P. asparagi*) has previously been identified from *Banksia media* and *Lomandra sonderi* in WA. *P. asparagi* has been identified within two City natural areas to date.

Phytophthora boodjera

Phytophthora boodjera (P. boodjera) has only been recently found in WA and is considered to be an introduced species. *P. boodjera* is closely related to *P. arenaria,* although *P. boodjera* has a faster growth rate.[10] *P. boodjera* has been identified within a total of six City parks and natural areas to date.

Eucalyptus species appear to be the main host of *P. boodjera* and it has also been associated with declining and dying *Agonis flexuosa, Banksia media, Banksia grandis, Corymbia calophylla, Eucalyptus* spp. and *Xanthorrhoea preissii*.[10]

Phytophthora multivora

Phytophthora multivora (P. multivora) is widespread throughout the south-west of WA and common in urban areas along the inland dune systems, with a similar distribution to *P. cinnamomi*. However, unlike *P. cinnamomi*, it seems to tolerate the higher pH soils of the Quindalup and Spearwood dune systems, and is now one of the most commonly encountered *Phytophthora* species associated with disease symptoms of native trees on these soil types. The probability of entry and establishment of *P. multivora* may also be higher in parks where machinery and vehicles are commonly used and soil and containerised nursery stock is introduced.[9] *P. multivora* has been identified within a total of 11 City parks and natural areas to date.

In the urban area *P. multivora* has been associated with declining and dying species such as *Acacia*, *Agonis*, *Eucalyptus, Banksia, Grevillea, Hakea, Allocasuarina, Ficus, Calothamnus* and *Xanthorrhoea*. Plant symptoms from *P. multivora* vary depending upon the host, environment and climatic conditions, however it can cause rapid death of plants, or a slow, perennial decline in the health of the crown. It has been observed causing large, aggressive lesions on *Banksia* species, but on other species such as Tuarts *(Eucalyptus gomphocephala)* it is considered to be a pathogen of the fine roots only. Unlike *P. cinnamomi*, it is not associated with 'dieback fronts' but is more commonly associated with individual spot deaths and areas of tree decline.[9]

[10] Simamora, Stukely, Hardy and Burgess, 2015
[11] E. O'Gara, 2017

Figure 6: Trees with Suspected *Phytophthora* within Granadilla Park, Duncraig

Phytophthora nicotianae

Phytophthora nicotianae (P. nicotianae) is a soil-borne pathogen which was identified as affecting herbaceous and woody plants used within agriculture and horticulture, however it is now established within natural ecosystems of WA. *P. nicotianae* has been identified within a total of 11 City parks and natural areas to date.

P. nicotianae has been recorded from numerous host species in WA including a range of native hosts such as *Adenanthos, Agonis*, *Allocasuarina*, *Eucalyptus, Banksia, Corymbia, Grevillea, Hibbertia* and *Xanthorrhoea*. The pathogen is found in soil or plant tissue and prefers moist conditions for survival, however it can also survive for long periods in unfavourable conditions.

P. nicotianae is widely associated with nursery stock and poses a significant risk of infecting vegetation within parks and reserves where nursery stock is used. The probability of entry and establishment in parks compared to natural areas is also higher as nursery stock and soil is regularly introduced, and the use of machinery and vehicles is common.

The symptoms produced on plants from *P. nicotianae* vary depending upon the host, environment and climatic conditions. It has been associated with large lesions at the base of *Eucalyptus* trees and causes collar rot of *Grevillea* species. *P. nicotianae* has also been identified as causing fine root death of numerous other native plant species.

Phytophthora Distribution and Dispersal

A number of species of *Phytophthora* are common throughout the south-west of WA, including within the Perth Metropolitan Region. *Phytophthora* is easily dispersed through the movement of infected soil and plant material by humans, animals and machinery/equipment/tools, as well as via water or root to root contact between plants. The pathogen is commonly spread by transplanting infected plants from one site to another or

from infected soil being moved on boots, tools and machinery. The application of untreated or raw green mulch is also considered a source of the pathogen.[9] Dispersal of *Phytophthora* is favoured by moist or wet conditions.[12]

Recreational activities within infected areas including cycling and bush walking can lead to increased infestation. Local Government has an important role to play in managing pathogens as activities such as road and drain construction and bushland management, have the potential to introduce pathogens to a previously uninfected area, or increase its rate of spread.

Phytophthora in the bushland environment can kill many susceptible plants, resulting in a permanent decline in biodiversity. It can also change the composition of the bushland. Native animals that rely on susceptible plants for survival are also at risk of population decline within sites infested by *Phytophthora* due to the loss of these species.[13]

Different species of *Phytophthora* affect a variety of host plants with many Western Australian native plant species being susceptible to infection by several species of *Phytophthora.* Table 1 outlines plant genera with species known to be affected by *Phytophthora.*

Proteaceae	Myrtaceae	Ericaceae	Other
Adenanthos	Agonis	Andersonia*	Allocasuarina
Banksia*	Beaufortia	Astroloma*	Anarthia
Conospermum	Calothamnus	Leucopogon*	Boronia
Dryandra	Calytrix	Lysinema*	Conostylis
Franklandia	Eremaea	Monotoca*	Dampiera
Grevillea	Eucalyptus	Sphenotoma*	Dasypogon
Hakea	Hypocalymma	Styphelia*	Daviesia
Isopogon*	Kunzea		Eutaxia
Lambertia*	Melaleuca		Gastrolobium
Persoonia*	Regelia		Hibbertia*
Petrophile*	Scholtzia		Hovea
Stirlingia*	Thryptomene*		Jacksonia
Synaphea	Verticordia*		Lasiopetalum*
Xylomelum			Latrobea
			Macrozamia
			Oxylobium
			Patersonia
			Phlebocarya
			Xanthorrhoea
			Xanthosia

Table 1: Plant Genera with Species known to be affected by *Phytophthora*[7]

* Many species in the genus are severely affected by *Phytophthora.*

2.2 *Pythium*

Pythium is similar to *Phytophthora* in that it is also a soil borne water mould that causes damping-off, seed decay, cutting and stem rot, as well as top (aerial) rot. *Pythium* are not regarded as aggressive pathogens of trees, however they have been associated with the death of roots of shrubs and trees in waterlogged sites such as sites with high temperatures and regular irrigation. Nurseries provide the ideal conditions for the development of *Pythium* species due to the frequent watering regimes used to establish nursery stock. Drainage

[12] Commonwealth of Australia, 2014b
[13] Dieback Working Group, 2000

management is important to prevent the spread of this pathogen. *Pythium* species can survive in soil and plant debris for several years.

There are several different species of *Pythium*, however not all of them are plant pathogens.[14] The pathogen species of *Pythium* that have been identified within the City include:

- *Pythium heterothallicum*
- *Pythium mamillatum*
- *Pythium spiculum*
- *Pythium irregulare.*

Pythium irregulare has been found in association with *Banksia* and *Eucalyptus* species. *Pythium* species have been identified within a total of seven City parks and natural areas to date.

Distribution and Dispersal

Pythium is spread via infected soil, plant material and water. A strict pathogen hygiene system is required in nurseries to prevent or control the disease and similar pathogen hygiene protocols to *Phytophthora* are required in bushland areas.[14]

2.3 *Armillaria luteobubalina*

Armillaria luteobubalina (*Armillaria*) is a fungus that causes root rot and wood decay of a wide variety of plants including many species of native flora. The fungus is native to Australia and can cause major damage to natural ecosystems. *Armillaria* reduces the function of the roots and affects the internal structure of the tree, often resulting in a slow decline in health and eventually death in trees. The symptoms produced on plants from *Armillaria* vary depending upon the host, environment and climatic conditions. *Armillaria luteobubalina* can cause large inverted V shaped lesions at the base of trees.[9,15]

The pathogen has been linked to severely declining species associated with the genera *Corymbia* (Eucalypts including Tuart and Jarrah) and *Acacia* (Wattles).[16] *Armillaria* has been identified in a total of 3 City parks or natural areas and is suspected within 22 City parks or natural areas.

Armillaria is commonly known as ‘Australian Honey Fungus’ due to the colour of the fruiting bodies which grow from May to June at the base of infected trees, up the main stem, or on dead stumps, as illustrated in Figure 7.

[14] Nursery and Garden Industry Australia, 2014
[15] The Royal Botanic Garden Sydney, n.d.
[16] Forest Science Centre, 2003

Figure 7: Fruiting Bodies of *Armillaria luteobubalina*

Distribution and Dispersal

Armillaria inhabits temperate regions of Australia and can be found in a range of environments such as coastal dunes and bushland areas including those that occur along the Swan Coastal Plain.[17]

Within Australia, *Armillaria* has been recorded impacting more than 50 different plant families, and more than 200 species are affected, not only in native forests, woodlands and heathlands, but also in reserves, parklands and residential gardens.[9]

Armillaria can be spread via spores, however it is most commonly spread within diseased plant material via root to root contact. Unlike *Phytophthora*, movement of soil is not considered a common means of dispersal as the pathogen usually requires plant material to survive, particularly in drier sites. If infected trees are removed but the stumps remain, the pathogen will rapidly colonise the stump and remaining roots, becoming a source of infection for many years.[9]

Untreated and green mulch is known to have been a source of *Armillaria*, therefore only composted mulch should be used within landscaping activities. Another way that *Armillaria* may spread is through transplanting infected plants from one site to another.[9]

The spread and development of *Armillaria* occurs throughout the Perth Metropolitan Region and is favoured by disturbance and irrigation, particularly through summer. Within the 25 City parks or natural areas that have *Armillaria* either identified or suspected, 20 of these sites are irrigated. Avoiding over-watering can prevent disease spread and development.[9]

It is difficult to manage the spread of *Armillaria* once it has entered a site and can be challenging and costly. Eradication is possible by the complete removal of infected stumps and roots. The spread of *Armillaria* into adjacent, uninfected areas may be prevented through deep trenching around infected trees. There are currently no commercial fungicides that can be successfully prescribed for controlling the pathogen.[9]

[17] Microbiology Australia, 2003

Where complete removal of infected trees and shrubs (including the infected stump and lateral roots) is not feasible, these trees should be retained rather than felled to minimise the risk of spread to neighbouring vegetation. These infected trees and shrubs should, however, be considered for removal if they are deemed to be structurally unsound. Removal of turf surrounding trees (infected and non-infected) and therefore the need for irrigation around them during summer may also reduce the spread and development of *Armillaria.*[9]

3.0 Pathogens in the City

The City of Joondalup *Pathogen Management Plan 2018-2028* provides information and management recommendations to address species of the pathogens *Phytophthora, Pythium* and *Armillaria.*

As recommended in the *Pathogen Management Plan 2013-2016*, the City engaged consultants to undertake targeted field sampling of areas showing decline in vigour (plant health) due to the possible presence of pathogens using a risk analysis prioritisation tool as well as spatial analysis of vegetation mapping. Pathogen sampling was conducted in 112 parks and natural areas from 2013 to 2017, including ground truthing and soil sampling. Following analysis of samples, a total of 48 sites were identified as having confirmed or suspected pathogens present.

Whilst the pathogen sampling program aimed to establish the extent of pathogens within the City, sampling results are only indicative due to the small number of samples taken per site. To minimise the introduction and spread of pathogens within the City, it is recommended that the precautionary principle should be adopted for all parks and natural areas regardless of whether pathogens have been confirmed on site (see Section 3.1).

For parks or natural areas with a negative pathogen sampling test result, it should be noted that this does not necessarily indicate that the site is free from pathogens as they may be present but not yet identified.

The key objective of the pathogen mapping and sampling program was to identify species of *Phytophthora, Pythium* and *Armillaria*. The following pathogens have been identified to date within the City of Joondalup parks and natural areas:

- *Phytophthora alticola*
- *Phytophthora arenaria*
- *Phytophthora asparagi*
- *Phytophthora boodjera*
- *Phytophthora multivora*
- *Phytophthora nicotianae*
- *Pythium* species (*irregulare, heterothallicum, mamillatum and spiculum*)
- *Armillaria luteobubalina*

The samples collected from City natural areas and parks were also tested for other weak plant pathogens. Weak pathogens, such as some species of fungi, can be dormant meaning that they may reside within healthy trees and then express disease when the tree is stressed. The following weak pathogens have been identified in the City and do not require management such as fungi belonging to the family *Botryosphaeriaceae* and genera *Holocryphia, Cytospora, Celoporthe, Neofusicoccum, Lasiodiplodia* and *Diplodia.* Examples of other weak pathogens identified in the City that do not require management include *Quambalaria cyanescens, Omphalotus nidiformis*, *Pestalotiopsis, Holocryphia* and *Fusarium.* This Plan does not focus on these weak pathogen species as it focuses on the management of key threatening pathogen species of *Phytophthora, Pythium* and *Armillaria* that pose a significant risk to the health of the vegetation within City natural areas and parks.

Figure 8 shows parks and natural areas within and managed by the City where *Phytophthora, Pythium* and *Armillaria* have been identified or are suspected.

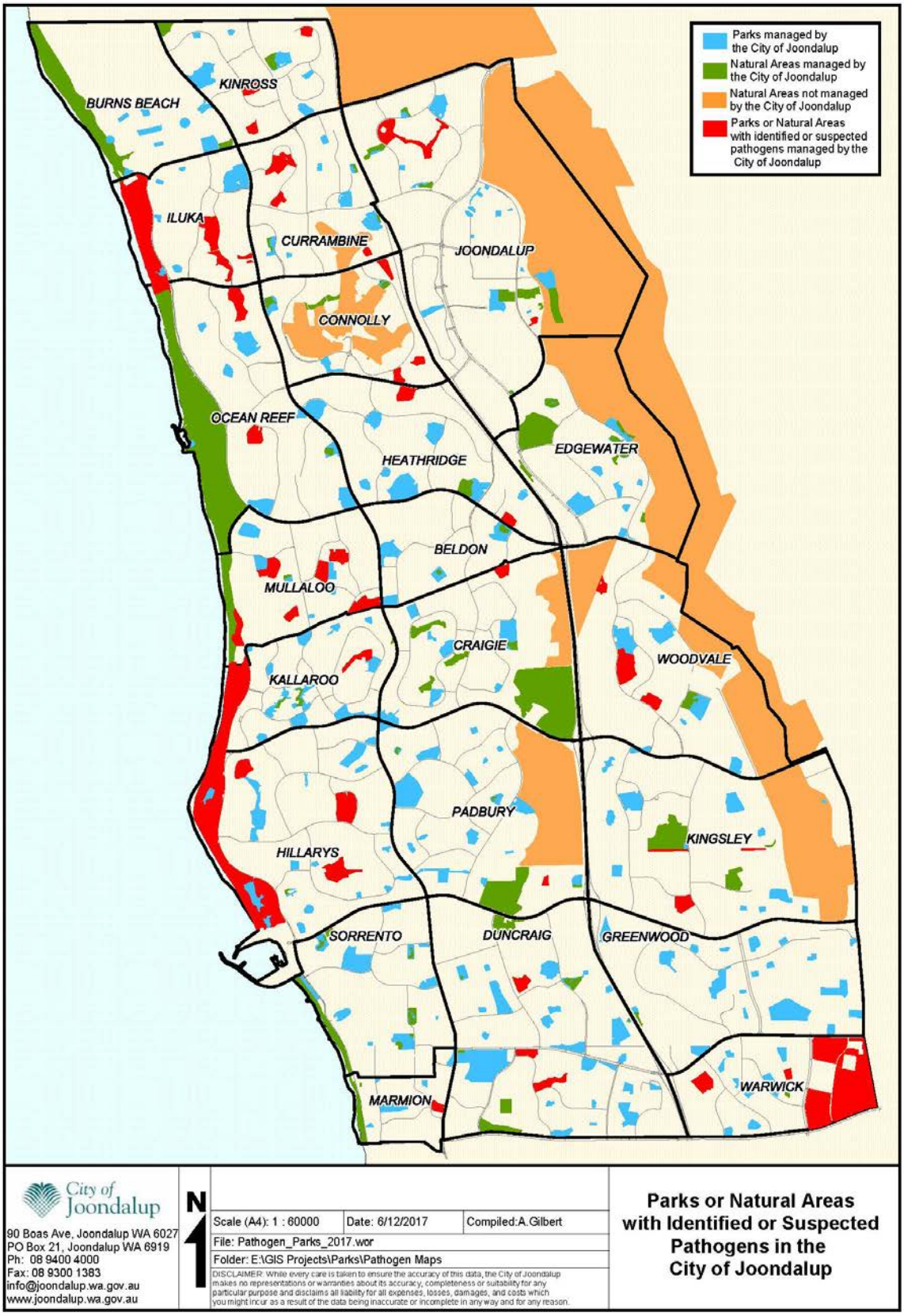

Figure 8: Parks or Natural Areas in the City with Identified or Suspected Pathogens

3.1 Precautionary Principle

The introduction or spread of any species of *Phytophthora, Pythium* or *Armillaria* into City natural areas and parks poses a threat to biodiversity as well as the health and vitality of the vegetation present. Fauna are directly impacted due to the loss of habitat used for foraging, shelter and nesting purposes and pathogen infestation commonly results in a reduction in floristic diversity and ecosystem function. It is therefore recommended that the precautionary principle of implementing pathogen prevention measures should be adopted for the management of pathogens within all City parks and natural areas.

4.0 Pathogen Risk Assessment

Following on from the Pathogen Desktop Risk Analysis of vegetated areas within the City to inform the *Pathogen Management Plan 2013-2016*, a further pathogen risk assessment was conducted on key natural areas within the City to assess their ecological values and prioritise them for pathogen treatment. The results of the pathogen risk assessment will inform the pathogen treatment program recommended in this Plan with top ranking sites being treated as priorities.

The pathogen risk assessment was conducted on key natural areas managed by the City due to their high biodiversity values. Parks were not included in the pathogen risk assessment as they have lower biodiversity values. Parks are prioritised for pathogen treatment in accordance with the City's revised Parks and Public Open Space Classification Framework. Parks are classified in the Framework using factors such as the site purpose, size and surrounding catchment.

The pathogen risk assessment on key natural areas within the City was conducted using the following ecological values criteria:

- City of Joondalup priority rankings based on the Natural Area Initial Assessment.
- Area of site including any connected bushland.
- Threatened Ecological Communities (TEC) or Priority Ecological Communities (PEC) identified on site.
- Declared Rare Flora (DRF) or priority flora identified on site.
- Site being infected or non-infected by pathogens (specifically *Phytophthora*, *Pythium* or *Armillaria*).

The top 15 natural areas infected by pathogens as ranked by the risk assessment are listed in priority order in Table 2:

Priority Number	Infected Sites
1	Warwick Open Space, Warwick
2	Ocean Reef Foreshore, Ocean Reef
3	Iluka Foreshore, Iluka
4	Chadlington Park, Padbury
5	Hillarys Foreshore, Hillarys
6	Kallaroo Foreshore, Kallaroo
7	Mullaloo Foreshore, Mullaloo
8	Blue Lake Park, Joondalup
9	Carnaby Reserve, Connolly
10	Beaumaris Park, Ocean Reef
11	Water Tower Park, Joondalup
12	Sir James McCusker Park, Iluka
13	Naturaliste Park, Iluka
14	Chichester Park, Woodvale
15	Periwinkle Park, Mullaloo

Table 2: Top 15 Natural Area Uninfected or Infected by Pathogens

The complete pathogen risk assessment prioritised list of infected and uninfected natural areas and detail on the criteria weightings and calculations are included in Appendix 4 and Appendix 5.

Limitations

It should be noted that the pathogen risk assessment is based on the known information for each site and there may be some natural areas with ecological values such as TEC's, PEC's, DRF or priority flora that have not yet been identified. There may also be some sites where pathogen infestations are yet to be identified.

5.0 Pathogen Management

5.1 Key Pathogen Risk Factors

Operational activities of managing bushland reserves and parks have the potential to spread pathogens from one area to another. Pathogens can be spread in small quantities of soil, such as mud attached to tyres, tools or walking shoes.

To minimise the risk of spreading pathogens a number of factors should be considered when planning and carrying out bushland management activities. This includes timing of activities such as fire break maintenance, slashing and weeding during dry soil conditions. It is essential that soil movement is minimised and that any materials, tools and vehicles that are bought onto the site are free of pathogens.

Other activities undertaken by the City also risk introducing pathogens to a previously uninfected area, or increase its rate of spread, these include road and drain construction and maintenance. Major land developments, landscaping activities and earthworks which involve the importation or movement of soil and plant material pose significant threats for the introduction and spread of the pathogens throughout the City.

The City has identified key pathogen risk factors for management actions related to City operations on City owned or managed land, as shown in Table 3. The management recommendations to address these key risk factors are detailed in this Plan. Appendix 3 outlines the links between the key pathogen risk factors and the management recommendations in the Plan.

Key Pathogen Risk Factor	Key Pathogen Risk Description
Construction and maintenance of roads, paths and drains	Yellow sand can carry pathogens and is used for construction of paths and paving and maintenance of roads and can carry pathogens.
Drainage run off into bushland	Some natural area sites have drainage run off into bushland. Pathogens can be spread through the movement of water.
Earthmoving and landscaping	Topsoil and mulch are used for landscaping and can carry pathogens.
Parks maintenance	Includes maintenance of irrigation which may require soil disturbance.
Fire break maintenance and installation	Fire break maintenance and installation may involve soil disturbance and the spread of pathogens through weed spraying, pruning and slashing, particularly if the soil is wet or moist. Fire break maintenance and installation is conducted by 31 October each year.
Prescribed burning	Fire can increase the risk of pathogen spread. The City does not currently conduct any prescribed burning.
Developments	Developments can be undertaken by the City, external parties on City managed land or external parties on private land. Developments may involve earthmoving and landscaping which could spread pathogens.
Installation and maintenance of play equipment	White sand is used for playgrounds and can carry pathogens.
People movement	Pathogens can be spread via soil or plant materials carried on the footwear of people.
Animal movement	Pathogens can be spread via soil or plant materials carried on the feet or bodies of domestic or native animals.
Vehicle movement / machinery use	Pathogens can be spread via soil or plant materials on vehicles and machinery.

Key Pathogen Risk Factor	Key Pathogen Risk Description
Revegetation using plant stock	Pathogens can be spread via plant stock, particularly if sourced from non Nursery Industry Accreditation Scheme Australia (NIASA) accredited nurseries.
Pruning / use of tools or equipment	Pathogens can be spread via soil or plant materials on tools and equipment.
Weed control (spraying / slashing / hand weeding)	Pathogens can be spread via soil or plant materials on footwear or tools when conducting weed control, particularly if it is conducted in wet or moist conditions.
Outdoor events	Outdoor events may require minimal soil disturbance for setting up and packing up infrastructure which could enable the spread of pathogens.
Dumping of green waste	Dumping of green waste into bushland can enable the spread of pathogens.
Activities undertaken when soil is wet	Soil that is warm and moist provides the best conditions for pathogens to spread.
Fencing maintenance and installation	Fencing maintenance and installation may involve soil disturbance which can enable the spread of pathogens.

Table 3: Key Pathogen Risk Factors

5.2 Pathogen Management Actions

At present there are no reliable methods for the complete eradication of *Phytophthora* and *Pythium* species and the control of *Armillaria* is both expensive and labour intensive. Management actions can be implemented to protect biodiversity values and minimise the spread of these pathogens within the City.

Pathogen management actions aim to:

- Protect biodiversity values within the City with a particular focus on the structure and function of susceptible ecosystems.
- Protect social and economic assets within City parks and natural areas.
- Minimise the spread of pathogens from infected areas to areas that are free from pathogens.
- Raise community awareness of pathogens and the risk to environmental, social and economic values within the City of Joondalup.

An integrated pathogen management approach should be implemented to reduce the spread of pathogens within the City, treat pathogen infected species and raise community awareness.

The following section provides details of the actions to be implemented over the life of the *Pathogen Management Plan 2018-2028* in order to effectively manage the threat of pathogens within the City.

5.2.1 Pathogen Interpretation and Mapping

Extensive pathogen mapping and sampling has been conducted within the City, as recommended in the *Pathogen Management Plan 2013-2016*. A limited amount of further investigations are recommended to focus on sites that haven't previously been sampled or those with species showing symptoms of disease. On ground observations by City staff and the use of high resolution multi-spectral imagery can determine areas of vegetation with declining health.

Ground Truthing and Soil Sampling

Ground truthing and soil sampling involves site assessments of the park or natural area by a qualified consultant to survey the area for signs of pathogen infestation. Soil and plant samples are also taken from the site which are analysed in a laboratory for the presence of pathogens.

Site investigations to determine the presence of pathogens enable appropriate responses to effectively manage parks and natural areas where pathogens are confirmed. Pathogen mapping and sampling results will continue to be uploaded to the City's Geographic Information System (GIS) and shared with relevant internal staff and external stakeholders to ensure appropriate pathogen hygiene is implemented.

Management Recommendation:

Continue to undertake ground truthing and soil sampling at priority City parks and natural areas to determine the extent of pathogens within the City of Joondalup.

Pathogen Identification

A *Pathogen Identification Checklist* has been developed to enable staff undertaking regular inspections of parks and natural areas to identify flora species infected by pathogens (see Appendix 6). These species can then be tested for pathogens in the ground truthing and soil sampling program. The *Pathogen Identification Checklist* is an internal procedure in the City's ISO 9001 Quality Management System. It is recommended that regular audits are conducted to ensure the use of the *Pathogen Identification Checklist* during regular inspections of parks and natural areas.

Management Recommendation:

In accordance with the ISO 9001 Quality Management System, annually audit the usage of the Pathogen Identification Checklist by staff during regular inspections of parks and natural areas.

5.3 Pathogen Prevention

The prevention of pathogens can be undertaken through an integrated pathogen management approach to address risks and implement controls related to hygiene, purchasing, access, signage, drainage and maintenance works.

5.3.1 Hygiene

Pathogen Hygiene Guidelines

Operational activities of managing bushland reserves have the potential to spread pathogens from one area to another. Pathogens can be spread in small quantities of soil, such as mud attached to tyres, tools or footwear.

Pathogen and Weed Hygiene Guidelines have been developed for usage by City staff and contractors working in natural areas, parks and urban landscaping areas. The guidelines outline the steps to be taken to minimise the risk of spreading pathogens including hygiene procedures and information on scheduling work during dry conditions where possible.

The City's Works Operation Centre in Craigie contains a car wash down bay for use to clean down vehicles and equipment. The City's *Pathogen and Weed Hygiene Guidelines* contain

steps for using the wash down bay. There is also signage installed on site outlining the vehicle wash down steps for users.

The City implements strict pathogen hygiene measures when conducting works in parks or natural areas with identified pathogens. For an example of these pathogen hygiene measures implemented, refer to the Granadilla Park Playground Pathogen Hygiene Case Study in Appendix 7.

The *Pathogen and Weed Hygiene Guidelines* are an internal procedure in the City's ISO 9001 Quality Management System. It is recommended that the *Pathogen and Weed Hygiene Guidelines* are audited annually to ensure that they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.

Management Recommendation:

In accordance with the ISO 9001 Quality Management System, annually audit the usage of Pathogen and Weed Hygiene Guidelines to ensure they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.

Nursery Hygiene Guidelines

The City operates a nursery at the Works Operation Centre in Craigie to grow and propagate plant stock for parks and natural areas. Nurseries can provide an environment for pathogens to thrive.

The *Nursery Hygiene Guidelines* have been developed for usage by City staff that conduct activities within the nursery or in the field for nursery operations such as plant propagation. The *Nursery Hygiene Guidelines* consist of protocols for works within the nursery and protocols for plant propagation. The *Nursery Hygiene Guidelines* are an internal procedure in the City's ISO 9001 Quality Management System. It is recommended that the *Nursery Hygiene Guidelines* are audited annually to ensure that they are being utilised by relevant City staff.

Management Recommendation:

In accordance with the ISO 9001 Quality Management System, annually audit the usage of Nursery Hygiene Guidelines to ensure they are being utilised by relevant City staff.

Boot Cleaning Stations

The City has installed a total of nine boot cleaning stations for the cleaning of footwear at the entrance points of two major conservation areas, Hepburn Heights Conservation Area, Padbury and Lilburne Park, Duncraig. This project was supported with funding from the Western Australian Government's State NRM Program. These sites were selected due to their conservation status, their connectivity to one another and because pathogens are yet to be identified within them. They were also selected as a pathogen was suspected to be impacting vegetation at a parkland adjoining one of the sites. The aim of the boot cleaning stations is to protect the sites from pathogen infestation. Signage accompanies the boot cleaning stations with information regarding pathogens, how to prevent pathogen spread, the purpose of the stations and how to use the stations.

The City has developed a Boot Cleaning Station Management Plan which identifies the on-going management, educational initiatives and public use of the stations. Education regarding usage of the boot cleaning stations has been undertaken through the Adopt a Bushland schools program and also through a pathogen hygiene education session with Friends Groups.

Educational brochures were installed in early 2018 to promote the protection of the City's natural areas and parks at the sites where the boot cleaning stations are installed. The brochures include information about the threat of pathogens and other environmental risks to the City's natural areas and parks.

A user survey was conducted in Hepburn Heights Conservation Area in September 2017 with 52 participants taking part in the survey. The results of the survey indicated that 65% of survey respondents used the boot cleaning station on entry into Hepburn Heights every time they visited or most of the time that they visited.

The City currently does not have plans to install further boot cleaning stations in its natural areas and parks and will instead focus on reducing pathogen spread through community education, pathogen treatment program, internal processes and staff education. See Appendix 7 for a case study on the City's boot cleaning stations.

Figure 9: Community Member using Boot Cleaning Station at Lilburne Park, Duncraig

Management Recommendation:

Continue to promote the usage of boot cleaning stations through pathogen hygiene education with the community, such as via the Adopt a Bushland schools program and Friends Group training.

Bushfire Management

Under the *Bush Fires Act 1954*, firebreaks must be established and maintained to certain specifications. The City conducts the establishment and maintenance of firebreaks on City managed land by 31 October each year to reduce the risk of a fire occurrence.

It is recommended that an education awareness campaign be conducted to encourage firebreaks to be established and maintained in late October (rather than earlier in the year) to enable more potential for works to be undertaken in dry soil conditions and minimise the risk

of pathogen spread. The *Pathogen and Weed Hygiene Guidelines* should be implemented for internal firebreak maintenance and establishment works.

After a fire incident, the City minimises disturbance to the fire scar, particularly in the first 3 months to encourage regrowth of native seedlings, in accordance with the *Fire-related Weed Management Guidelines*. This also assists to reduce pathogen spread after a fire.

Management Recommendation:

Implement a firebreak education awareness campaign to encourage the establishment and maintenance of firebreaks in late October to enable more potential for works to be undertaken in dry soil conditions.

5.3.3 Purchasing

Purchasing Guidelines for the Supply of Landscaping Materials

Purchasing Guidelines for the Supply of Landscaping Materials have been developed for usage by City staff that purchase landscaping materials for natural areas, parks, urban landscaping areas and the nursery. The *Purchasing Guidelines for the Supply of Landscaping Materials* include information on Australian Standards, NIASA and purchasing principles.

The Guidelines recommend that landscaping products purchased such as soil, potting mix, sand, mulch, seeds and plant stock should be certified pathogen free by meeting Australian Standards and/or be from NIASA accredited suppliers, where possible, to reduce the spread of pathogens. An example of the City implementing the Guidelines is that pathogen free certified mulch is purchased for use in parks and urban landscaping areas.

The *Purchasing Guidelines for the Supply of Landscaping Materials* are an internal procedure in the City's ISO 9001 Quality Management System. It is recommended that the *Purchasing Guidelines for the Supply of Landscaping Materials* are audited annually to ensure that they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.

Management Recommendations:

In accordance with the ISO 9001 Quality Management System, annually audit the usage of Purchasing Guidelines for the Supply of Landscaping Materials to ensure they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.

Continue to purchase accredited pathogen free certified mulch for use in parks and urban landscaping areas.

Review Leafy City and Street Tree Species

The City implements a Leafy City program and a Street Tree program to cool the environment, provide shade, create habitat for native fauna, reduce greenhouse gases and help improve air quality. Some of the species selected for City tree planting may be susceptible to pathogens. It is recommended that the City review the tree species selection in these programs to determine if they are the most suitable in regards to minimising susceptibility to pathogens.

Management Recommendation:

Review the tree species selection in the Leafy City program and Street Tree program to determine if they are the most suitable in regard to minimising susceptibility to pathogens.

5.3.4 Access

Paths

Many of the City's parks and natural areas have unrestricted access and are often traversed by numerous tracks and paths, increasing the likelihood of pathogens being introduced or spread in the area. Whilst the City has a large amount of asphalt and limestone paths, there are also informal sand paths that have been created. Limestone and asphalt paths reduce the ability of pathogens to spread. It is recommended to convert sand paths into limestone or asphalt paths in pathogen infested areas, where relevant.

Management Recommendation:

Develop and implement a schedule to convert sand paths into limestone or asphalt paths in pathogen infested areas.

Fencing

All of the City's major conservation areas and the majority of the high priority natural areas are fenced on the boundary perimeter. The City could consider restricting access to areas with several occurrences of identified or suspected pathogens, for example by installing additional internal fencing around these areas if required. Signage could also be installed to explain why the fencing has been installed and suggesting pathogen hygiene practices.

Management Recommendation:

Investigate restricting access to areas with several occurrences of identified or suspected pathogens and installing pathogen signage.

5.3.5 Signage

The City has identified five key bushland reserves and eight coastal reserves as major conservation areas due to their high biodiversity values, ecological connectivity and their regional environmental importance. The Major Conservation Area icon is included on signage at bushland major conservation area sites to indicate their high conservation status within the City. The Major Conservation Area icon could also be included on signage at coastal major conservation area sites.

Management Recommendation:

Utilise the 'Major Conservation Area' icon on signs at coastal major conservation areas to highlight the ecological values of these sites.

Figure 10: Signage with 'Major Conservation Area' icon at Hepburn Heights Conservation Area, Padbury

5.3.6 Drainage

Warm and moist soil provide the ideal conditions for pathogens such as *Phytophthora* to spread via the soil water.[7] Bushland sites where drainage runs into the bushland can therefore facilitate the spread of pathogens. The City has several natural areas where stormwater drainage is not fully controlled and can regularly or periodically run off into the bushland, including:

- Warwick Open Space, Warwick
- Chichester Park, Woodvale (scheduled for improvements in 2021/22)
- Clermont Park, Currambine
- Beaumaris Park, Ocean Reef
- Key West Car Park, Mullaloo (scheduled for improvements in 2020/21)
- Naturaliste Park, Iluka
- Periwinkle Park, Mullaloo (scheduled for catchment upgrade in 2017/18).

Capital works could be undertaken to improve the control and management of stormwater drainage run off into bushland in natural areas, such as installation of bunds around the drain outlet, redirecting stormwater flows, reduction of catchment or provision of underground storage and infiltration. Each site would need to be investigated and an appropriate level of service and upgrade determined and prioritised.

Management Recommendation:

Investigate the feasibility of developing and implementing a schedule of works to be undertaken for drainage sites in natural areas to improve the control and management of stormwater drainage run off into the bushland.

5.3.7 Maintenance Works

The use of soil or mulch rather than turf adjacent to trees enables a build up of organic matter and beneficial microbes which can assist to suppress *Armillaria*. Where feasible, the City plants new trees in parks in mulched areas. It is recommended to continue the practice of planting new trees in mulched areas in parks, where possible.

Management Recommendation:

Continue planting new trees in mulched areas in parks, where possible, to suppress Armillaria.

5.4 Pathogen Treatment Program

As treatment options for *Phytophthora, Pythium* and *Armillaria* have limited effectiveness, preventing the introduction of the diseases into vegetated areas is the preferred approach to protect biodiversity. Pathogen treatment is recommended once pathogens have been identified.

The pathogen sampling conducted from 2013 to 2017 in 112 City parks and natural areas identified a total of 48 sites with confirmed or suspected pathogens. Of those 48 sites, 35 sites had confirmed pathogens. Some sites have more than one type of pathogen present. Within the City, there are currently:

- 26 sites with confirmed *Phytophthora*
- 7 sites with confirmed *Pythium*
- 3 sites with confirmed *Armillaria* and 22 sites with suspected *Armillaria.*

It is recommended that a pathogen treatment program schedule is developed using the results of the pathogen risk assessment (Section 4.1) to prioritise top ranking natural areas and the pathogen mapping and sampling program results.

Chemical Treatment

There is currently no chemical that will eradicate *Phytophthora* and *Pythium,* however phosphite can help control the spread and impact of the diseases by acting as a health booster to plants. Phosphite is an environmentally safe, systemic, biodegradable fungicide that can protect plants for up to five years if injected.[18]

Phosphite can be applied ahead of an advancing *Phytophthora* or *Pythium* front to form a protective barrier. It can also be applied in an already infested area to protect susceptible plants that have not yet been infected and boost the health of infected plants. Further research needs to be conducted to determine whether vegetation infected with *P. boodjera* and *Pythium* will respond to phosphite treatment.

A pathogen treatment program schedule will be developed and implemented to improve vegetation health in infected areas. Inspections to investigate further occurrences of pathogen infestation will also be conducted in conjunction with the phosphite treatment.

It is recommended to either spray infected species every 1-2 years or inject phosphite on infected species every 3-5 years. The frequency of the pathogen treatment program will be determined based on observations of vegetation health in infected areas.

[18] Dieback Working Group, 2014

Figure 11: Phosphite injections being conducted at Naturaliste Park, Iluka in April 2016

Armillaria Treatment

It is difficult to control *Armillaria*, however it can be eradicated by the complete removal of infected stumps and roots. If complete removal of the infected stump and roots is not feasible, these should be retained rather than cut down to minimise the spread of infection. Installing deep trenches around infected species may prevent the spread into nearby uninfected areas.[9] There are currently specialised trials being undertaken to treat *Armillaria* using a combination of soil and systemic treatments.

Management Recommendations:

Develop a Pathogen Treatment Program schedule using the prioritisation of sites from the pathogen risk assessment.

Implement a Pathogen Treatment Program schedule in City parks and natural areas.

Trial New Treatment Options

There is a large body of research yet to be conducted regarding pathogens, but research to date indicates that the encouragement of beneficial microbes such as mycorrhizal fungi and bacteria in the soil around infected species could suppress the activity of *Phytophthora*.[9]

The City will investigate and consider trialling newly developed pathogen treatment options that are not associated with negative environmental impacts to determine the best approach to pathogen treatment.

Management Recommendation:

Investigate and trial newly developed environmentally friendly pathogen treatment options to determine the best approach to treating pathogens within the City, such as for treatment of Armillaria.

5.5 Communication and Education

Raising the awareness of pathogens within the City of Joondalup to staff, contractors and community members is critical to minimise the introduction and spread of disease within vegetated areas of the City.

Staff Pathogen Awareness Campaign

Pathogen Training

Training of City parks and natural areas staff that work within vegetated areas will assist to reduce the risk of introducing and spreading pathogens within the City. The City undertakes annual Green Card Training for staff members working in parks and natural areas that haven't previously undertaken the training. Green Card Training ensures that staff are kept up to date with industry developments regarding pathogen management and includes topics such as:

- Pathogen background information
- Disease identification
- Outcomes of monitoring and treatment programs
- Hygiene and cleaning requirements
- Control measures.

Management Recommendation:

Ensure City employees who work within City parks and natural areas undertake relevant training to increase awareness of pathogen management.

Pathogen Prevention Group

Engaging key staff from different areas of the organisation about pathogen management can create buy in and encourage implementation of pathogen hygiene and purchasing practices.

It is recommended that a Pathogen Prevention Group is established within the organisation including members of staff from key areas of the organisation who are involved in work activities requiring pathogen management. The aim of the formation of this group would be to collectively identify areas in internal practices and processes that could be improved to encourage pathogen management. Communications could be conducted every six months via email or meetings to discuss any identified areas for improvement in pathogen management.

Management Recommendation:

Establish internal Pathogen Prevention Group that communicates every six months to identify practices and processes that could be improved to encourage pathogen management.

Friends Groups Pathogen Awareness Campaign

The City has 16 Friends Groups that work voluntarily to protect, preserve and enhance significant bushland areas in the City.

Pathogen Education

A *Natural Areas Friends Group Manual* has been developed by the City and distributed to groups including information on pathogen awareness and hygiene measures. The *Natural Areas Friends Group Manual* could be updated to include some additional information on pathogen management such as more recent information on pathogens identified in the City and encouraging the purchase of pathogen free products such as plant stock.

The City develops a Friends Group newsletter that is distributed quarterly via email to Friends Groups and is also available on the website to share information about bushland management and local bushland activities. It is recommended that information about pathogen management is included annually in the Friends Group newsletter.

Management Recommendations:

Update the Natural Areas Friends Group Manual with additional information on pathogen management.

Include pathogen management information annually in the Friends Group newsletter.

Pathogen Training Sessions

Pathogen training sessions are organised on an ad-hoc basis for Friends Groups working in natural areas within the City. A pathogen hygiene education session was most recently held in 2017 at Hepburn Heights Conservation Area in Padbury. It is recommended that pathogen related training is delivered for Friends Group members every three years. For example, Dieback Buster Days could be held with Friends Groups in sites with high levels of pathogen infestation to encourage pathogen hygiene and train community members to implement pathogen treatment.

Management Recommendation:

Deliver pathogen related training for Friends Group members every three years.

Pathogen Hygiene Equipment

The City's Friends Groups conduct activities that create soil disturbance such as revegetation and weeding. These activities can also be conducted in areas with fire scars. Fire occurrences can disturb the soil and enable the spread of pathogens. It is recommended that pathogen hygiene kits are distributed to each Friends Group within the City including guidance on usage when entering and exiting natural areas and parks and when entering and exiting fire occurrence spots.

Management Recommendation:

Distribute pathogen hygiene kits to each Friends Group including guidance on usage when entering and exiting natural areas and parks and when entering and exiting fire occurrence spots.

Schools Pathogen Awareness Campaign

The City annually implements an Adopt a Coastline and Adopt a Bushland program for primary school students to provide interactive educational bushland management programs. These programs raise awareness about pathogen management and include education on pathogen hygiene measures.

Management Recommendation:

Continue to implement an Adopt a Coastline and Adopt a Bushland program for primary school students including pathogen education.

Community Pathogen Awareness Campaign

In order to provide ongoing and consistent messages to the community regarding the importance of pathogen management an awareness campaign is implemented as part of the City's Environmental Education Program.

Educational Materials

Pathogen educational information is available on the City's website including pathogen descriptions, the City's approach and pathogen hygiene practices that can be implemented.

A *Protecting our Natural Areas and Parks* brochure has been developed to encourage community members to minimise environmental impacts in the City's natural areas and parks, including implementing pathogen hygiene practices such as keeping to paths, avoiding walking in wet soil conditions and cleaning footwear. The brochure is distributed via the City's libraries, community service centres, the website, at two major conservation areas where boot cleaning stations are installed and during events.

Management Recommendation:

Continue to distribute the Protecting our Natural Areas and Parks brochure to community members to encourage pathogen hygiene practices.

Signage

The City has developed a Wayfinding Signage Strategy to provide a coordinated approach to signage within the City. Wayfinding, directional and interpretive signage has been installed in the City's bushland major conservation areas in accordance with the Wayfinding Signage Strategy.

Interpretive signage includes information on key vegetation communities and flora and fauna species found in each site. Interpretive signage in major conservation areas could also include information from the *Protecting our Natural Areas and Parks* brochure to highlight environmental threats and specific ways to care for bushland and minimise environmental impacts, including pathogen education.

Management Recommendation:

Include information on environmental threats and specific ways to protect and care for bushland in future installations of interpretive signage in major conservation areas.

Booking Community Facilities and Public Open Space

The City has numerous facilities, parks and beaches that are available for hire by completing a *Casual Hire Application Form*. Events held in parks, natural areas and beaches could pose a risk of attendees entering vegetation and disturbing the soil. The *Casual Hire Application Form* includes terms and conditions of hire which could be updated to include a condition regarding minimising disturbance to soil and vegetation to prevent the spread of pathogens.

Management Recommendation:

Update the City's Casual Hire Application Form used to book facilities, parks and beaches to include a condition regarding minimising disturbance to soil and vegetation.

5.6 Partnerships

Keeping up to date with developments in the area of pathogen management will ensure that the City is implementing best practice approaches. There are a number of private companies, research organisations and working groups within WA that focus on building the capacity of land managers to effectively address pathogens, including the Dieback Working Group, Western Australian Local Government Association (WALGA) and Centre for Phytophthora Science and Management (CPSM) at Murdoch University.

The City has presented pathogen information at a number of events including a WALGA Natural Area Managers Forum, UWA Plant Symposium and Dieback Information Group Conference. The City has also collaborated with a CPSM student completing a PhD thesis involving soil samples and related pathogens collected within the City parks and natural areas.

The City will continue to actively partner with relevant organisations to participate in research projects and take up opportunities for sharing information related to best practice approaches to the management of pathogen species.

As part of Project Dieback Natural Resource Management WA, a Dieback Information Delivery and Management System (DIDMS) has been developed by Gaia Resources in association with South Coast NRM. DIDMS is a user registered web based platform for storage, viewing, basic mapping and sharing of spatial pathogen information. The data can be publicly accessed and may be beneficial for strategic planning as well as for pathogen management by key stakeholders such as Friends Groups, utility providers and other local governments. It is recommended that the City upload spatial pathogen mapping data to DIDMS to publicly share spatial pathogen information and enable pathogen management by key stakeholders.

Pathogens can easily spread from neighbouring local government areas via people movement. The City shares boundaries with the City of Wanneroo and the City of Stirling with the potential for pathogen spread between these local government areas. It is recommended that communications via email or meetings are conducted annually with key Environment Officers from these neighbouring local governments to share information and encourage collaborative pathogen management practices.

Management Recommendations:

Investigate opportunities to partner with industry groups and research institutions to enable the City to build capacity and share and gain information relating to best practice approaches to pathogen management.

Publicly share City spatial pathogen information via the DIDMS web based platform to enable pathogen management by key stakeholders.

Liaise with key Environment Officers from City of Joondalup, City of Wanneroo and City of Stirling to share information and encourage collaborative pathogen management practices.

5.7 Monitoring and Reporting

Ongoing monitoring of City parks and natural areas is critical to ensuring the long term management of biodiversity within the City of Joondalup. Regular monitoring of vegetated areas ensures the early detection of new infestations and enables management actions to be assessed in terms of effectiveness in minimising the spread of the disease.

Effective monitoring of large areas of vegetation can be resource and time intensive; however a number of tools are available which can assist in assessing vegetated areas for the signs of possible pathogen infestation such as high resolution multi-spectral imagery.

The City currently acquires high resolution multi-spectral imagery of parks and natural areas every two years and an analysis is undertaken to identify changes in the condition of native vegetation in order to identify areas that are potentially affected by pathogens or other factors.

The City annually reports against a range of natural area key performance indicators (KPIs) for selected major conservation and high priority natural areas including the following related to pathogen management:

- Overall change in vegetation vigour (condition) per area – expressed as an increase or decrease in the Vegetation Condition Index (VCI) every two years
- Canopy Cover – expressed as a percentage per natural area every two years
- Vegetation condition per area – expressed using the Keighery Scale of vegetation condition, expressed as a percentage for each classification (pristine to degraded) every 5 years.

Whilst the City reports against natural area KPIs annually, not all of the data is collected each year as detailed above.

Management Recommendation:

Continue to report against natural area key performance indicators to identify changes in vegetation condition that are potentially affected by pathogens.

6.0 Management Plan Review

The City of Joondalup Pathogen Management Plan will be reviewed and reported on an annual basis to track the progress of the implementation of recommended management actions.

A major review will be undertaken in 2028/29 in order to ensure that the City is managing pathogens in accordance with best practice approaches.

7.0 Summary of Management Recommendations

Management Area	Management Recommendation	Detail	No.
Pathogen Interpretation and Mapping	Ground Truthing and Soil Sampling	Continue to undertake ground truthing and soil sampling at priority City parks and natural areas to determine the extent of pathogens within the City of Joondalup.	1
	Pathogen Identification Checklist	In accordance with the ISO 9001 Quality Management System, annually audit the usage of the Pathogen Identification Checklist by staff during regular inspections of parks and natural areas.	2
Pathogen Prevention	Pathogen Hygiene Guidelines	In accordance with the ISO 9001 Quality Management System, annually audit the usage of Pathogen and Weed Hygiene Guidelines to ensure they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.	3
	Nursery Hygiene Guidelines	In accordance with the ISO 9001 Quality Management System, annually audit the usage of Nursery Hygiene Guidelines to ensure they are being utilised by relevant City staff.	4
	Boot Cleaning Stations	Continue to promote the usage of boot cleaning stations through pathogen hygiene education with the community, such as via the Adopt a Bushland schools program and Friends Group training.	5
	Bushfire Management	Implement a firebreak education awareness campaign to encourage the establishment and maintenance of firebreaks in late October to enable more potential for works to be undertaken in dry soil conditions.	6
	Purchasing Guidelines for the Supply of Landscaping Materials	In accordance with the ISO 9001 Quality Management System, annually audit the usage of Purchasing Guidelines for the Supply of Landscaping Materials to ensure they are being utilised by relevant City staff and contractors and incorporated into relevant contracts.	7
	Purchasing Guidelines for the Supply of Landscaping Materials	Continue to purchase accredited pathogen free certified mulch for use in parks and urban landscaping areas.	8
	Review Leafy City and Street Tree Species	Review the tree species selection in the Leafy City program and Street Tree program to determine if they are the most suitable in regard to minimising susceptibility to pathogens.	9
	Paths	Develop and implement a schedule to convert sand paths into limestone or asphalt paths in pathogen infested areas.	10
	Fencing	Investigate restricting access to areas with several occurrences of identified or suspected pathogens and installing pathogen signage.	11
	Signage	Utilise the ‘Major Conservation Area’ icon on signs at coastal major conservation areas to highlight the ecological values of these sites.	12

Management Area	Management Recommendation	Detail	No.
	Drainage	Investigate the feasibility of developing and implementing a schedule of works to be undertaken for drainage sites in natural areas to improve the control and management of stormwater drainage run off into the bushland.	13
	Maintenance Works	Continue planting new trees in mulched areas in parks, where possible, to suppress *Armillaria*.	14
	Pathogen Treatment Program Schedule	Develop a Pathogen Treatment Program schedule using the prioritisation of sites from the pathogen risk assessment.	15
	Implement Pathogen Treatment Program Schedule	Implement a Pathogen Treatment Program schedule in City parks and natural areas.	16
	Trial New Treatment Options	Investigate and trial newly developed environmentally friendly pathogen treatment options to determine the best approach to treating pathogens within the City, such as for treatment of *Armillaria*.	17
Communication and Education	Staff Pathogen Training	Ensure City employees who work within City parks and natural areas undertake relevant training to increase awareness of pathogen management.	18
	Staff Pathogen Prevention Group	Establish internal Pathogen Prevention Group that communicates every six months to identify practices and processes that could be improved to encourage pathogen management.	19
	Friends Groups Pathogen Education – Friends Group Manual Update	Update the Natural Areas Friends Group Manual with additional information on pathogen management.	20
	Friends Groups Pathogen Education – Friends Group Newsletters	Include pathogen management information annually in the Friends Group newsletter.	21
	Friends Groups Pathogen Training	Deliver pathogen related training with Friends Group members every three years.	22
	Friends Groups Pathogen Hygiene Kits	Distribute pathogen hygiene kits to each Friends Group including guidance on usage when entering and exiting natural areas and parks and when entering and exiting fire occurrence spots.	23
	Schools Pathogen Awareness Program	Continue to implement an Adopt a Coastline and Adopt a Bushland program for primary school students including pathogen education.	24
	Community Pathogen Awareness Campaign – Brochure	Continue to distribute the Protecting our Natural Areas and Parks brochure to community members to encourage pathogen hygiene practices.	25
	Community Pathogen Awareness Campaign – Interpretive Signage	Include information on environmental threats and specific ways to protect and care for bushland in future installations of interpretive signage in major conservation areas.	26
	Community Pathogen Awareness Campaign - Bookings	Update the City's Casual Hire Application Form used to book facilities, parks and beaches to include a condition regarding minimising disturbance to soil and vegetation.	27

Management Area	Management Recommendation	Detail	No.
Partnerships	Industry Groups and Research Institutions	Investigate opportunities to partner with industry groups and research institutions to enable the City to build capacity and share and gain information relating to best practice approaches to pathogen management.	28
	Spatial Data on DIDMS	Publicly share City spatial pathogen information via the DIDMS web based platform to enable pathogen management by key stakeholders.	29
	Liaisons with Neighbouring Local Government	Liaise with key Environment Officers from City of Joondalup, City of Wanneroo and City of Stirling to share information and encourage collaborative pathogen management practices.	30
Monitoring and Reporting	Natural Area Key Performance Indicators Annual Reporting	Continue to report against natural area key performance indicators to identify changes in vegetation condition that are potentially affected by pathogens.	31

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9.0 Appendices

Appendix 1 – Key Achievements of the Pathogen Management Plan 2013 - 2016

Appendix 2 – Relevant City Plans

Appendix 3 – City Key Pathogen Risk Factors and Management Recommendations

Appendix 4 – Pathogen Risk Assessment Criteria

Appendix 5 – Pathogen Risk Assessment Prioritised Natural Areas

Appendix 6 – Pathogen Identification Checklist for *Phytophthora* species

Appendix 7 – City of Joondalup Pathogen Management Case Studies

Appendix 1 – Key Achievements of the Pathogen Management Plan 2013 - 2016

Pathogen Management Area	Project Name	Description	Timeframe
Pathogen Interpretation and Mapping	Pathogen Mapping and Sampling Program	Desktop studies and field sampling to determine the extent of pathogens within the City's parks and natural areas. 94 sites (including 55 high priority sites) were included within the Program.	2012/13-2016/17
	Multi-spectral Imagery	Acquisition and analysis of high resolution multi-spectral imagery of parks and natural areas in October 2012, October 2014 and November 2015. Analysis of imagery was undertaken to identify changes in vegetation condition and indicate the presence of pathogens.	2012/13-2015/16
	Spatial Data and GIS Mapping	Development of pathogen spatial layers on the City's Geographic Information System (GIS) utilising results from the Pathogen Mapping and Sampling Project to provide information to City staff regarding areas of known pathogen infestation.	2012/13-2016/17
Communication and Education	Staff Training	Relevant staff within the City have undertaken Pathogen Awareness and Dieback Treatment Training. Over 130 staff members attended training over the life of the Plan.	2013/14-2015/16
	Pathogen Awareness Workshop	A pathogen education workshop was conducted for City of Joondalup Friends Groups. Held at Hepburn Heights Conservation Area, the workshop included demonstrations on the use of boot cleaning stations, information on reducing the spread of pathogens and new pathogen species and their susceptibility.	2016/17
	Pathogen Awareness Campaign	Distribution of community information regarding the threat of pathogens and ways to reduce the impacts via the City's website, brochures and presentation of information at community events.	2012/13-2016/17

Pathogen Management Area	Project Name	Description	Timeframe
	Adopt a Bushland Program	Development and implementation of an Adopt a Bushland Program to encourage primary school students to be involved in bushland management.	2015/16-2016/17
Access Signage	Boot Cleaning Stations	Successful grant funding through the Western Australian Government's State NRM Program for the installation of nine boot cleaning stations and the installation of accompanying signage at entrances to two of the City's major conservation areas, Hepburn Heights Conservation Area and Lilburne Park.	2016/17
Bushland Management	Bushland Management Manual	Development and implementation of a Bushland Management Manual to provide hygiene and purchasing guidelines for City staff to prevent pathogen spread when undertaking activities within parks and natural areas.	2013/14-2016/17
Treatment	Pathogen Treatment	Following staff training, phosphite injections were conducted in Naturaliste Park, Iluka in April 2016 to manage individual trees showing signs of pathogen infestation.	2015/16
Partnerships	Pathogen Research Partnerships	The City has presented information on the Pathogen Management Plan at a number of workshops including the WALGA Natural Area Managers Forum in April 2013 and UWA Plant Symposium in September 2013. The City also presented at the Dieback Information Group (DIG) Conference in July 2016.	2012/13-2016/17

Appendix 2 – Relevant City Plans

The purpose of the Pathogen Management Plan aligns with the environmental aims and objectives of a number of City of Joondalup Plans including:

Strategic Plan

The City of Joondalup *Strategic Community Plan 2012 – 2022* highlights the focus on preservation, conservation and accessibility of the City's natural assets and the importance of engaging with the community and regional stakeholders.

Environment Plan

The City of Joondalup *Environment Plan 2014 – 2019* provides strategic direction in the delivery of environmental initiatives within the City of Joondalup.

Biodiversity Action Plan

The City of Joondalup *Biodiversity Action Plan 2009 – 2019* provides direction for the City's biodiversity management activities and recommends the development of Dieback Management Plans as an action.

Appendix 3 – City Key Pathogen Risk Factors and Management Recommendations

Key Risk Factor	Key Risk Description	Relevant Management Recommendation
Construction and maintenance of roads, paths and drains	Yellow sand can carry pathogens and is used for construction of paths and paving and maintenance of roads and can carry pathogens.	3, 7, 18
Drainage run off into bushland	Some natural area sites have drainage run off into bushland.	13
Earthmoving and landscaping	Topsoil and mulch are used for landscaping and can carry pathogens.	3, 7, 8, 18
Parks maintenance	Includes maintenance of irrigation which may require soil disturbance.	3, 18
Fire break maintenance and installation	Fire break maintenance and installation may involve soil disturbance and the spread of pathogens through weed spraying, pruning and slashing, particularly if the soil is wet or moist. Fire break maintenance and installation is to be conducted by 31 October each year.	6, 18
Prescribed burning	Fire can increase the risk of pathogen spread. The City does not currently conduct any prescribed burning.	6
Developments	Developments can be undertaken by the City, external parties on City managed land or external parties on private land.	3
Installation and maintenance of play equipment	White sand is used for playgrounds and can carry pathogens.	3, 7
Human foot traffic	Pathogens can be spread via soil or plant materials carried the footwear of humans.	3, 5, 10, 11, 18, 22, 23, 24, 25, 26
Animal movement	Pathogens can be spread via soil or plant materials carried on the feet of animals.	11, 25, 26
Vehicle movement / machinery use	Pathogens can be spread via soil or plant materials on vehicles and machinery.	3, 18
Revegetation using plant stock	Pathogens can be spread via plant stock, particularly if sourced from non Nursery Industry Accreditation Scheme Australia (NIASA) accredited nurseries.	4, 7, 9, 23
Pruning / use of tools or equipment	Pathogens can be spread via soil or plant materials on tools and equipment.	3, 18
Weed control (spraying / slashing / hand weeding)	Pathogens can be spread via soil or plant materials on footwear or tools when conducting weed control, particularly if it is conducted in wet or moist conditions.	3, 18, 23

Key Risk Factor	Key Risk Description	Relevant Management Recommendation
Outdoor events	Outdoor events may require minimal soil disturbance for setting up and packing up infrastructure which could enable the spread of pathogens.	27
Dumping of green waste	Dumping of green waste into bushland can enable the spread of pathogens.	25
Activities undertaken when soil is wet	Soil that is warm and moist provides the best conditions for pathogens to spread.	3
Fencing maintenance and installation	Fencing maintenance and installation may involve soil disturbance which can enable the spread of pathogens.	3

Appendix 4 – Pathogen Risk Assessment Criteria

A pathogen risk assessment was conducted on the City's key natural areas using the following ecological values and weightings.

Ecological Value	Description	Weighting
City of Joondalup Priority Classification – based on Natural Area Initial Assessment	Major Conservation Area	5
	High Priority	3
	Medium Priority	1
Area of site including connected bushland	50 ha+	5
	30.1-50 ha	4
	10.1-30 ha	3
	5.1-10 ha	2
	0-5 ha	1
Threatened Ecological Community (TEC) or Priority Ecological Community (PEC) - based on flora survey, City observations or DBCA data	TEC / PEC present	4
	TEC / PEC likely to occur	3
	Not assessed	2
	Assessed but none identified	1
Declared Rare Flora (DRF) or Priority Flora - based on flora survey, DBCA data or Natural Area Initial Assessment	DRF or priority flora present	3
	Not assessed	2
	Assessed but none identified	1

Note: The City conducts Natural Area Initial Assessments to assess site-specific ecological values, biodiversity significance and threatening processes, at a level that is consistent with regional scientific standards.

As part of the pathogen risk assessment, natural areas were also differentiated regarding whether or not they have identified pathogens on site based on the pathogen mapping and sampling program.

An example of the pathogen risk assessment calculation used for Craigie Bushland, a site with no pathogens identified from 2013 to present, is outlined below:

Ecological Value	Ranking
City of Joondalup priority ranking – major conservation area	5
Area of site including connected bushland – 98 ha (includes connected bushland surrounding the Beenyup Water Treatment Plant)	5
TEC / PEC on site – Banksia Woodlands TEC occurs on site	4
DRF or priority flora on site – *Jacksonia sericea* (Priority 4)	3
TOTAL	**17**

The total values for the pathogen risk assessment of natural areas ranged from 17 (the highest) to 6 (the lowest).

Appendix 5 – Pathogen Risk Assessment Prioritised Natural Areas

Pathogen Risk Assessment – Sites without pathogens identified from 2013 to present (in priority order)

Site	Suburb	CoJ Priority Ranking (according to NAIA)	Area of Site	Conservation Protection
Craigie Bushland	Craigie	Major Conservation Area	56 ha	Bush Forever
Hepburn Heights Conservation Area	Padbury	Major Conservation Area	22 ha	Bush Forever, DPS2 S5
Neil Hawkins Park	Joondalup	Major Conservation Area	8.5 ha	Regional Park
Picnic Cove	Edgewater	Major Conservation Area	3.9 ha	Regional Park
Burns Beach Foreshore	Burns Beach	Major Conservation Area	29 ha	Bush Forever
Shepherds Bush Reserve	Kingsley	Major Conservation Area	16.5 ha	Bush Forever, DPS2 S5
Lakeside Park	Joondalup	High Priority	3 ha	DPS2 S5
Marmion Foreshore	Marmion	Major Conservation Area	4.7 ha	MRS - Parks and Recreation
Sorrento Foreshore	Sorrento	Major Conservation Area	8.7 ha	MRS - Parks and Recreation
Saint Clair Park / Quarry Park	Edgewater	High Priority	17.7 ha	MRS - Urban
Lilburne Park	Duncraig	Major Conservation Area	5.5 ha	DPS2 S5
Garrong Park	Edgewater	Medium Priority	0.5 ha	Bush Forever
Warrandyte Park	Craigie	Medium Priority	1.2 ha	MRS - Urban
Central Park	Joondalup	High Priority	5.7 ha	DPS2 S5
Glenbar Park	Duncraig	High Priority	5.2 ha	DPS2 S5
MacNaughton Park	Kinross	High Priority	8.9 ha	MRS - Urban
Pine Valley Park	Connolly	Medium Priority	2.2 ha	DPS2 S5
Nanika Park	Joondalup	High Priority	2.3 ha	DPS2 S5
Timberlane Park	Woodvale	High Priority	7.8 ha	DPS2 S5
Cadogan Park	Kingsley	High Priority	4.9 ha	DPS2 S5
Lady Evelyn Park	Joondalup	High Priority	2.2 ha	MRS - Urban
Fairway Park	Connolly	High Priority	1 ha	DPS2 S5
Sandalford Park	Beldon	High Priority	4.5 ha	DPS2 S5
Lakevalley Park	Edgewater	High Priority	1.7 ha	DPS2 S5
Huxley Park	Burns Beach	High Priority	1.4 ha	MRS - Urban
Porteous Park	Sorrento	High Priority	2 ha	DPS2 S5
Cranston Park	Kinross	High Priority	1.5 ha	DPS2 S5
Cawarra Park	Craigie	High Priority	3 ha	DPS2 S5
Littorina Park	Heathridge	High Priority	4.4 ha	DPS2 S5
Bonnie Doon Park	Connolly	High Priority	1.1 ha	DPS2 S5
Trigonometric Park	Duncraig	High Priority	2 ha	DPS2 S5
Quarry Ramble Park	Edgewater	Medium Priority	3.2 ha	DPS2 S5

Site	Suburb	CoJ Priority Ranking (according to NAIA)	Area of Site	Conservation Protection
Okely Park	Edgewater	Medium Priority	0.9 ha	MRS - Urban
Alfreton Park	Duncraig	Medium Priority	2.9 ha	DPS2 S5
Robin Park	Sorrento	Medium Priority	5 ha	MRS - Urban
Manapouri Park	Joondalup	Medium Priority	1 ha	MRS - Urban
Duncraig Library	Duncraig	Medium Priority	0.4 ha	MRS - Urban
Harman Park	Sorrento	Medium Priority	1.4 ha	MRS - Urban
Madana Park	Craigie	Medium Priority	1.7 ha	MRS - Urban
Negresco Park	Currambine	Medium Priority	0.8 ha	MRS - Urban
Lacepede Park	Sorrento	Medium Priority	2.6 ha	MRS - Urban
Ledge Park	Sorrento	Medium Priority	0.6 ha	MRS - Urban
Gunida Park	Mullaloo	Medium Priority	0.8 ha	MRS - Urban
Mandalay Park	Craigie	Medium Priority	2.3 ha	MRS - Urban
Castlecrag Park	Kallaroo	Medium Priority	2.8 ha	MRS - Urban
Brisbane Park	Padbury	Medium Priority	1.6 ha	MRS - Urban
Trig Point Park	Ocean Reef	Medium Priority	2.3 ha	MRS - Urban

Pathogen Risk Assessment - Infected sites in priority order

Site	Suburb	CoJ Priority Ranking (according to NAIA)	Area of Site	Conservation Protection
Warwick Open Space	Warwick	Major Conservation Area	60 ha	Bush Forever
Ocean Reef Foreshore	Ocean Reef	Major Conservation Area	110 ha	Bush Forever
Iluka Foreshore	Iluka	Major Conservation Area	34 ha	Bush Forever
Hillarys Foreshore	Hillarys	Major Conservation Area	55 ha	Bush Forever
Kallaroo Foreshore	Kallaroo	Major Conservation Area	21 ha	Bush Forever
Chadlington Park	Padbury	High Priority	0.9 ha	MRS - Urban
Mullaloo Foreshore	Mullaloo	Major Conservation Area	11.6 ha	Bush Forever
Blue Lake Park	Joondalup	High Priority	5.9 ha	DPS2 S5
Carnaby Reserve	Connolly	High Priority	2.2 ha	DPS2 S5
Beaumaris Park	Ocean Reef	High Priority	5.8 ha	DPS2 S5
Water Tower Park	Joondalup	High Priority	3 ha	DPS2 S5
Sir James McCusker Park	Iluka	High Priority	7.7 ha	DPS2 S5
Naturaliste Park	Iluka	High Priority	3.3 ha	DPS2 S5
Chichester Park	Woodvale	Medium Priority	13.7 ha	MRS - Urban
Periwinkle Park	Mullaloo	High Priority	3.7 ha	DPS2 S5
Kallaroo Park	Mullaloo	High Priority	4.9 ha	MRS - Urban
St Michaels Park	Connolly	High Priority	1.9 ha	DPS2 S5
Clermont Park	Currambine	High Priority	1.8 ha	DPS2 S5
Caledonia Park	Currambine	Medium Priority	3.4 ha	DPS2 S5
Bethany Park	Iluka	Medium Priority	0.7 ha	MRS - Urban
Conidae Park	Heathridge	Medium Priority	2.1 ha	MRS - Urban
Maritana Park / Bridgewater Park	Kallaroo	High Priority	2.7 ha	DPS2 S5
Kuta Park	Iluka	Medium Priority	0.3 ha	MRS - Urban
Huntingdale Park	Connolly	Medium Priority	1.5 ha	MRS - Urban
Candlewood Park	Joondalup	Medium Priority	0.7 ha	DPS2 S5
Lysander Park	Heathridge	Medium Priority	3.6 ha	MRS - Urban
Adelaide Park	Craigie	Medium Priority	2.3 ha	MRS - Urban
Callander Park	Kinross	Medium Priority	2.6 ha	MRS - Urban
Earlsferry Park	Kinross	Medium Priority	1.6 ha	MRS - Urban
Greenshank Park	Joondalup	Medium Priority	0.7 ha	MRS - Central City Area
Finney Park	Marmion	Medium Priority	1.8 ha	MRS - Urban
Korella Park	Mullaloo	Medium Priority	3.3 ha	MRS - Urban
Menteith Park	Kinross	Medium Priority	1.6 ha	MRS - Urban

Appendix 6 – Pathogen Identification Checklist for *Phytophthora* species

Organisms such as fungi, bacteria and viruses that cause plant diseases are known as pathogens. Pathogens are usually spread through infected soil from footwear, vehicles and tools. They can also be spread by planting infecting plants or using infected materials such as soil, mulch or gravel.

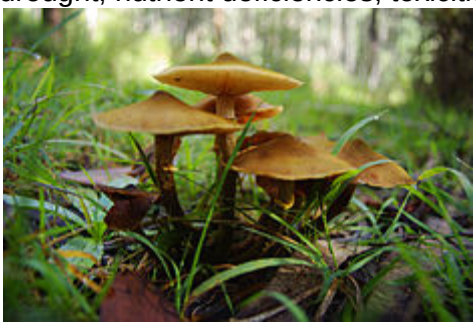
Several pathogens have been identified in the City of Joondalup including the following *Phytophthora* species:

- *Phytophthora alticola*
- *Phytophthora arenaria*
- *Phytophthora asparagi*
- *Phytophthora boodjera*
- *Phytophthora multivora*
- *Phytophthora nicotianae*

The presence of *Phytophthora* species can be determined by observing susceptible plants that are killed by these pathogens. These susceptible plants are called 'indicator species' and include species such as Sheoak, Banksia, Marri, Tuart, Jarrah, Zamia Palm and Grass Trees (see Table 1 and Table 2).

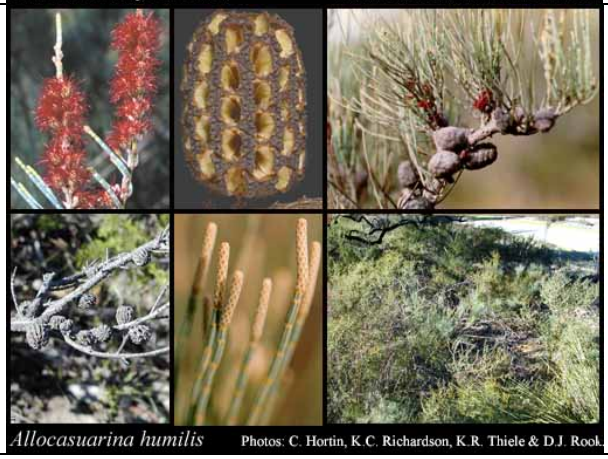
A good quality aerial photograph from IntraMaps may assist you to identify dead vegetation. Locate the infection edge and map its spread. If visiting the site for mapping purposes, aim to be on site when the soil is dry or keep footwear free of soil to avoid spreading potentially infected soil.

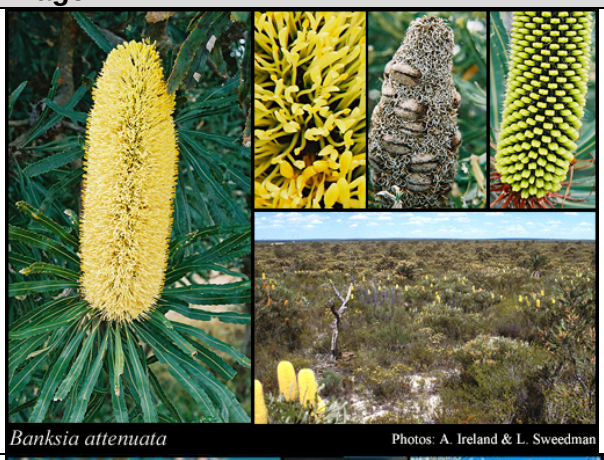
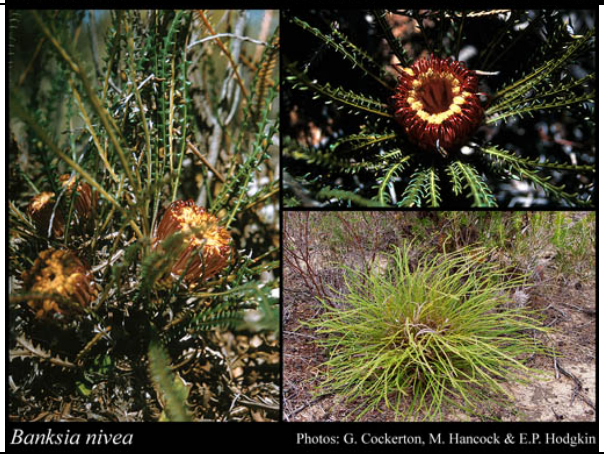
Complete the following checklist to indicate the presence of *Phytophthora* species. One or more ticks may indicate that *Phytophthora* species are present. If *Phytophthora* species are suspected, please let your Coordinator know and pathogen sampling may be conducted to verify if any pathogens are present.

Vegetation Features	**Tick box if indicated**
Are the effected plants listed as susceptible or indicator plant species in Table 1 or Table 2?	☐
Are there no other signs why the plant has died such as fire, insects, flood, drought, nutrient deficiencies, toxicities or *Armillaria luteobubalina* root rot?  Example of *Armillaria luteobubalina* (commonly known as Australian honey fungus)	☐

Vegetation Features	Tick box if indicated
Is the plant completely dead? *Note: Phytophthora species kill most plants completely and quickly. Most plants do not die one branch at a time, and there is usually no chance of recovery. For example, an infected Banksia often suffers from a sudden death. However, occasionally Jarrah trees may look sick for a number of years before suddenly succumbing.*	☐
Are there lines, groups or localised areas of plant deaths? *Note: Lines, groups or localised areas of plant deaths are more likely to be caused by Phytophthora species than odd scattered individual plant deaths in otherwise healthy vegetation.*	☐
Is there a clear distinction between healthy and diseased vegetation (called an edge effect)?	☐
Are the dead plants of a varied age range? *Note: Look for old deaths and recently killed plants, that is, an 'age range' in the deaths. This is because Phytophthora species move from plant to plant over time (often through root to root contact), killing each plant as it goes.*	☐
Is there a track, road or vehicle activity nearby that could have introduced the disease? Has there been any recent landscaping works in the area? This may include mulching, pruning, planting works and the installation of irrigation.	☐

Table 1: Common Plants Susceptible or Indicator Species for *Phytophthora* species

Latin Name	Common Name	Image
Allocasuarina fraseriana	Sheoak	
Allocasuarina humilis	Dwarf Sheoak	

Latin Name	Common Name	Image
Banksia attenuata	Slender Banksia	
Banksia littoralis	Swamp Banksia	
Banksia menziesii	Firewood Banksia	
Banksia nivea	Honeypot Dryandra	

Latin Name	Common Name	Image
Banksia sessilis	Parrot Bush	
Corymbia calophylla	Marri	
Eucalyptus gomphocephala	Tuart	
Eucalyptus marginata	Jarrah	

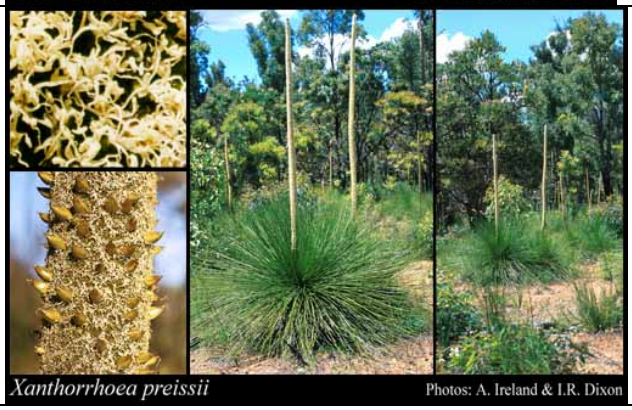
Latin Name	Common Name	Image
Macrozamia riedlei	Zamia Palm	
Xanthorrhoea preissii	Grass Tree	

Table 2: Plant Genera with Species Known to be Affected by *Phytophthora* Species

Proteaceae	***Myrtaceae***	**Other**
*Banksia**	*Agonis*	*Acacia*
Grevillea	*Corymbia*	*Allocasuarina*
	Calothamnus	*Macrozamia*
	Eucalyptus	*Xanthorrhoea*
	Melaleuca	

* many species in the genus are severely affected.

Banksia woodland free of *Phytophthora* species (Image: Sharon Kilgour)

Banksia woodland heavily impacted by *Phytophthora* species (Image: Chris Dunne)

Appendix 7 – City of Joondalup Pathogen Management Case Studies

Installation of Boot Cleaning Stations

In December 2015, the City of Joondalup received a Community Action Grant from the Western Australian Government's State NRM Program for the installation of nine boot cleaning (pathogen hygiene) stations across two of its major conservation areas.

The sites selected for the installation of the pathogen hygiene stations were Hepburn Heights Conservation Area (Hepburn Heights) located in the suburb of Padbury and Lilburne Park in Duncraig. The sites were selected due to:

- Their local significance as major conservation areas;
- The level of public activity experienced within the bushland areas;
- The level of community involvement currently existing at the sites (i.e. active volunteer Friends group and existing school partnership through the City's 'Adopt a Bushland' initiative);
- Their current status as pathogen free sites; and
- Soil sampling undertaken in 2014 recovering the suspicion of *Omphalotus nidiformis* (Ghost fungus) a pathogen with similar hygiene requirements to the destructive *Armillaria luteobubalina* (Australian honey fungus) at nearby Brazier Park, which connects to and has the potential to spread into Hepburn Heights.

In November 2016, pathogen hygiene stations were installed at each access way into Hepburn Heights and Lilburne Park (9 in total). The stations include step-by-step instructions on how they should be used.

Interpretive signage was also installed at the entrances into Hepburn Heights and Lilburne Park to accompany each station. The signage informs users of the bushland about the threats pathogens pose on the environment and encourages the public to use the stations.

A community workshop was held for City of Joondalup Friends groups in March 2017 to inform the groups about various forms of pathogens, their spread and interactions within the ecosystem and to promote the use of the newly installed stations. Nineteen participants attended the workshop which involved discussion about plant and root system traits in managing pathogen resistance and susceptibility. Positive feedback was received following the workshop with many participants indicating they felt more informed about plant pathogens and their interaction within the environment.

Three year 4 (8-10 year olds) classes from neighbouring Padbury Catholic Primary School attended educational workshops in April 2017 at Hepburn Heights. In total approximately 100 students each had a turn at using the pathogen hygiene stations. The workshops discussed the threats to the environment and healthy bushland and delivered the concept of pathogen hygiene in the same context as human hygiene, to inform the students how easy pathogens and plant diseases can be spread. Feedback received from teachers suggested their students promoted the use of the stations when using the Hepburn Heights bushland for both school and out-of school activities.

As part of the City's Think Green Environmental Education Program, an Adopt a Bushland and Coastline program is delivered to selected primary schools within the City of Joondalup on an annual basis. Through the delivery of this program pathogen hygiene awareness is addressed and the use of the City's pathogen hygiene stations is promoted. Many local primary school students have reported they use available pathogen hygiene stations when visiting areas both within and outside of the City of Joondalup.

A user survey was undertaken at Hepburn Heights from 16th to 22nd September 2017. A total of 52 participants took part in the survey. The results of the survey indicated 65% of survey respondents used the boot cleaning station on entry into Hepburn Heights. Furthermore, the majority of respondents who reported using the station also reported they either use the station every time they visit or most of the time they visit.

Following the results of the user survey in September 2017, the City will continue undertaking awareness initiatives to educate the community about the risks pathogens pose to the environment and the importance of hygiene practices. In March 2018, the City installed two brochure holders at Hepburn Heights Conservation Area and one at Lilburne Park to display an educational brochure promoting the protection of the City's valuable natural areas and parks.

The City has developed a Boot Cleaning Station Management Plan which identifies the on-going management, educational initiatives and public use of the stations. It is anticipated further community education will result in a greater understanding of pathogens and subsequently an increase in the usage of the stations.

In future if the City deems further pathogen hygiene stations are required in its natural areas or parks, the City will investigate grant funding opportunities, as well as incorporating the costs of further stations in its internal operating budgets.

Usage of Boot Cleaning Station at Lilburne Park, Duncraig

Granadilla Park Playground Pathogen Hygiene

The City's Pathogen Mapping and Sampling Program results are used to inform pathogen hygiene practices for City operations and onground works. The Pathogen Mapping and Sampling Program identified several species of *Phytophthora* in the south-western part of Granadilla Park in Duncraig (*nicotianae*, *multivora* and *alticola*).

Granadilla Park is an approximately 4 ha park including vegetation, a playground in the centre of the site, BBQ, seats, bins and goals used for ball sports. Granadilla Park previously contained two aged playgrounds that were due for replacement. Works were conducted from February to March 2018 to remove the existing playgrounds and build one consolidated new playground.

The City engaged a contractor to supply and install landscape works for the new playground at Granadilla Park in Duncraig. A Request for Quotation (RFQ) was provided to the contractor including an attached Pathogen Protocol. The scope of work in the RFQ for the contractor included:

- Demolition and removal of existing playground equipment to Red Hill Waste Management Facility.
- Removal and disposal of existing white sand in sand pit to Red Hill Waste Management Facility.
- Removal of grass for new rubber softfall, white sand and mulch to Red Hill Waste Management Facility.
- Supply and installation of limestone block walls, limestone boulders, concrete mowing kerb and timber steppers.
- Installation of new seat.
- Supply and install of certified pathogen free mulch to garden bed areas.
- Supply and install of new turf.
- Supply and install of clean white silica sand to playground areas.
- Supply and install of 3 x 100 litre trees free of pathogens.

The Pathogen Protocol attached to the RFQ included requirements for pathogen hygiene of machinery, vehicles, tools and footwear prior to leaving Granadilla Park each day. A vehicle washdown facility was located on site. The Pathogen Protocol also included a requirement for disposal of excavated soil and turf to Red Hill Waste Management Facility, an approved waste facility for disposal of contaminated waste. Proof of disposal to the Red Hill Waste Management Facility was required.

Different contractors were used for the supply and installation of site signage, concrete pathways, play equipment, rubber softfall, seating and adjustments to existing irrigation. A similar RFQ and attached Pathogen Protocol was also provided to these contractors.

The City will continue to implement pathogen hygiene requirements when conducting works in sites with identified pathogens.

Granadilla Park, Duncraig