DRAFT

HOBSONS BAY URBAN FOREST STRATEGY

2020 BACKGROUND REPORT

HOBSONS BAY CITY COUNCIL

Acknowledgements

This report is prepared by Gallagher Studio for Hobsons Bay City Council.

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Prepared by GALLAGHERSTUDIO for HOBSONS BAY CITY COUNCIL

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DRAFT

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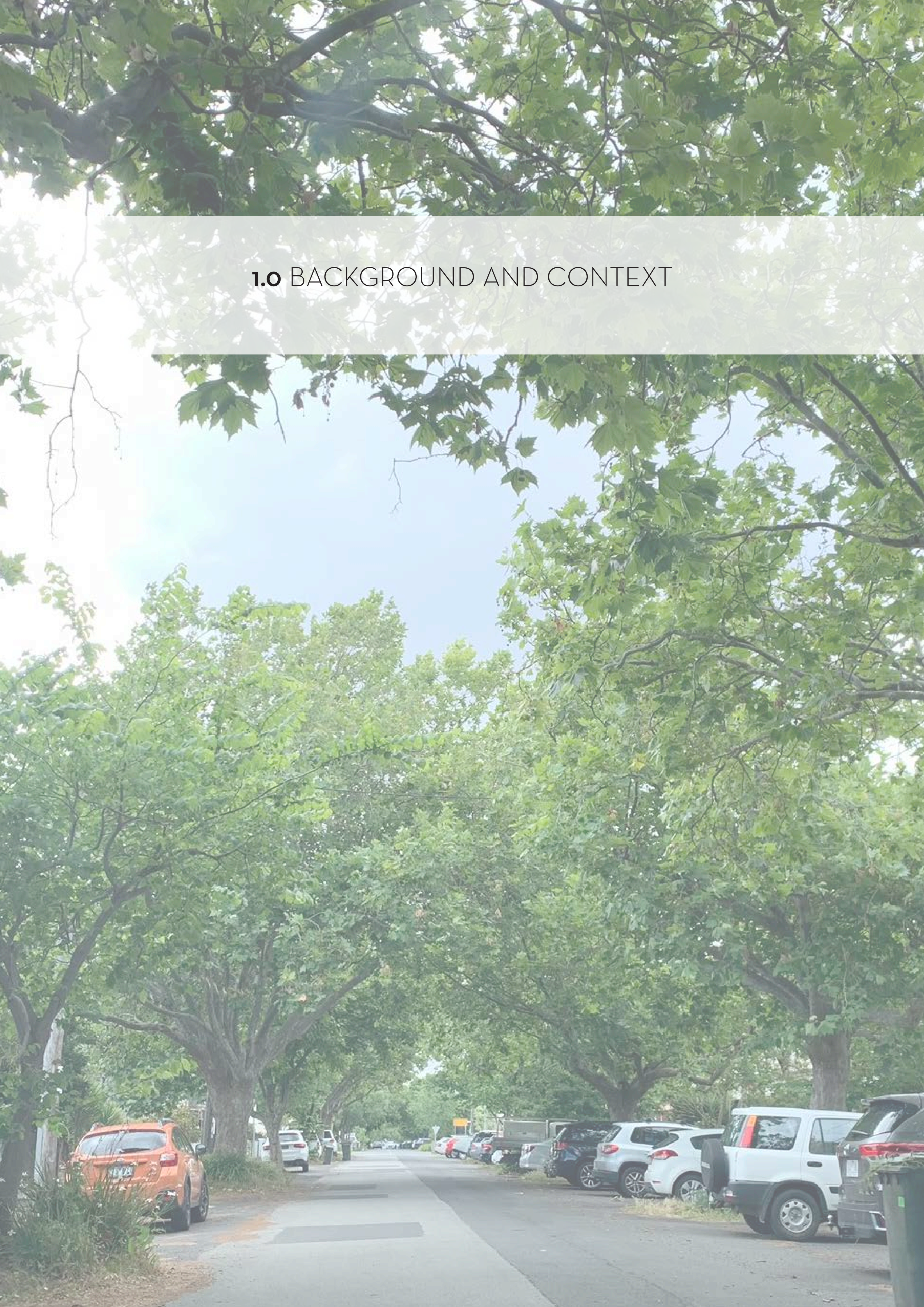
1.0 BACKGROUND AND CONTEXT



1. BACKGROUND AND CONTEXT
1.1 WHAT IS THE URBAN FOREST?

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The urban forest refers to all trees on public and private land within urban areas. The urban forest can comprise tree groves, avenues or individual specimens, located in a range of environments from public parks, squares, street verges, main streets to rail corridors, creek embankments, schools, campuses, business parks and private gardens. The urban forest can also include all types of trees including exotics, natives, deciduous and evergreens of varying sizes.

1. BACKGROUND AND CONTEXT

1.2 BENEFITS OF THE URBAN FOREST

1.2 BENEFITS OF THE URBAN FOREST

Trees in urban areas have traditionally been valued for their role in creating attractive streets, parks and gardens. However, in the last two decades, research has indicated that urban trees also provide substantial environmental, economic and social benefits. Increasingly, urban trees have been viewed as critical infrastructure, that protect and enhance community health and wellbeing. The increased recognition of the benefits provided by trees has encouraged many local authorities to develop strategies to enhance and expand their urban forest.

Climate and Environmental Benefits of the Urban Forest

Trees cool local temperatures through the process of direct shading and transpiration. Trees reduce the amount of heat absorbed by urban surfaces, and play a role in moderating and reducing the urban heat island. An urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. This is caused by the higher proportion of buildings, pavements and asphalt streets in cities and the lower amount of landscape areas such as gardens, plants and trees. This is further exacerbated by waste heat from mechanical devices such as air conditioning units (Nowak and Dwyer 2007).

Studies have found that urban forests and parklands can reduce local temperatures by up to 10°C in urban areas (Hart and Sailor 2009). Tree canopy cover of 30% or more have been found to be effective in reducing local temperatures by up to 2.7°C (Pincetl et al, 2012). Trees also provide direct shade to buildings and homes, reducing the need for air conditioning.

Trees also can act as carbon sinks by absorbing atmospheric carbon from the atmosphere. Tree canopies and root systems reduce stormwater flows and nutrients that can pollute waterways. Broad tree canopies can reduce the impact of heavy rainfalls. Trees also enhance biodiversity and provide opportunities for improved habitat for fauna. Urban forests have been shown to support a wide range of species, including endangered animals.

Economic Benefits of the Urban Forest

The urban forest has been found to have substantial economic benefits. Tree shade can reduce household costs for residents. One study found that street trees can reduce electricity consumption for homes used for cooling, and provide savings of up to $438 over one year (Gallagher 2015). Tall trees with wide canopies are the most effective means of providing shade for cooling.

Urban trees have been found to improve property values for homes and businesses; and increase retail sales and tourism activities. It is estimated that properties in tree-lined streets are valued around 30% higher than those in streets without trees. Research has shown that customers prefer shopping in streets with large trees and that customers would pay up to 12% more for goods sold in districts with high quality trees. People would travel further to visit tree lined retail streets and would stay longer. Tree shade can also improve the lifespan of certain assets, such as asphalt, by protecting them from harmful rays and reducing maintenance and replacement costs.

Social and Health Benefits of the Urban Forest

Trees have been found to improve social connection and cohesion by providing attractive places to meet and socialise. Trees also contribute to local identity and enhance local character. Trees have also been found to improve health and well-being outcomes, including reduced stress and obesity levels. Access to and views of trees have been shown to alleviate depression and improve mental health.

One of the most significant human health benefits trees provide is in alleviating urban heat. In Melbourne, the risk of heat-related morbidity and mortality for vulnerable people (those over 64 years of age, the very young, the infirm and economically disadvantaged) increases significantly on days over 30°C. Evidence suggests that buildings with little or no surrounding vegetation are at higher risk of heat-related morbidity.

Trees also reduce ozone levels by cooling local temperatures. This can reduce the occurrence of smog, a major factor affecting air quality. Research has found that canopy trees can capture certain air borne pollutants and avenues of trees in certain configurations can improve air quality.

1. BACKGROUND AND CONTEXT
1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

Overview

Hobsons Bay is located on the banks of Phillip Bay, approximately 10 kilometres west of Melbourne CBD. Bounded on the east by Port Phillip Bay, with the Yarra River to the north, Stony Creek to the south and Skeleton Creek to the west, the landscape of Hobsons Bay is characterised by rivers, creeks, wetlands and waterfronts. Smaller tributaries, including Kororoit Creek and Laverton Creek, drain to Truganina Swamp, Cherry Lake, and the intertidal mudflats and saltmarshes along the coast, at Altona and Seaholme.

She-oak Forests, Creeks and Wetlands

Located on a basalt plain, the natural landscape of Hobsons Bay would have been comprised of grasslands, mud flats, wetlands, saltmarshes, mangroves and she-oak forests. This landscape provided an abundance of hunting and gathering opportunities for the local aboriginal people who lived in this area, know as the Yalukit-willam, meaning 'river camp' or 'river dwellers'. The Yalukit-willam people lived semi-nomadic lives and moved throughout their territory taking advantage of freshwater supplies and seasonal availability of plants and animals on the land as well as in the bay.

Hobsons Bay's location, close to deep water, and expansive and flat landform made it attractive as a port and for residential and industrial development. The natural landscape has been significantly altered through quarrying, land reclamation, and heavy industry which brought rapid degradation, especially to Stony Creek and Kororoit Creek. While much of the ecological landscape has been lost, several unique landscapes remain including saltmarshes, mangroves and wetlands at Altona Coastal Park, Jawbone Flora and Fauna Reserve and Cheetham wetlands. Other important natural landscapes have been preserved in military and recreation lands including Truganina Explosives Reserve, and the former Williamstown Racecourse site (now Altona Coastal Reserve).

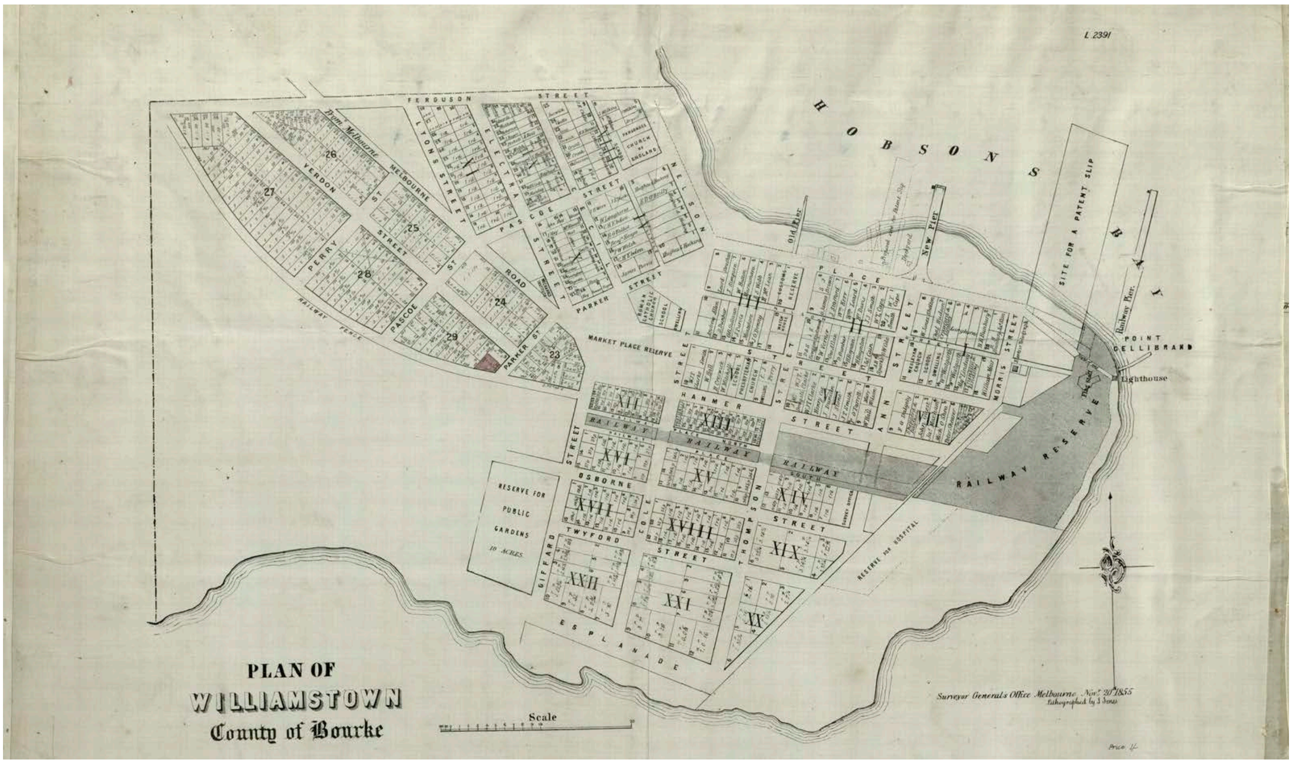


Figure 1.1: Plan of Williamstown, County of Bourke Date 1855 with Williamstown Botanic Gardens (annotated as a reserve for public gardens)

1. BACKGROUND AND CONTEXT
1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

Pattern of Development

Hobsons Bay contains a mix of old and newer neighbourhoods. Hobsons Bay was settled by Europeans in 1836 at Williamstown, the oldest continuous settlement on the shores of Port Phillip. Surveyed by Robert Hoddle, Williamstown's grid of wide streets extended from Point Gellibrand west, following the alignment of the coastline (Figure 1.1). The street network was subsequently extended in stages - north, east and southwest, in alignment with the railway lines to Melbourne and Geelong (as evident in Figure 1.2: Geological Survey of Victoria 1860). While parts of Hobsons Bay evolved early, large areas remained as pastoral lands until the mid-twentieth century, with Altona and Laverton undergoing rapid change in the post-war period. Newport and Spotswood stayed largely rural until the late-nineteenth and early-twentieth century, when major industries relocated to these areas, attracted by the flat land and proximity to rail and port facilities. Large industrial landowners were also evident in Altona including the Mobil (Vacuum Oil Company) refinery, located on low lying lands adjacent to Kororoit Creek (Figure 1.3). Subsequent residential and commercial development saw the construction of post war public housing.

Parklands, Gardens and Military Reserves

The early establishment of public parks, gardens and military reserves has delivered an expansive network of large public open space across the locality. This commenced early, with the establishment of Point Gellibrand in 1839 and Williamstown Botanic Gardens (annotated as a reserve for public gardens in Figure 1.1). By 1945 a network of foreshore parklands and reserves extending west along the Bay, including Williamstown Racecourse Reserve and the rifle range is apparent. The transfer of former military reserves to public open space at Point Gellibrand, the Truganina Explosives Reserve and the Merrett Rifle Range has added to this extensive public open space network.

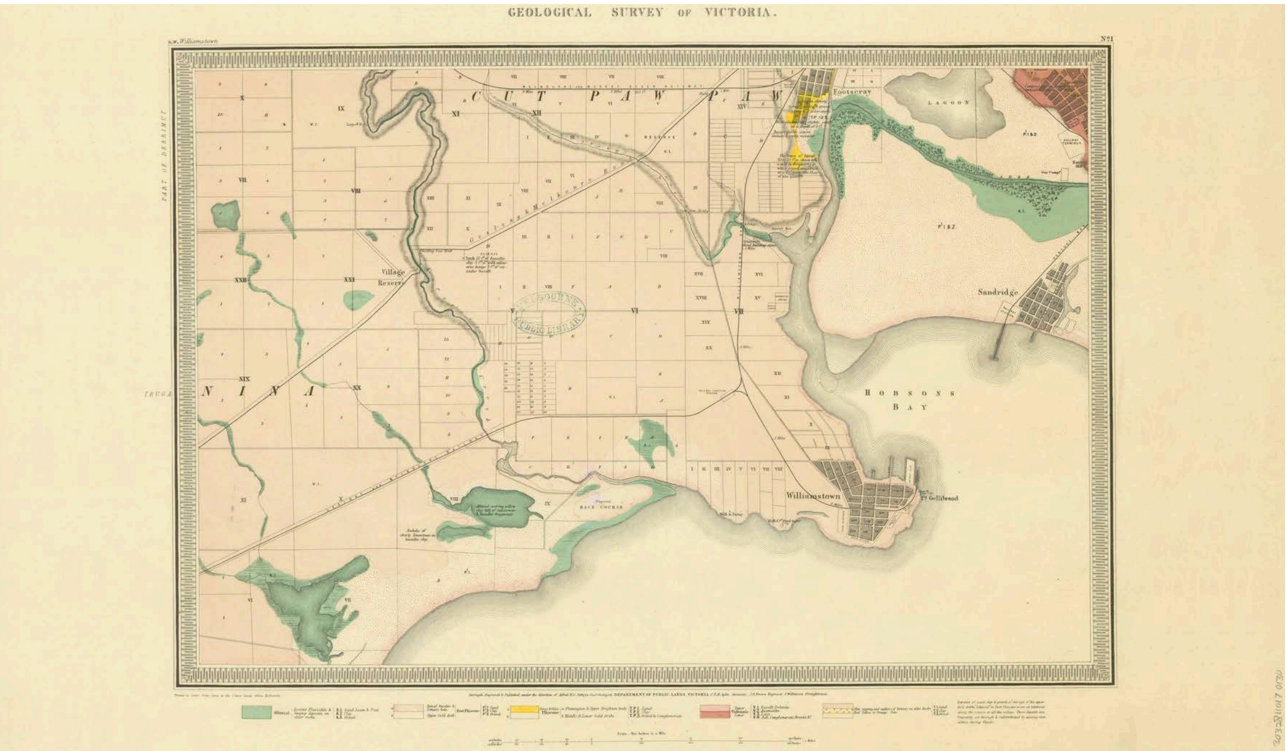


Figure 1.2: The street network was subsequently extended in stages - north, east and southwest, in alignment with the railway lines to Melbourne and Geelong. Source: Geological Survey of Victoria

1. BACKGROUND AND CONTEXT

1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

Figure 1.3: Oblique aerial photograph of the Mobil (Vacuum Oil Company) refinery at Altona looking east toward5 Williamstown 1961. The photo shows Millers Road running across the foreground and Kororoit Creek and Port Phillip Bay beyond.
Photographer: Jim Paynes. Source: Museums Victoria.

Figure 1.4: Aerial view of Williamstown looking south-easterly in 1930 showing the established trees at Williamstown Cemetery on Champion Road and the Williamstown Botanic Gardens. Photographer: Charles Daniel Pratt.

1. BACKGROUND AND CONTEXT
1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

Trees as Part of the Urban Fabric

Street trees are an integral element of the historic fabric of Hobsons Bay. Although the exact date of the first planting of street trees in the city is not known, the City of Williamstown Conservation Study (1993) notes that extensive planting of street trees probably began in the 1880's in Williamstown. These trees were integrated into the streetscape design and often given quite elaborate guards, of timber or iron. Descriptions from newspapers and historic documents cited the importance of and need for tree planting.

> *It is "one of the most noticeable features in the place", the Argus commented in 1884. ..... One Councillor commented in 1912 that Centre Ward had been "greatly beautified", but that trees were needed in Garden, Gifford, Osborne Streets and Esplanade in the South Ward.*
>
> (Heritage Streets and Laneways Management Plan 2008, p7)

The 2008 Heritage Streets and Laneways Management Plan (ibid) has identified the significance of street trees in early street layouts in the Government Survey precinct and Osborne Street. The plan includes a policy that mature street trees in all precincts are to be conserved, and only replaced for safety reasons.

Landmark trees and avenues defined parklands, foreshore areas and cemeteries. Aerial images from 1930 (Figure 1.4) shows the established trees at Williamstown Cemetery on Champion Road and the Williamstown Botanic Gardens. At Logan Reserve in Altona, the Moreton Bay Fig (*Ficus macrophylla*), likely planted in 1917, with a canopy spread of 28m is a spectacular specimen (Figure 1.5). This tree has been recently listed in the National Trust of Australia Register of Significant Trees.

Avenues of Norfolk Island Pines, located on the Esplanade at Altona Foreshore, were well established in the 1971 image of Altona foreshore and remain today (Figure 1.6). Historic images also indicate that large native trees were retained and integrated into gardens and along street verges, as evident in 1908 and 1911 images of Williamstown (Figures 1.8 and 1.9).

Figure 1.5: Logan Reserve in Altona, the Moreton Bay Fig (*Ficus macrophylla*), likely planted in 1917 is a landmark specimen, 2019.

1. BACKGROUND AND CONTEXT
1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

Figure 1.6: Logan Reserve in Altona 1971 showing lines of Norfolk Island Pines along the Foreshore. Photographer: Ken Davis.

Figure 1.7: Avenue of Norfolk Island Pines on the Esplanade in Altona today, 2019.

1. BACKGROUND AND CONTEXT
1.3 THE EVOLUTION OF URBAN CANOPY IN HOBSONS BAY

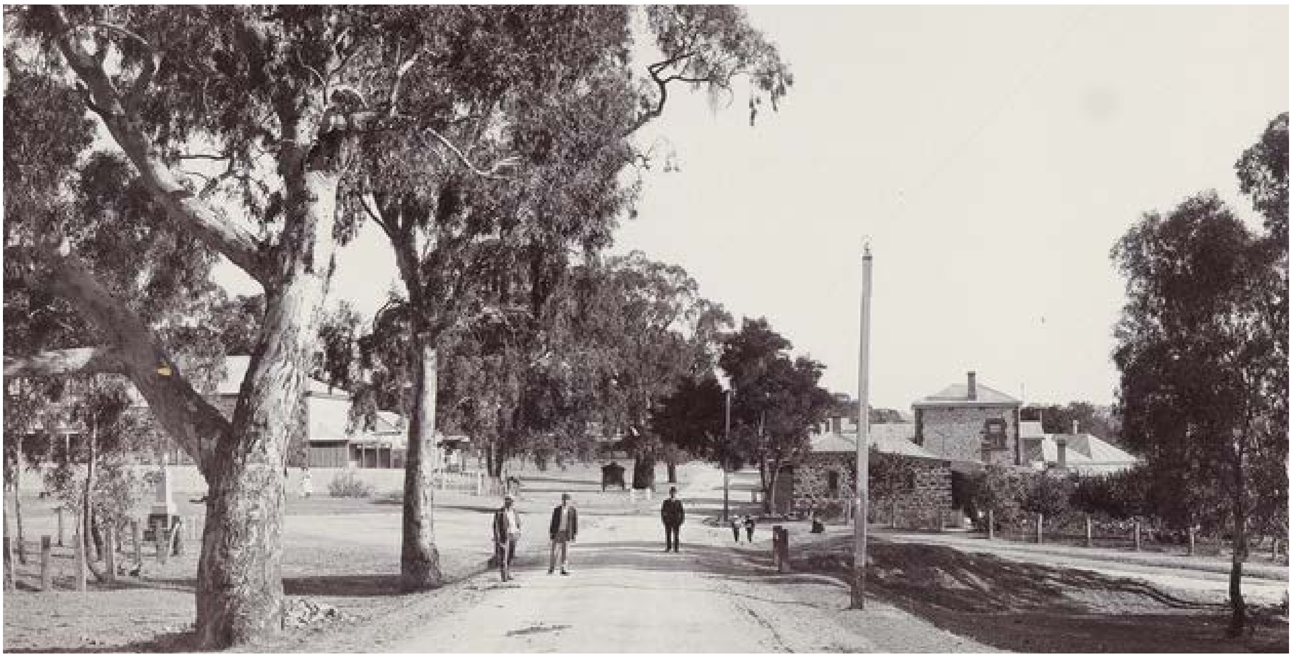
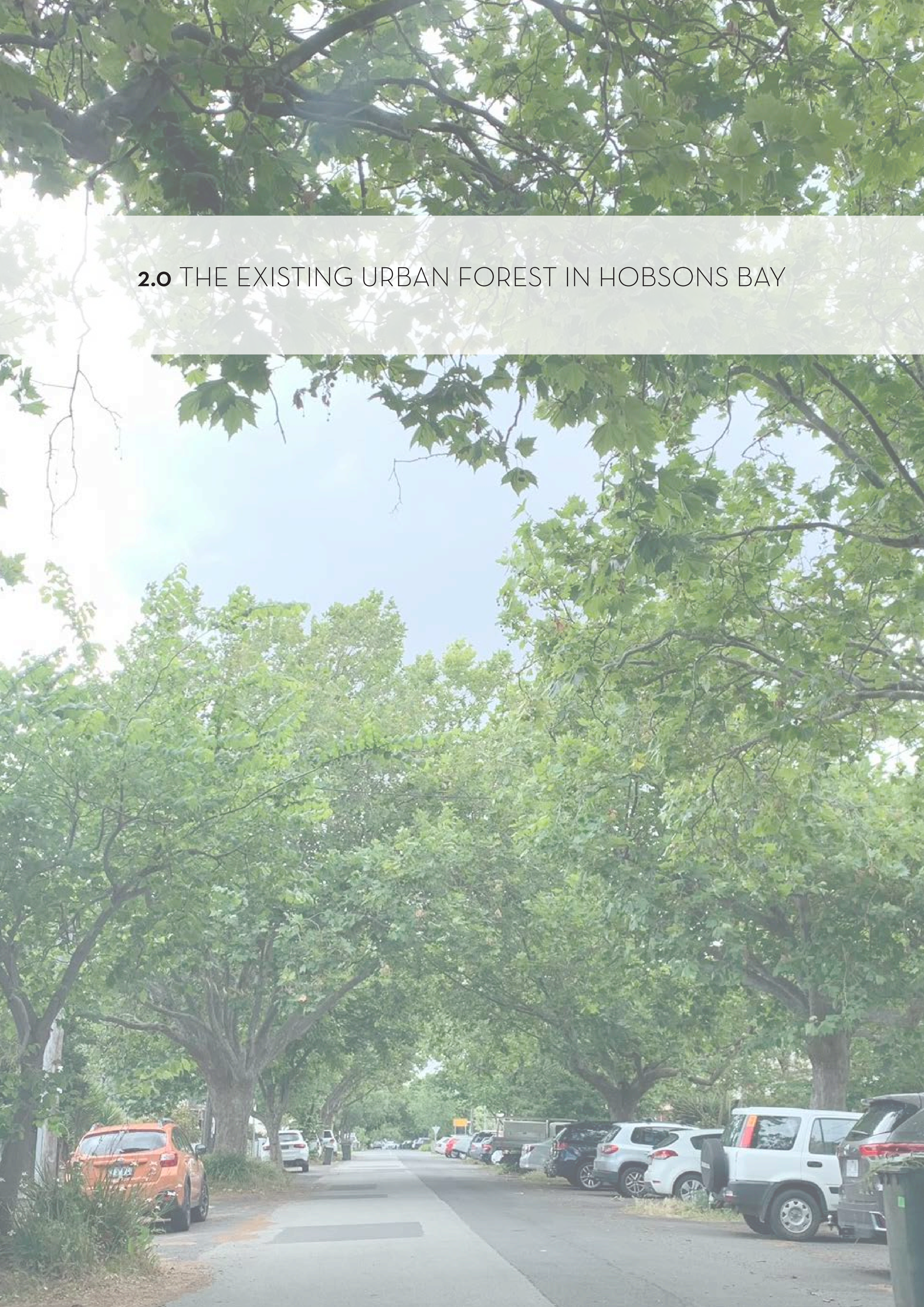


Figure 1.8: 1908 view of Williamstown main street, looking south-west from the hotel verandah showing large gum trees retained on street verges. Source: Williamstown Collection.

Figure 1.9: 1911 image of Williamstown showing shops and houses with a large gumtree in the foreground, partially obscuring W.S. Haworth's general store. Photographer : WJ Angus.

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY



2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.1 URBAN CANOPY DISTRIBUTION

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Canopy refers to the extent of an individual tree crown (including branches and leaves) or the combined canopy area of a group of trees. A common method for determining the amount of urban tree canopy is to measure the area of canopy as a percentage of total land area.

The proportion of urban tree canopy in Hobsons Bay was analysed using LIDAR data collected in Feb 2018 via GIS-based software.

The analysis was undertaken to understand:

- the proportion of urban tree canopy on public lands (parks, reserves and streets) and private land;
- the proportion of urban tree canopy cover on different land uses across the LGA; and
- the potential increase of urban tree canopy based on council's assessment of available streetscape verge space.

The land use zones in the following analysis are drawn from planning scheme classifications. The findings from this analysis was to determine priority locations and mechanisms to improve tree canopy provision.

Canopy cover in Hobsons Bay

There is approximately 7.5% canopy cover across Hobsons Bay. Almost two thirds of these trees (4.7%) are in streets, parks and reserves. While over half of the LGA is comprised of private land (54% including land zoned residential, industrial, commercial, comprehensive development and mixed use), these lands contain only one third of trees in the LGA (Figure 2.11 and 2.12).

Low canopy cover is evident across Western Melbourne, which has the lowest amount of tree canopy (at 5.5%) of any region across the metropolitan area. While Hobsons Bay LGA was found to have the third lowest provision of urban canopy, it is one of only a few municipalities where tree canopy cover has increased since 2014 (Figures 2.3 and 2.4).

Figure 2.1: Mature pines located within Logan Reserve, Altona.

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.1 URBAN CANOPY DISTRIBUTION

Figure 2.2: Tree Canopy Distribution in Melbourne by Region - Source: Planning Victoria

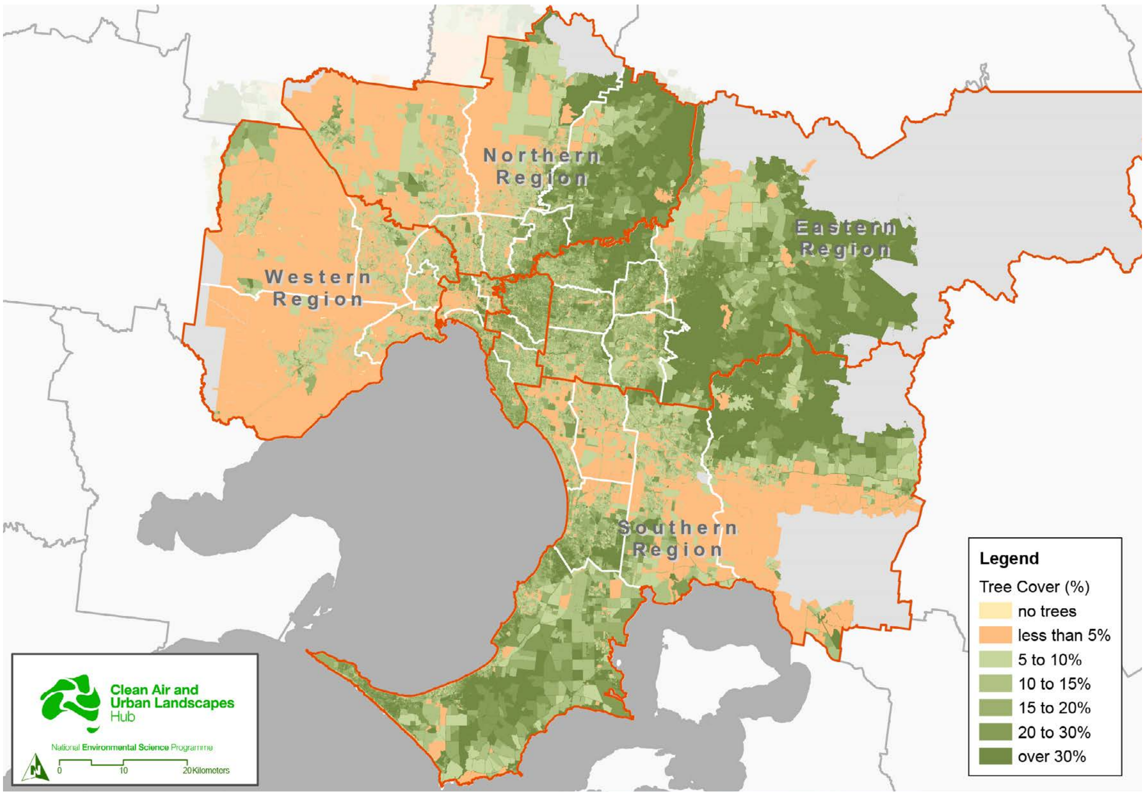


Figure 2.3: 2018 % Tree Cover in Melbourne by Local Government Area - Source: Planning Victoria

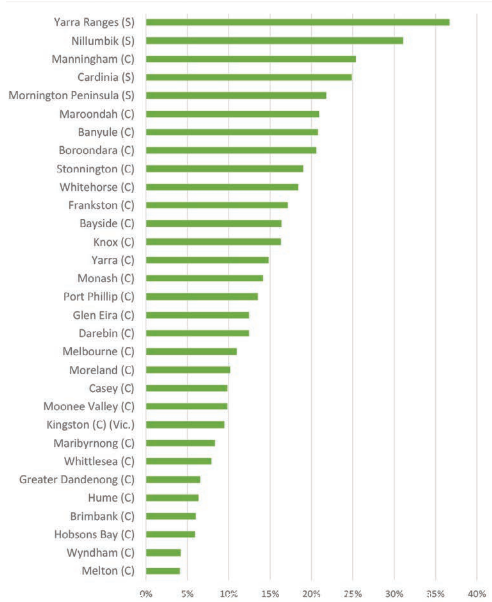
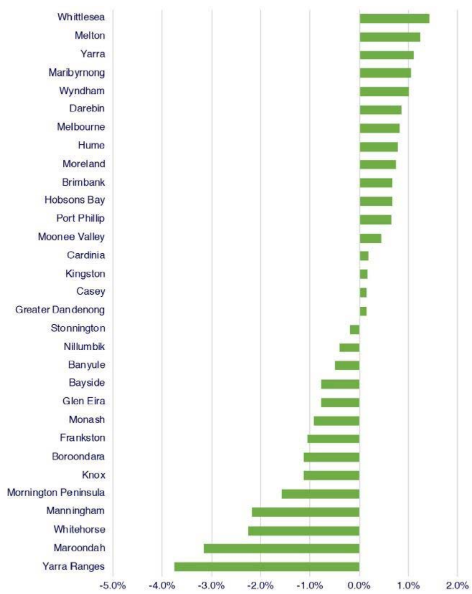


Figure 2.4: % Point Change in Urban Tree Canopy Cover by LGA 2014-2018 - Source: Planning Victoria



2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.1 URBAN CANOPY DISTRIBUTION

Canopy Cover by Land Use

The two largest land uses in Hobsons Bay are residential (36 % of total land area) and industrial lands (26%). There is a considerable variation between tree canopy in these land uses (over half of the city's total urban tree forest is in residential lands, whereas only one tenth of the total urban tree canopy is in industrial lands). Other land uses such as infrastructure (5%), commercial (1%) and mixed use (0.2%) take up small areas of land. These areas have limited capacity to provide substantial areas for additional tree canopy.

Street trees are a major contributor to urban canopy. Trees on residential streets form over one third (38%) of Hobsons Bay's urban forest. Trees on main roads contribute 0.4% of the LGA's urban forest. Even in locations where there are few streets, street verges provide the primary space for trees.

In industrial lands, streets comprise only 6% of the industrial land area but contain the same number of trees as all private industrial land combined. Even so, there is capacity to implement additional tree planting on street verges immediately. An assessment of street verges has found that simply planting in these zones can provide an additional 2% canopy cover to the LGA (approx. 18 000 large trees).

Another unique characteristic of Hobsons Bay is that almost one quarter (22%) of the LGA is comprised of public parklands and conservation reserves. However, many of these parks have very low canopy cover (5% or less). Over half (12%) of this land is in conservation zones, reserves and golf courses with many of these conservation zones being wetland and saltmarsh environments. Additional tree planting needs to be carefully considered in these zones to ensure there would be minimal impact on the ecological integrity and health of these vegetation communities.

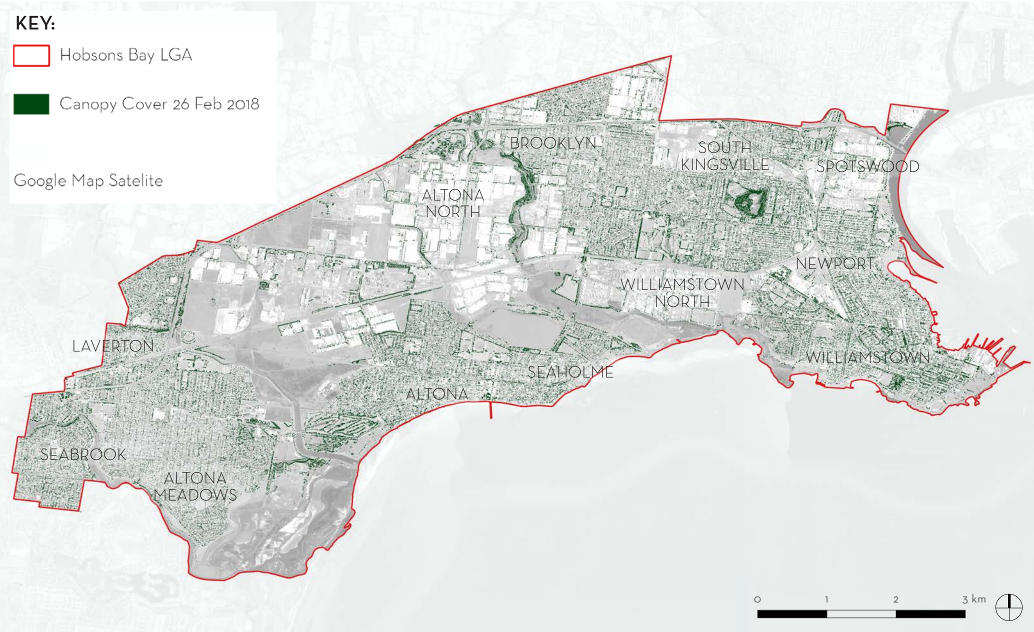
From this analysis, it is evident that the areas of public land with the most opportunity for additional tree planting are streets and public parks. Other public lands such as conservation lands, private golf courses, public facilities and Port of Melbourne Planning Scheme areas may have limited capacity for additional tree planting. There are also substantial opportunities available to increase tree canopy in industrial lands and on residential lands.

Figure 2.5: *Eucalyptus sp*

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

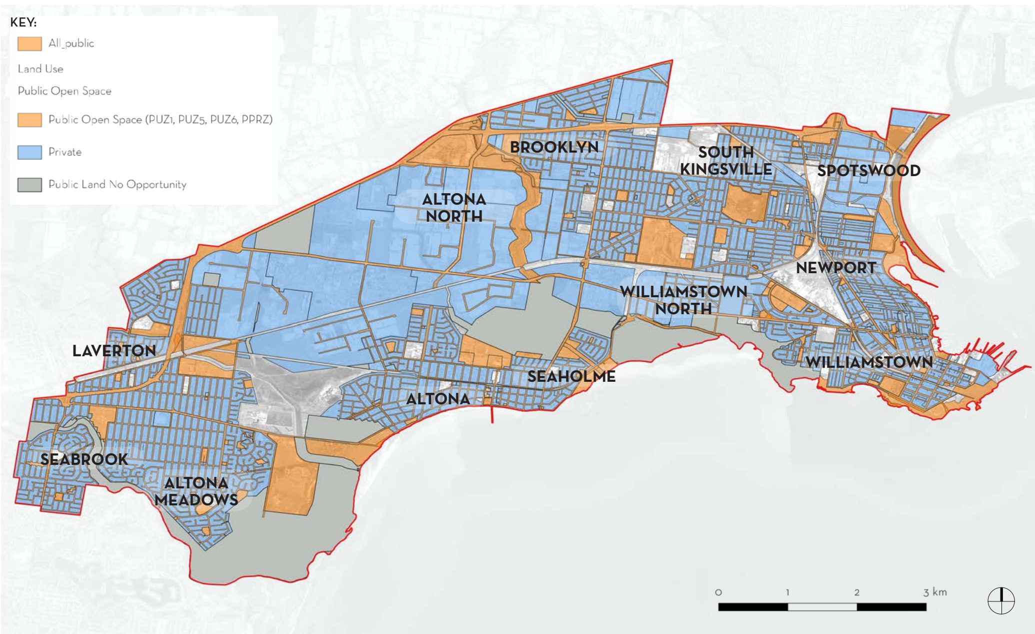
2.1 URBAN CANOPY DISTRIBUTION

Figure 2.6: Total Canopy Cover in LGA



7.5%
TOTAL CANOPY COVER
ACROSS HOBSONS BAY LOCAL GOVERNMENT AREA

Figure 2.7: LGA Proportion of Public and Private Land



4.7%
CANOPY COVER
As a proportion of the total Hobsons Bay Urban Forest.

26%
LGA PUBLIC LAND WITH OPPORTUNITY
Public land incl. land zones streets and public open space across the LGA.

0.8%
CANOPY COVER
As a proportion of the total Hobsons Bay Urban Forest.

20%
LGA PUBLIC LAND WITH LIMITED OPPORTUNITY
Conservation, land reserves, and private gold club.

2%
CANOPY COVER
As a proportion of the total Hobsons Bay Urban Forest.

54%
LGA PRIVATE LAND*
Private land incl. all residential, industrial, commercial, comprehensive development, mixed use land zones and land without category.

Note: Canopy cover calculations are based on LIDAR data collected on 26 Feb 2018 provided by council. Total canopy cover measured in Hobsons Bay City Council LGA boundary shape file is 4,844,500 sqm. This is 7.49% canopy cover across Hobsons Bay City Council. Total canopy cover in areas estimated is 4,866,793 sqm. (7.52% canopy cover across the LGA). The margin for error is 0.03%.

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.2 TREE SPECIES

2.2 TREE SPECIES

In urban environments, trees can be impacted by harsher conditions, such as low water availability, reduced soil volumes and regular disruptions to roots and canopies. This can make trees susceptible to death and decline from changes caused by urban development and modified climate. The diversity of a city's tree species can help to minimise impact from these disruptions and can provide greater resilience.

Hobsons Bay's street and park trees contain around 147 separate genera and more than 550 different species within these genera. However only 20 genera were in large enough numbers to be statistically significant. Over 87% of trees in Hobsons Bay belong within 20 genera. An extensive review of the city's park and street tree species was undertaken by Alison Jasper in 2018. Key findings from the report are noted below.

Lack of Diversity and Vulnerability

Jasper's study found that 50% of Hobsons Bay's street and park trees are in the Myrtaceae family. This dominance of a single family or genus within a family can leave the overall tree population at risk of mass decline if a pest or disease is introduced. This issue was highlighted in recent years with the discovery of Myrtle Rust (*Puccinia psidii*) in the Greater Melbourne area. At this point, the impact of Myrtle rust has been low although its presence highlights the potential impact that such a disease could have. This species targets primarily members of the Myrtaceae family. This has the potential to significantly impact trees in the LGA.

Approximately one quarter of public street and park trees (24%) are in the Eucalyptus genus. While this makes up a large proportion of trees, this genus of tree is well adapted to the local soil and climatic conditions. Careful species selection may limit issues with this tree genus and there is potential to trial the use of other species to ensure long term success. Issues such as limb failure potential can generally be managed with formative pruning during the establishment years. This form of treatment can provide high value trees with minimal maintenance requirements.

	GENUS	% OF POPULATION
1	Eucalyptus	24.2%
2	Melaleuca	10%
3	Callistemon	7.1%
4	Acacia	6.6%
5	Corymbia	6%
6	Allocasuarina	3.6%
7	Casuarina	3.2%
8	Lophostemon	3.9%
9	Prunus	2.9%
10	Ulmus	2.7%
11	Pyrus	2.7%
12	Lagunaria	2%
13	Fraxinus	1.8%
14	Olea	1.8%
15	Angophora	1.7%
16	Melia	1.6%
17	Lagerstroemia	1.5%
18	Banksia	1.3%
19	Cupressus	1.25%
20	Agonis	0.9%

Figure 2.8: Top 20 genera in Hobsons Bay

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.2 TREE SPECIES

Tree selection

There were higher numbers of complaints associated with several genera but notably within areas with higher densities of *Lagunaria patersonia* (Norfolk Island Hibiscus), mature Melaleucas and mature *Melia azedarach* (White Cedar). *Lagunaria patersonia* (Norfolk Island Hibiscus) is known to cause health issues and it is acknowledged that this species of tree is unlikely to be a suitable future street tree.

Melaleuca is the second most prevalent genus in park areas and the third in streetscapes. Melaleuca was a popular genus for street tree plantings from 30 – 40 years ago and is known to be relatively hardy and adaptable to a wide range of growing conditions. They have not been used as widely in recent years and several species are now known to be environmental weeds. They have often been associated with a high number of customer service requests.

Of note is research highlighting the importance of taller trees with wider canopies to improve local temperatures and mitigate urban heat. Providing street and park tree species of an appropriate size is an important factor in combating urban heat and should be a priority in future tree species selection.

Figure 2.9: *Lagunaria patersonia*, Norfolk Hibiscus

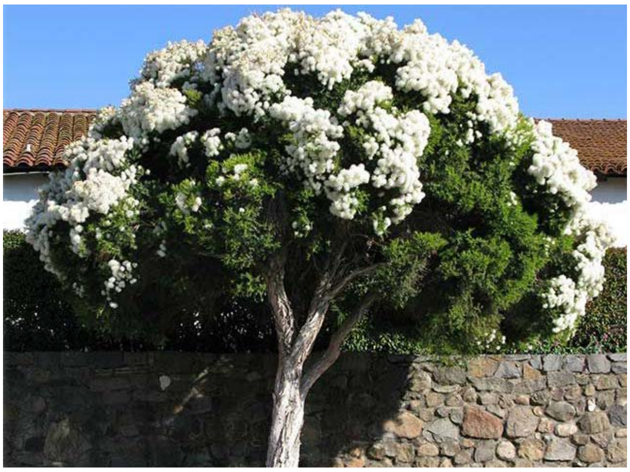


Figure 2.10: *Melaleuca liniariifolia*, Snow In Summer

Figure 2.11: *Melia azedarach*, White Cedar

2.0 THE EXISTING URBAN FOREST IN HOBSONS BAY

2.3 TREE HEALTH AND LONGEVITY

2.3 TREE HEALTH AND LONGEVITY

Approximately 70% of Hobsons Bay's street and park trees have been assessed to determine their useful life expectancy. The Useful Life Expectancy (ULE) is the length of time that a tree is likely to remain in the landscape based on their health, amenity and environmental services. Of the trees assessed in Hobsons Bay, close to half (33%) had a ULE of 20 years or more, and half (33%) had a ULE of 5 - 20 year. Only 3% had a ULE of 1 – 5 years and 1% had a ULE of 1 year or less. Over half of the trees assessed (42,933 trees) were determined to be in good health.

The lack of comprehensive data available on the city's trees means that it is difficult to adequately determine the capacity or long-term health of the city's trees. It is also considered that the ULE categories of 5 – 20 years and 20+ years may be too broad to be able to adequately determine long term health or to plan for replacements. A priority would be to expand and review the current database to provide more detailed ULE information and to provide a more in-depth ULE categorisation (11 - 20 years, 20 – 30 years, 31 – 60 years).

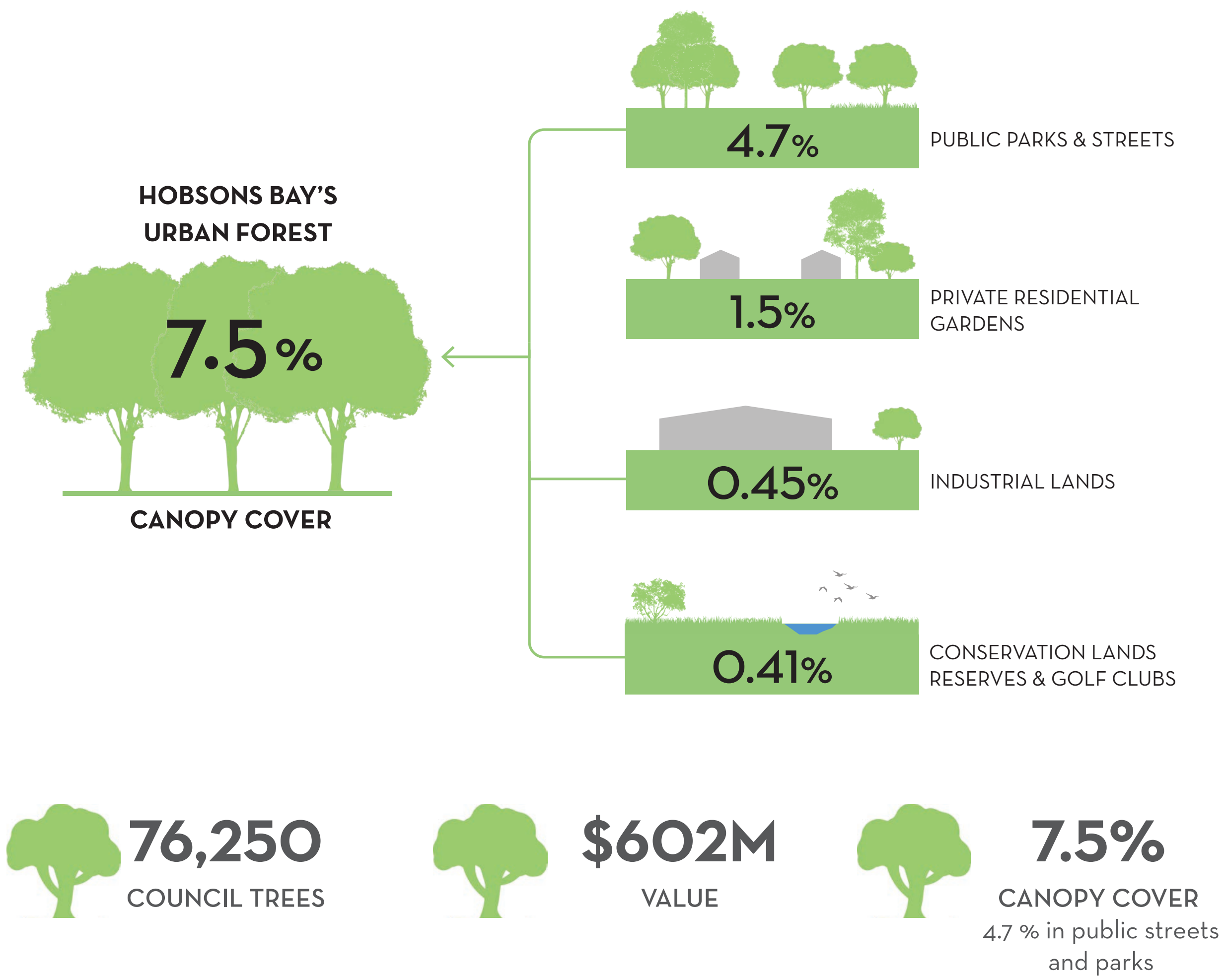
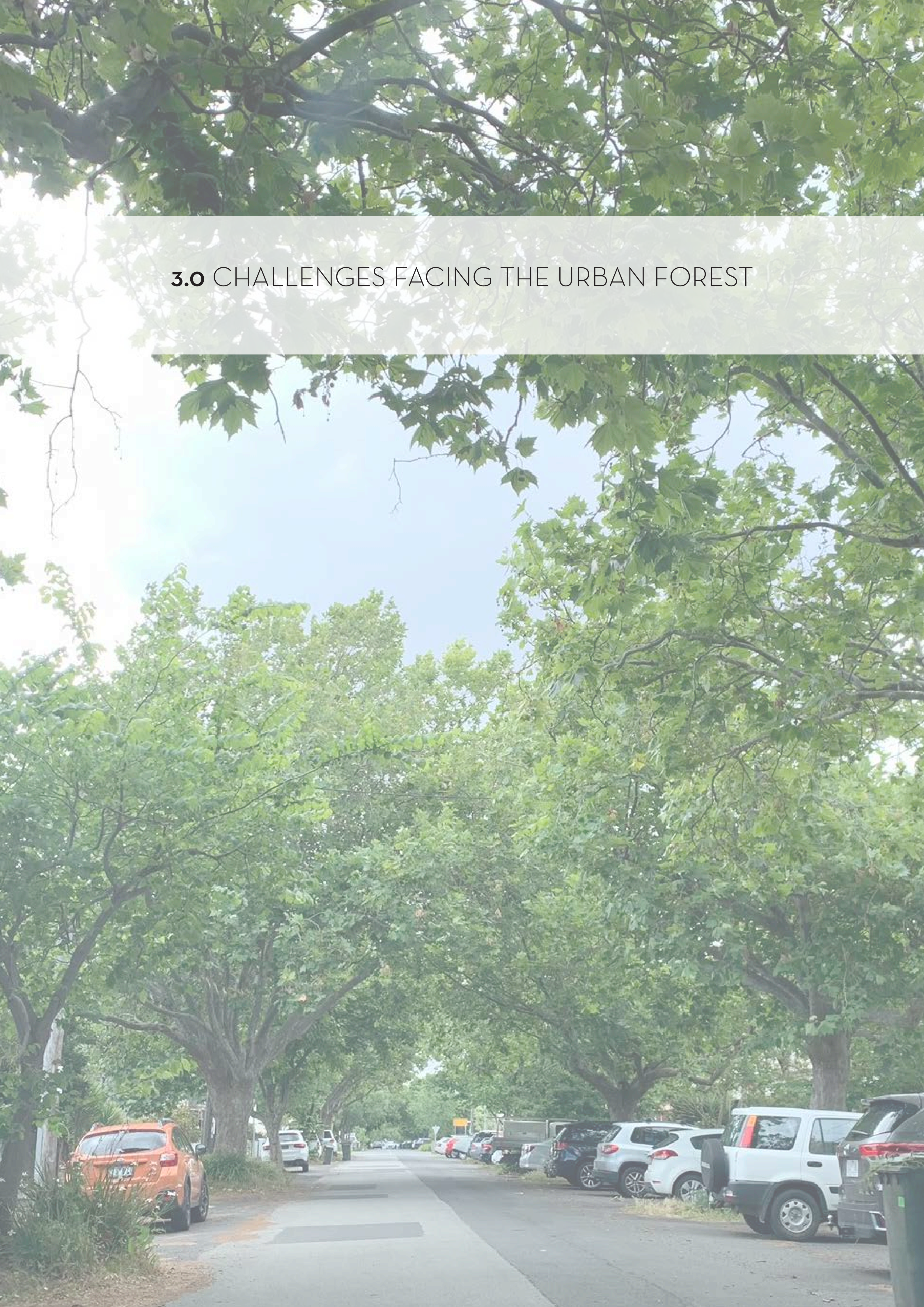


Figure 2.12: Hobsons Bay's existing urban forest location and value.

3.0 CHALLENGES FACING THE URBAN FOREST



3.0 CHALLENGES FACING THE URBAN FOREST IN HOBSONS BAY

3.1 CLIMATE CHANGE AND URBAN HEAT

3.1 CLIMATE CHANGE AND URBAN HEAT

Climate change, according to the Victoria Government, will affect all communities. Action to reduce greenhouse gas emissions is critical, the impact of existing emissions mean that changes to climate are already underway. Victoria is predicted to be warmer and drier, with higher year-round temperatures, fewer frosts, more frequent and intense downpours, less rainfall in winter and spring. The urban heat island - the phenomena of increased temperature in urban areas, caused by loss of vegetation and changes in built form can be exacerbated by climate change. Data produced by the Victorian Government indicates that on average, Melbourne's urban areas are over 8˚C hotter than non-urban areas.

The intensity and duration of heat waves can be increased, causing critical urban infrastructure to malfunction or fail, and interrupt health services such as medical supplies, hospitals and emergency services (Cretikos et al 2007). Heat can also increase smog levels which increases respiratory illness. Heat wave events have been linked to higher hospital admissions, not only for heat related injuries but a wide range of illnesses including cardiovascular disease, diabetes, mental disorders and renal disease (Wilson et al 2013). In Melbourne, deaths begin to rise when the mean daily temperature reaches 28°C, with hospital admissions for heart attacks increasing by nearly 11% when the mean daily temperature reaches 30°C. The elderly, the very young, infirm and the economically disadvantaged city dwellers suffer the most in these conditions.

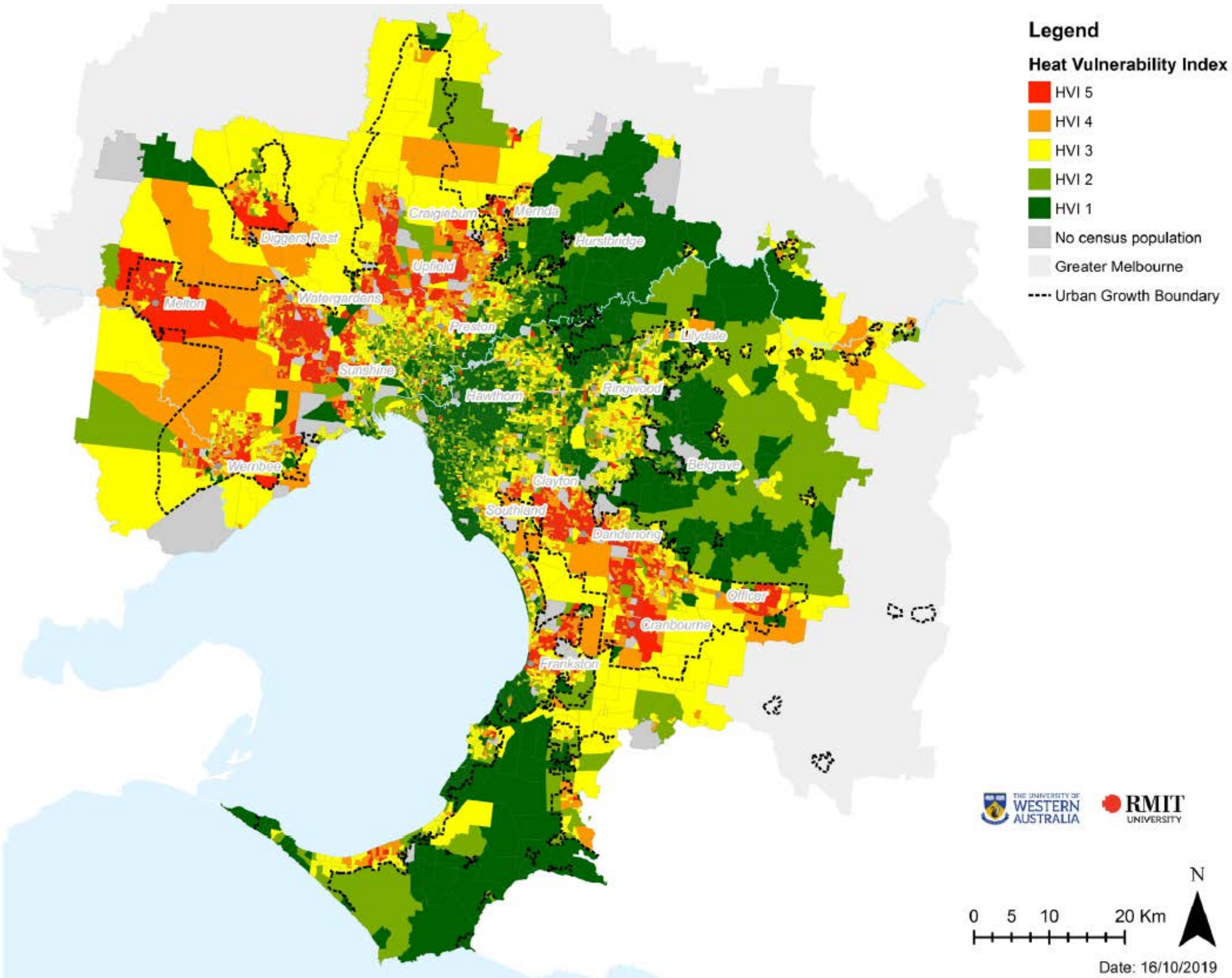


Figure 3.1: Heat Vulnerability Index across Metropolitan Melbourne. Source: State Government Victoria.

3.0 CHALLENGES FACING THE URBAN FOREST IN HOBSONS BAY

3.1 CLIMATE CHANGE AND URBAN HEAT

Hobsons Bay is vulnerable to the adverse effects of climate change. Sea level rise, coastal erosion and storm surge will affect housing and infrastructure. Heatwaves will also increase in frequency and intensity, putting people at risk. The Heat Vulnerability Index (HVI) developed by Planning Victoria assesses how vulnerable specific populations are to extreme heat events based on three indicators - heat exposure, sensitivity to heat and adaptive capability. The index rates areas on a scale from 1 to 5, with 5 representing high vulnerability. In Hobsons Bay, some suburbs have been identified as 4 on the index. These areas include the suburbs in the south and west including Altona North, Altona Meadows, Seabrook, Laverton and Brooklyn.

Tree health and climate change

Tree canopy has been found to be effective in reducing urban heat and mitigating the urban heat island. However, trees will also be affected by changes to climate, particularly through changes to rainfall patterns. Extreme weather events such as storms can damage trees. Heat waves can impact on tree canopy and result in trunk scorch. Urban trees can also be vulnerable to climate change through shifts in tree habitat suitability and potential for increases in pests and diseases. With 50% of the LGA's street and park trees in the Myrtaceae family, the dominance of a single family can leave the overall tree population at risk of mass decline if a pest or disease is introduced. The discovery of Myrtle Rust (*Puccinia psidii*) in the Greater Melbourne area may substantially impact on the LGA's trees.

Tree canopy in Hobsons Bay is already challenged due to the LGA's soils, wind exposure, and contaminated lands. Changed local climates will place further pressure on tree health. Strategies need to be employed to improve tree health and resilience. 'Tree friendly' civil and engineering design standards can be developed to maximise tree health. Design standards that are 'tree friendly' requires adequate provision of soil, use of permeable materials, minimising impact of services and unnecessary future design changes, integration of passive watering and designing adequate space above and below ground for healthy tree growth. Water sensitive urban design measures are integral to improve tree health.

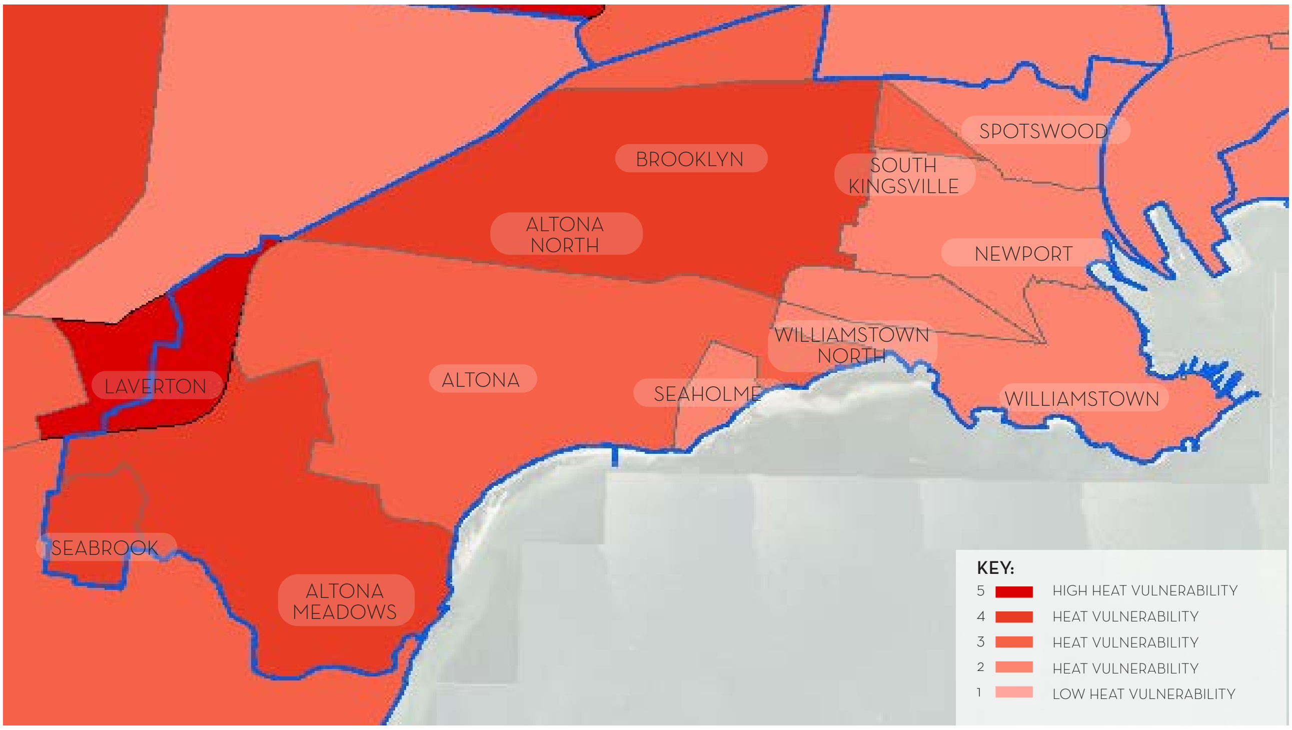


Figure 3.2: Heat Vulnerability Index 2018 in Hobsons Bay. Source: State Government Victoria.

3.0 CHALLENGES FACING THE URBAN FOREST IN HOBSONS BAY

3.2 DEVELOPMENT AND CHANGE

3.2 DEVELOPMENT AND CHANGE

The changing urban and development context is a significant challenge for urban tree canopy. The resident population in Hobsons Bay is forecast to increase from an estimated 88,990 people to 107,240 people by 2036 (Hobsons Bay Activity Centres Strategy 2019). Most population growth is forecast in the North Precinct, primarily in Altona North, Spotswood, and South Kingsville. Activity Centres will play an increasingly significant role in accommodating urban growth and development. Within Hobsons Bay, three Major Activity Centres are identified - Altona (Altona Beach), Altona North (Altona Gate Shopping Centre) and Williamstown.

This will require an adequate supply of housing delivered through urban renewal, infill and green field development. This development often leads to existing vegetation being removed and replaced with hard paved surfaces. With many neighbourhoods transitioning from single dwellings to higher density apartments, designing to allow appropriate space for urban trees is critical. Increased tree shade will also be required to encourage walkability.

Developing and integrating clear goals and targets across all planning controls and mechanisms can protect the existing and future urban tree canopy. This may include incorporating tree targets into the planning scheme, to be part of planning approval requirements, municipal strategic statements and neighbourhood character statements. There is capacity to support and strengthen tree canopy into other council polices such as biodiversity plans, climate change adaptation plans and the integrated water strategy. Compliance and tree protection may also require strengthening to protect existing trees on private land.

Community and landowner acceptance and engagement will be critical to the success of the urban forest. Innovative methods to encourage greater acceptance of trees in streets and encourage planting on private land will be vital. The importance of tree canopy– linked to broader messages of climate resilience and urban heat can foster wider acceptance.

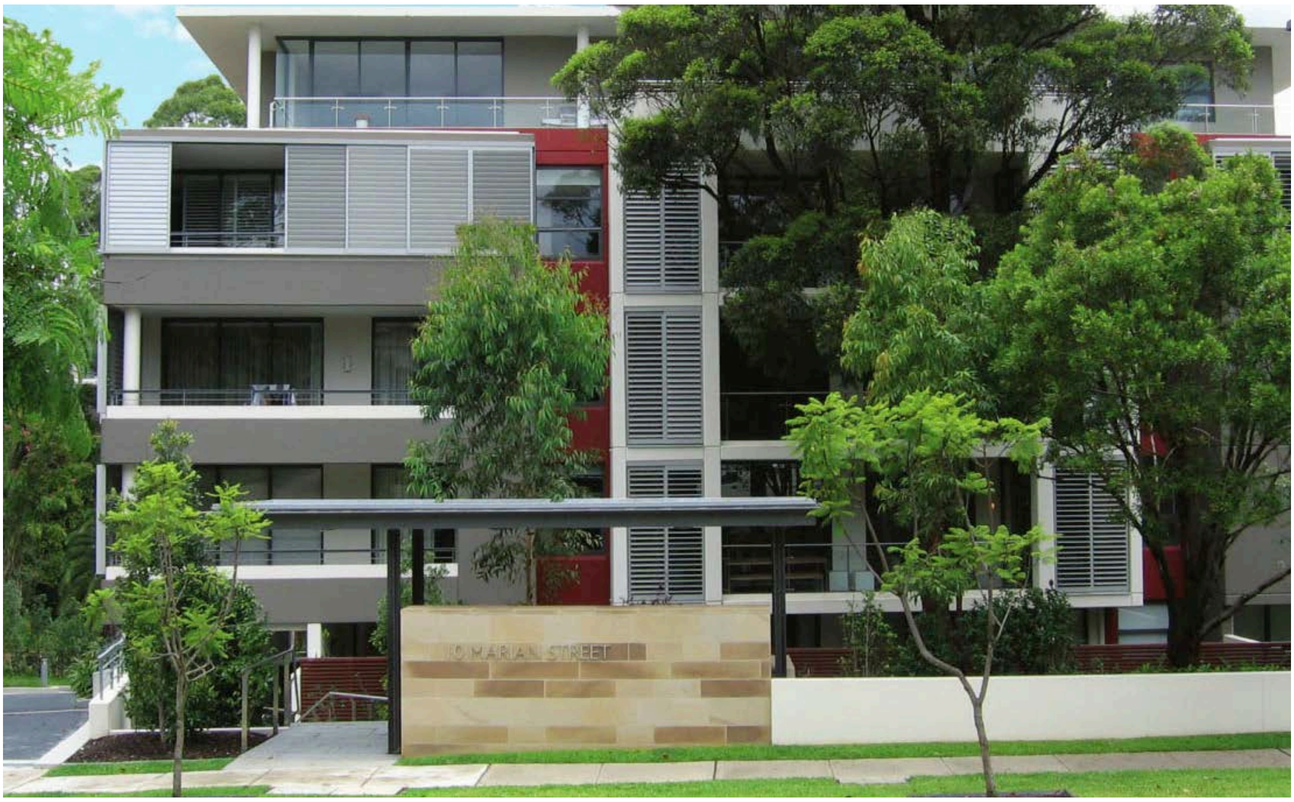


Figure 3.3 New trees and gardens within new high density developments.

3.0 CHALLENGES FACING THE URBAN FOREST IN HOBSONS BAY

3.2 DEVELOPMENT AND CHANGE

Governance and integration

A key factor is the complicated governance structures that manage urban trees. Urban tree canopy crosses multiple jurisdictions and disciplinary boundaries and can be impacted by decisions from multiple parties. Furthermore, the absence of priorities and goals for urban tree canopy further complicates this context. Adopting clear goals, targets and standards and mechanisms to deliver these targets, can provide clarity and facilitate a coordinated process for prioritising and planning for urban tree canopy.

The Victorian Government has noted that councils are often best placed to help the local community reduce risks and adapt to climate change (Department of Environment Land, Water and Planning 2020). Tree canopy as a core adaptive measure, to protect community health and wellbeing will require a holistic and integrated approach across council services and departments. This will require additional resources including staffing to undertake planning reviews and approvals, provide ongoing tree management and input on capital projects.

Urban infrastructure

The design of urban infrastructure – roads, utilities, etc. are critical to providing capacity for urban tree canopy. Historically urban infrastructure has not prioritised designs to accommodate urban trees. This can limit space above and below ground for trees, allow for only small urban trees or remove tree capacity altogether. In Hobsons Bay, existing infrastructure (such as the LGA's extensive gas pipelines) and new infrastructure (such as the Westgate tunnel) impacts on tree canopy. Additionally, powerlines can impact on the establishment of an urban canopy. In Hobsons Bay 23% of all trees in the asset database are located under powerlines.

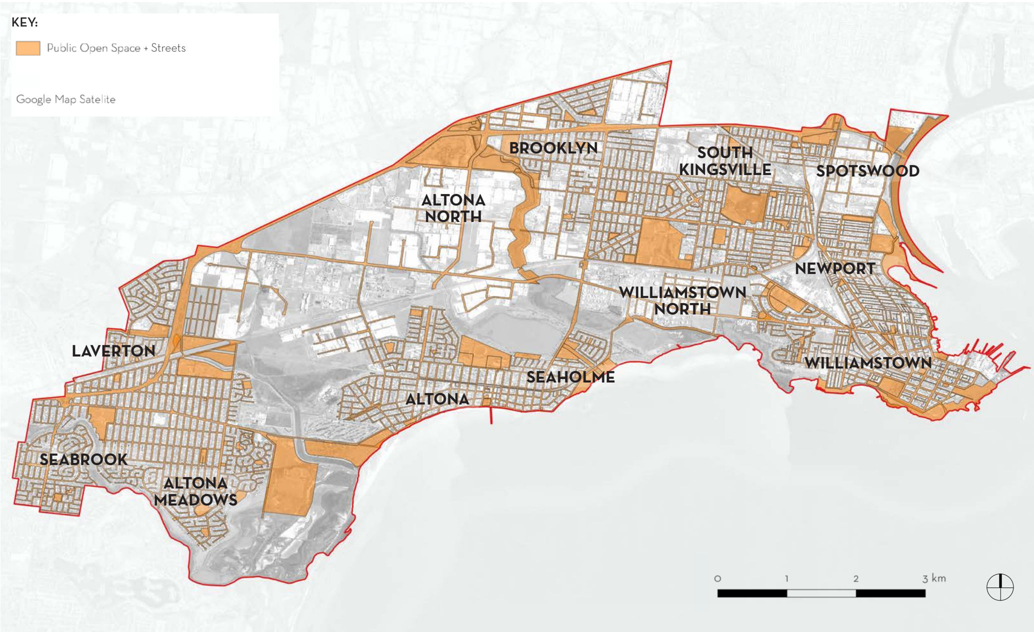
Effective tree canopy of medium and large trees provide the most effective shade and urban heat mitigation benefits. A collaborative cross disciplinary approach is required to design and develop grey infrastructure for urban tree canopy. Holistic streetscape design, that integrates trees as priority in all streetscape design is necessary and early integration for trees at project outset can overcome obstacles. Collaboration with other infrastructure stakeholders, such as VicRoads and Melbourne Water, can improve tree canopy provision.

Figure 3.4 Maximising tree canopy within wide street verges.

APPENDIX 1

URBAN CANOPY DISTRIBUTION

Canopy Cover on Public Land



25.7%

LGA PUBLIC LAND WITH OPPORTUNITY

Public land incl. land zones streets and public open space across the LGA.

4.7%

CANOPY COVER ON PUBLIC LAND

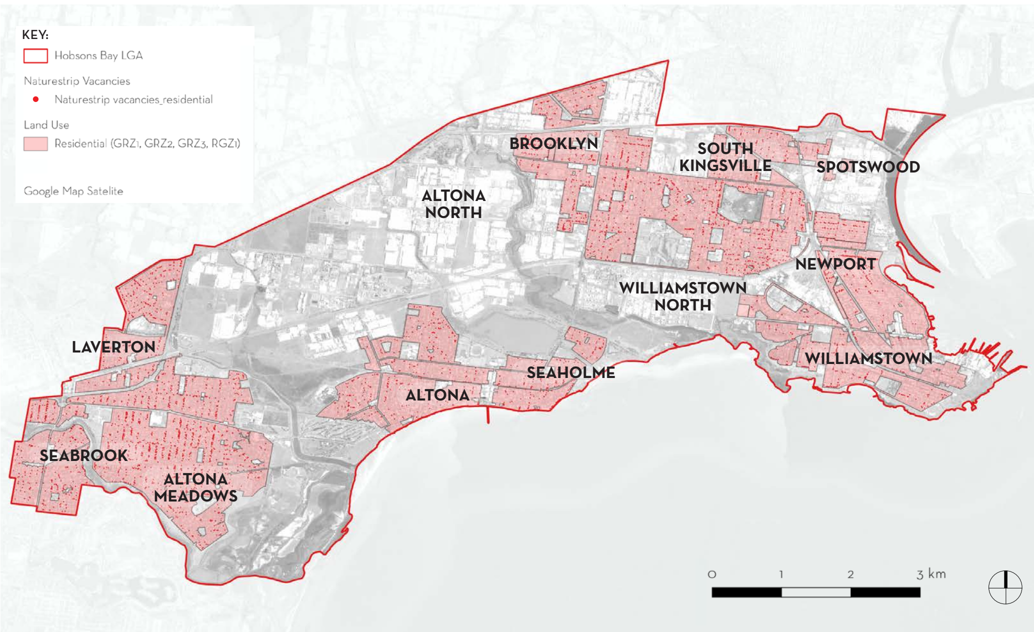
As a proportion of the total Hobsons Bay Urban Forest.

5,717 NATURE STRIP VACANCIES

1.02% INCREASE
Based on 3 x 7m trees per vacancy

2.08% INCREASE
Based on 3 x 10m trees per vacancy

Residential: Public and Private Land



36%

LGA RESIDENTIAL LAND
TOTAL PROPORTION OF RESIDENTIAL LAND IN THE LGA

25% PUBLIC STREETS / 75% PRIVATE LAND

1.47%

CANOPY COVER ON RESIDENTIAL PRIVATE LAND

As a proportion of the total Hobsons Bay Urban Forest.

3,975 NATURE STRIP VACANCIES

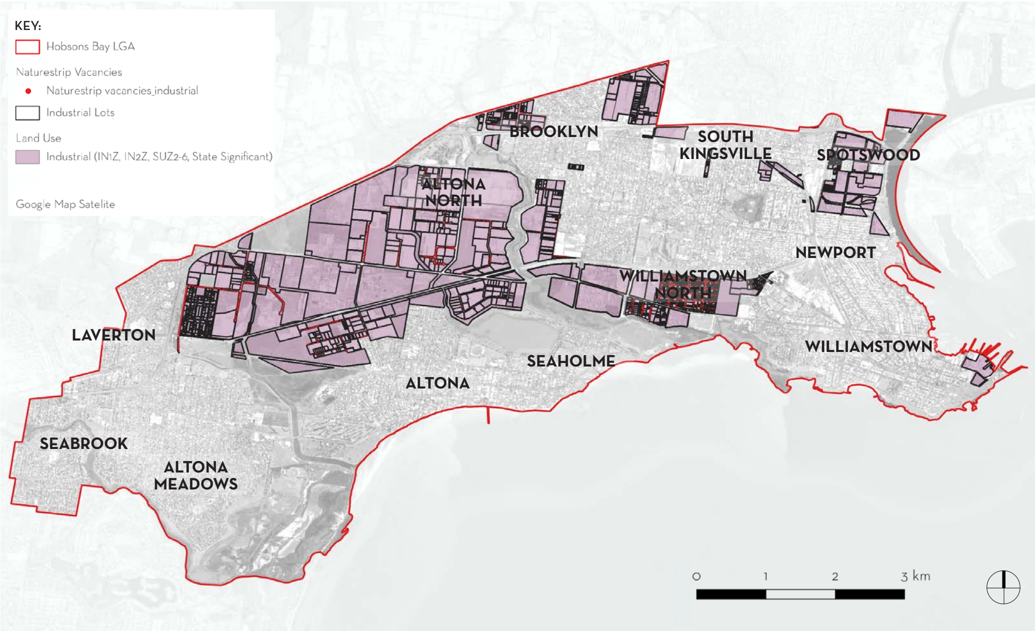
0.71% INCREASE
Based on 3 x 7m trees per vacancy

1.45% INCREASE
Based on 3 x 10m trees per vacancy

APPENDIX 1

URBAN CANOPY DISTRIBUTION

Industrial: Public and Private Land



26%
INDUSTRIAL PUBLIC & PRIVATE
TOTAL PROPORTION OF INDUSTRIAL LAND IN THE LGA

6% PUBLIC STREETS/
94% PRIVATE LAND

0.44%
CANOPY COVER INDUSTRIAL PRIVATE LAND
As a proportion of the total Hobsons Bay Urban Forest.

1,169
NATURE STRIP VACANCIES

0.21%
INCREASE
Based on 3 x 7m trees per vacancy

0.43%
INCREASE
Based on 3 x 10m trees per vacancy

Conservation, Land Reserves and Private Golf Courses

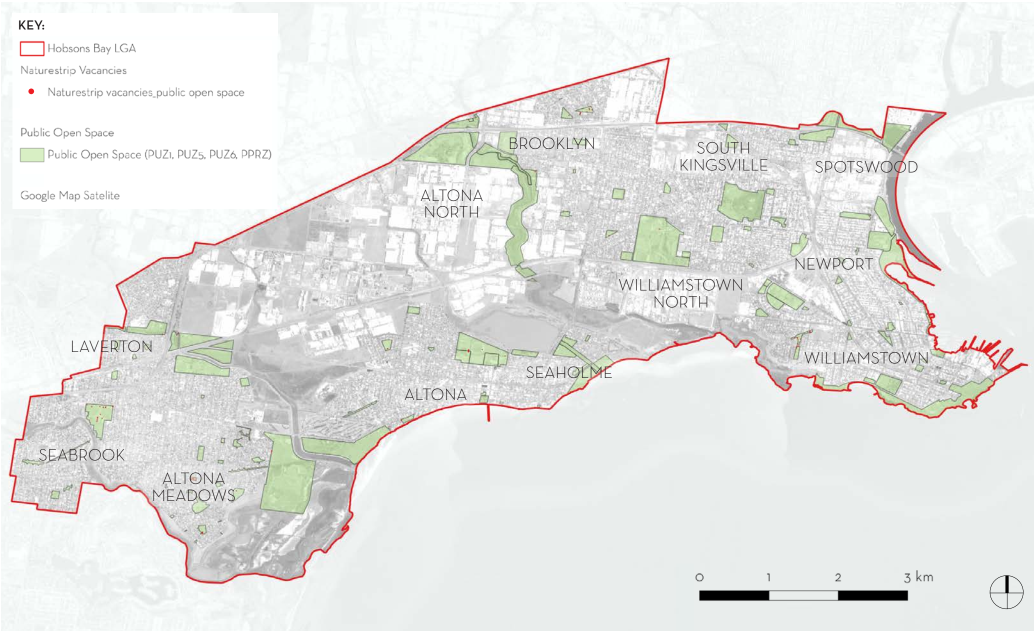
12%
CONSERVATION, LAND RESERVE AND PRIVATE GOLF CLUB
TOTAL PROPORTION OF CONSERVATION/ GOLF COURSE LAND IN THE LGA

0.41%
CANOPY COVER
As a proportion of the total Hobsons Bay Urban Forest.

APPENDIX 1

URBAN CANOPY DISTRIBUTION

Public Open Space



10%
PUBLIC OPEN SPACE
TOTAL PROPORTION OF PUBLIC LAND IN THE LGA

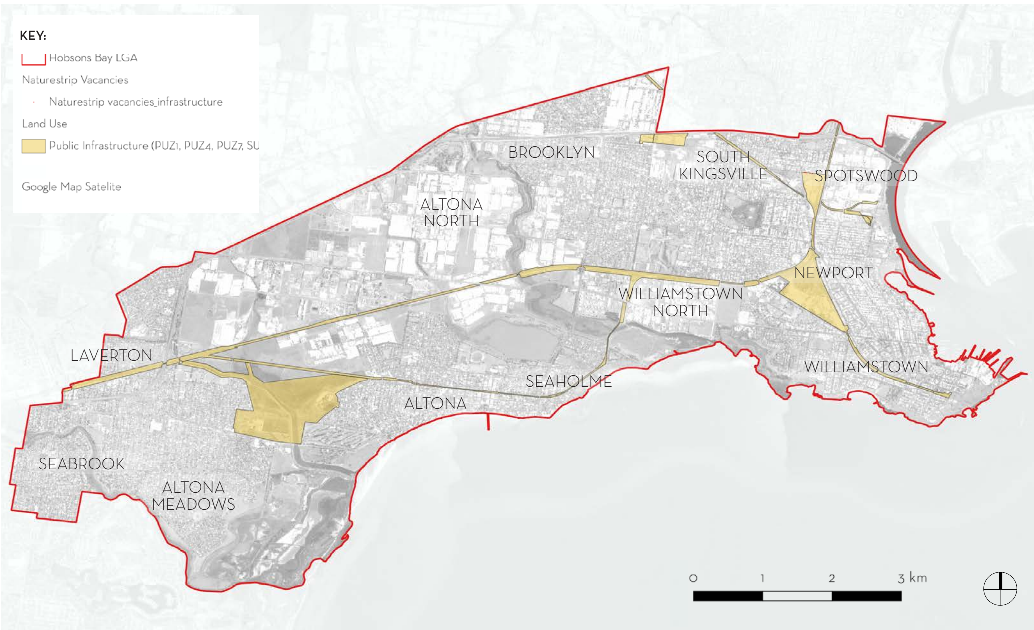
1.1%
CANOPY COVER PUBLIC OPEN SPACE
As a proportion of the total Hobsons Bay Urban Forest.

71
NATURE STRIP VACANCIES

0.01%
INCREASE
Based on 3 x 7m trees per vacancy

0.03%
INCREASE
Based on 3 x 10m trees per vacancy

Infrastructure: Public and Private Land



6%
INFRASTRUCTURE PUBLIC & PRIVATE
TOTAL PROPORTION OF LAND IN THE LGA

0.21%
CANOPY COVER INFRASTRUCTURE PRIVATE LAND
As a proportion of the total Hobsons Bay Urban Forest.

5
NATURE STRIP VACANCIES

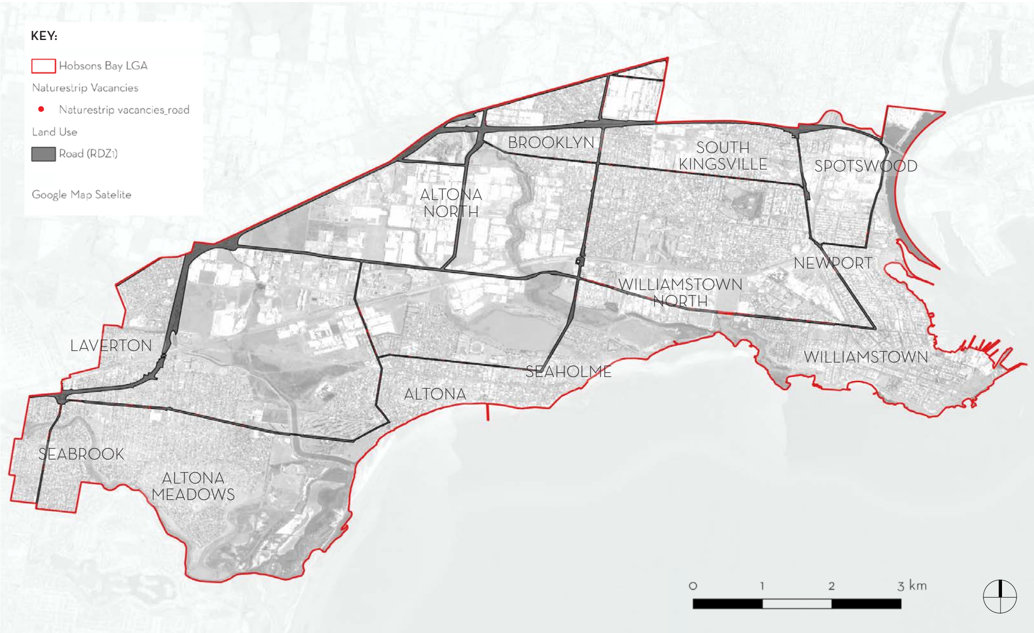
<0.01%
INCREASE
Based on 3 x 7m trees per vacancy

<0.01%
INCREASE
Based on 3 x 10m trees per vacancy

APPENDIX 1

URBAN CANOPY DISTRIBUTION

Roads



4%
ROAD
TOTAL PROPORTION OF LAND IN THE LGA

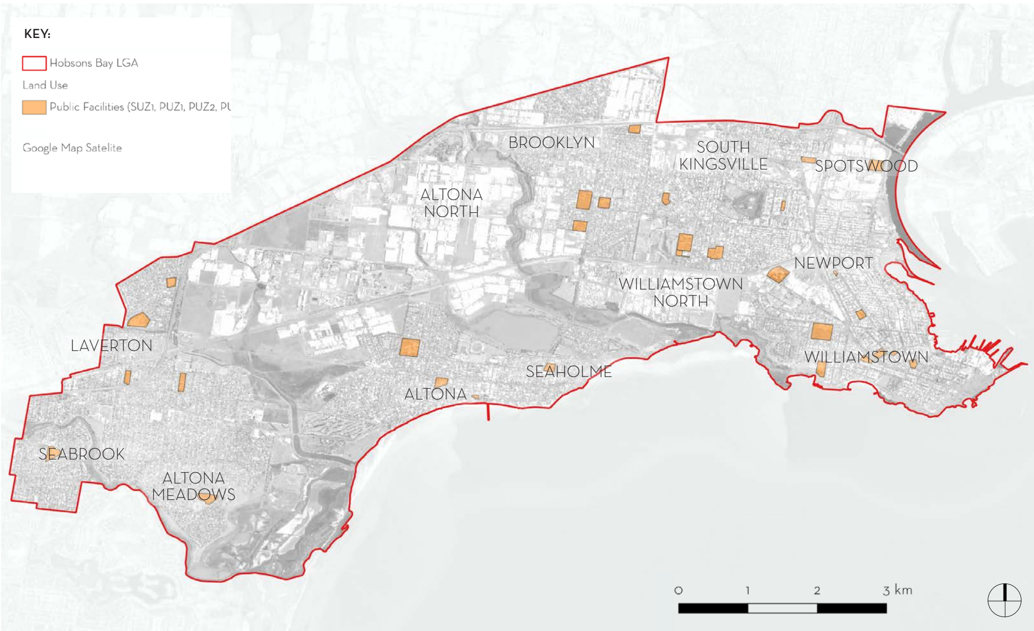
0.4%
CANOPY COVER ROADS
As a proportion of the total Hobsons Bay Urban Forest.

424
NATURE STRIP VACANCIES

0.1%
INCREASE
Based on 3 x 7m trees per vacancy

0.2%
INCREASE
Based on 3 x 10m trees per vacancy

Public Facilities



1%
PUBLIC FACILITIES
TOTAL PROPORTION OF LAND IN THE LGA

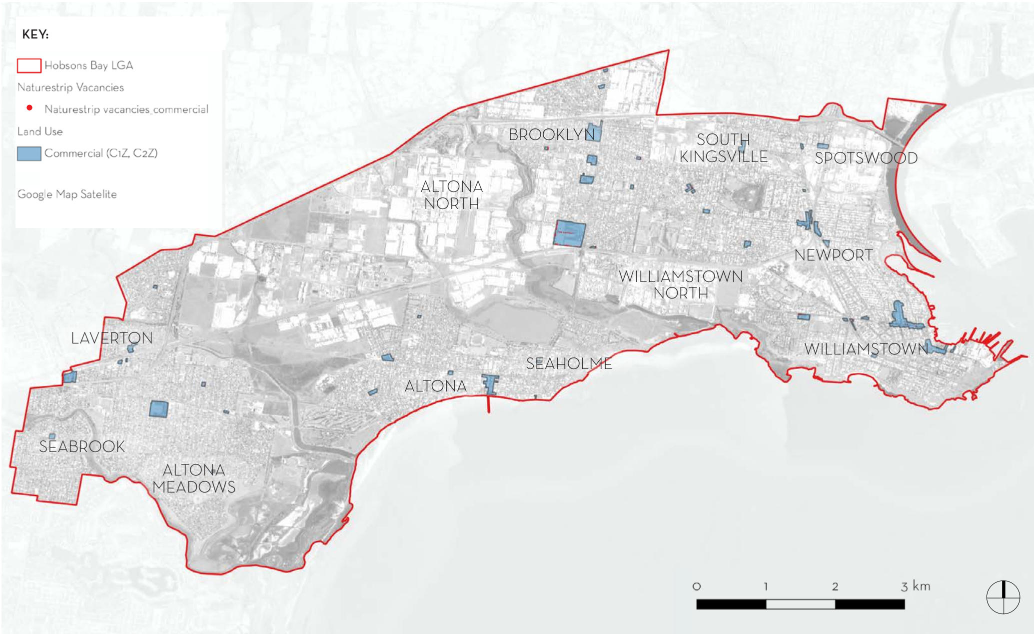
0.2%
CANOPY COVER PUBLIC FACILITIES
As a proportion of the total Hobsons Bay Urban Forest.

0
NATURE STRIP VACANCIES

APPENDIX 1

URBAN CANOPY DISTRIBUTION

Commercial: Public and Private



1%

COMMERCIAL PUBLIC & PRIVATE

TOTAL PROPORTION OF LAND IN THE LGA

24% PUBLIC STREETS / 76% PRIVATE LAND

< 0.1%

CANOPY COVER COMMERCIAL PRIVATE LAND

As a proportion of the total Hobsons Bay Urban Forest.

55

NATURE STRIP VACANCIES

0.01%

INCREASE

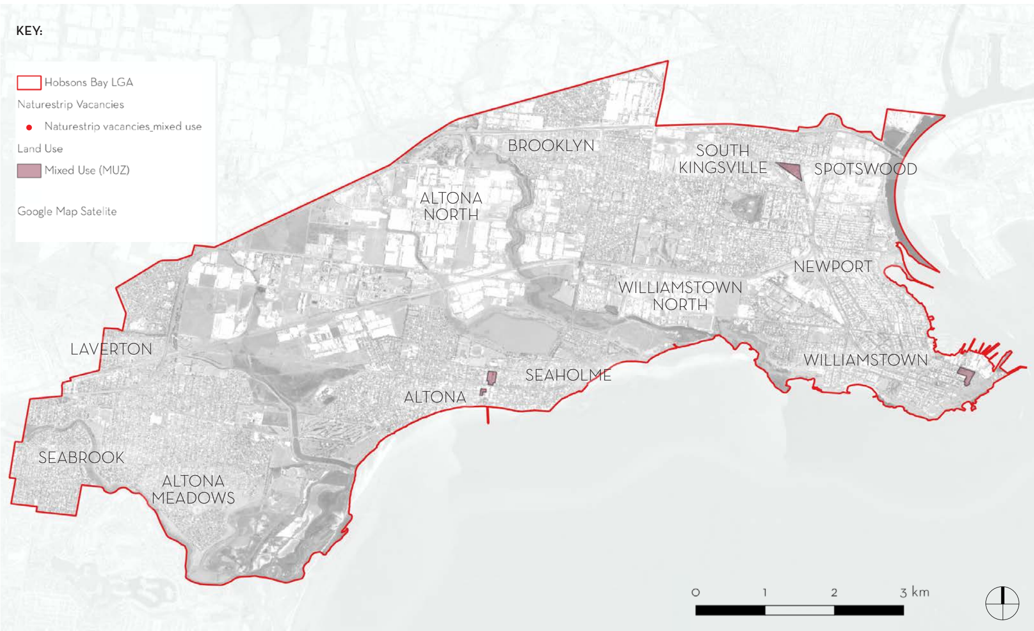
Based on 3 x 7m trees per vacancy

0.02%

INCREASE

Based on 3 x 10m trees per vacancy

Mixed Use: Public and Private



<1%

MIXED USE PUBLIC & PRIVATE

TOTAL PROPORTION OF LAND IN THE LGA

19% PUBLIC STREETS / 81% PRIVATE LAND

< 0.1%

CANOPY COVER MIXED USE

As a proportion of the total Hobsons Bay Urban Forest.

55

NATURE STRIP VACANCIES

< 0.01%

INCREASE

Based on 3 x 7m trees per vacancy

< 0.01%

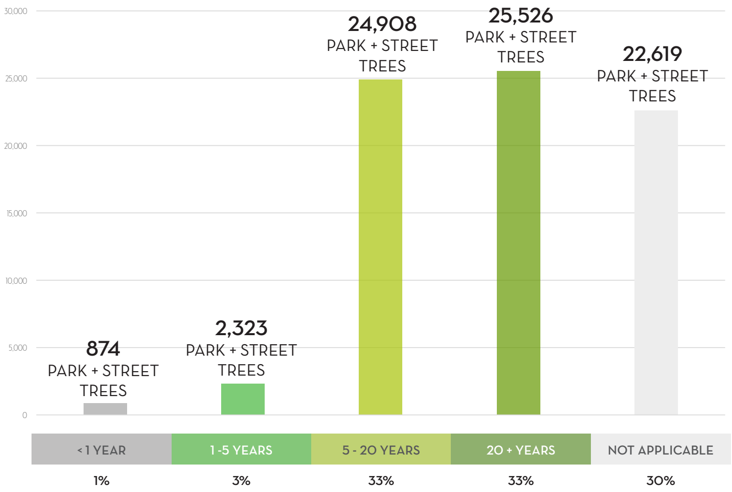
INCREASE

Based on 3 x 10m trees per vacancy

APPENDIX 2

USEFUL LIFE EXPECTANCY FOR TREES IN HOBSONS BAY

Useful Life Expectancy for Hobsons Bay's Street and Park Trees



GLOSSARY

Biodiversity refers to the wide variety of ecosystems and living organisms from all sources including terrestrial, marine and other aquatic ecosystems, their habitats and their genes, and the ecological complexes of which they are part. Biodiversity also refers to the degree of variation of life forms within a given species or ecosystem, and is a measure of the health of ecosystems.

Botanical family (pl. families). A taxonomic group composed of one or more genera. The names of most botanical families end in '-aceae' (e.g., Myrtaceae, Ulmaceae, Plantanaceae etc.), however, there are some exceptions. Groups of similar families are placed in orders.

Botanical genus (pl. genera). A taxonomic group consisting of related species that resemble each other more closely than they resemble other groups. Genus is subordinate to family and ranked above species. The genus name forms the first part of a scientific name (e.g., *Eucalyptus leucoxylon*) and is written in Latin with the first letter capitalized. Collections of similar genera are grouped into families.

Canopy (in addition to the definition in Section 2.1). The uppermost branches of the trees in a forest, forming a more or less continuous layer of foliage.

A carbon sink is a natural or artificial reservoir process that accumulates and stores any carbon-containing chemical compound for an indefinite period, thus lowering the amount of carbon dioxide in the atmosphere.
Photosynthesis by terrestrial plants is a major natural carbon sink.

Climate change adaptation refers to the ability of natural or human systems (i.e. ecosystems or communities) to adjust in response to actual or expected climate change, including climate variability and extremes. It involves a process (or outcome of processes) of anticipating or monitoring change and undertaking actions to address the consequences of that change – such as moderating potential damage, reducing harm or risk of harm, coping with the consequences, and taking advantage of beneficial opportunities (evident or unforeseen) of climate events, variability and climate change.

Greenfield sites are areas of land, often in rural or countryside areas in proximity to towns and cities that have not been built on before but are being considered for urban development. While these areas usually support agricultural or environmental amenity, as development potential they offer better access, have less congestion, a more pleasant environment, and have more space to expand.

Resilience is the capacity to deal with change and continue to develop. Ecological resilience refers to the capacity of an ecosystem or natural population to resist or recover from major changes in structure and function following natural or human-caused disturbances, without undergoing a shift to a vastly different regime but remain within its natural variability and viability. Social resilience is the ability of human communities to withstand and recover from stresses, such as environmental change or social, economic or political upheaval. Resilience in societies and their life-supporting ecosystems is the key to sustainable development and is crucial in maintaining options for future human development.

Urban forest (in addition to definition in Section 1.1). 'The art, science and technology of managing trees and forest resources in and around urban community ecosystems for the physiological, sociological, economic and aesthetic benefits trees provide society'. (Helms, 1998) 'The art, science and technology of managing trees, forests and natural systems in and around cities, suburbs and towns for the health and wellbeing of all people'. (USDA Forest Service).

Urban forestry is a planned and programmatic approach to the development and maintenance of an urban forest, including all elements of green infrastructure within the community, especially when resulting from a community visioning and goal-setting process. (Schwab, 2009). In its broadest sense, it is a multidisciplinary process that takes account of water municipal water catchments, wildlife habitats, outdoor recreation opportunities, design, and care of trees and cultivated landscapes.

Urban Heat Island Effect (UHI) or urban heat refers to the significantly warmer temperatures found in urban areas in comparison to surrounding areas due to there being less green cover and more hard surfaces which absorb, store and radiate heat.

Useful Life Expectancy (ULE) (in addition to the definition in Section 2.3) is the safe 'with an acceptable level of risk' life expectancy of a tree modified by economic considerations (Jeremy Barrell 1996). The objective of an ULE assessment is to determine the relative value of individual trees for the purpose of informing future management options.

Vulnerability refers to the propensity and degree of sensitivity of social and ecological systems to suffer from exposure to external stresses and shocks. It is generally regarded as the antithesis of resilience.

Water Sensitive Urban Design (WSUD) is an approach to urban planning and design that is 'sensitive' to the issues of water sustainability, resilience and environmental protection. The strategy is often to reuse stormwater, stopping it from reaching natural waterways by mimicking the natural water cycle as closely as possible.

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Photographer: Jim Paynes. Source: Museums Victoria.

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Figure 3.3 New trees and gardens within new high density developments.

Figure 3.4 Maximising tree canopy within wide street verges.

REFERENCES

Barrell, J. 1996. *Safe Useful Life Expectancy of Trees (SULE).*

Cretikos, MA, et al. 2007. Mitigating the Health Impacts of a Natural Disaster-the June 2007 Long-Weekend Storm in the Hunter Region of New South Wales. *Medical Journal Australia*, vol. Dec 3-17, no. 187 (11-12), pp. 670–73.

Gallagher, L. 2015. *Beyond Green Streets Mitigating Climate Change through Residential Streetscape Design.*

Gallagher Studio. 2019. Stakeholder Workshop Minutes - Hobsons Bay City Council 2 December 2019.

Hart, M., and D. Sailor. 2009. Quantifying the Influence of Land-Use and Surface Characteristics on Spatial Variability in the Urban Heat Island. *Theoretical Applied Climatology*, vol. 95, pp. 397–406.

Hobsons Bay City Council. 2008. *Heritage Streets + Laneways Policy and Management Plan.*

Hurley, J., et al. 2018. *Urban Vegetation Cover Analysis, Melbourne Metropolitan Region 2018, (Unpublished Report).*

Jasper, A. 2018. *Urban Forest Analysis Report Prepared for Hobsons Bay City Council.*

Lardner, H. 2017. *Altona and Laverton Foreshore Heritage Precinct - Hobsons Bay Heritage Amended 2017 - Volume 3 - Heritage and Place Citations.*

Nowak, D., et al. 2014. Tree and Forest Effects on Air Quality and Human Health in the United States. *Environmental Pollution*, vol. 193, pp. 119–29.

Pincetl, S., et al. 2012. Urban Tree Planting Programs, Function or Fashion? Los Angeles and Urban Tree Planting Campaigns. *GeoJournal*, vol. 78, no. 3, pp. 475–93.

State Government of Victoria. 2020. *Department of Environment, Land, Water and Planning.*

Stearns, K., et al. 1993. Williamstown Council. City of *Williamstown Conservation Study 1993.*

Wilson, L., et al. 2013. The Impact of Heat on Mortality and Morbidity in the Greater Metropolitan Sydney Region: A Case Crossover Analysis. *Environmental Health*, vol. 12, no. 98.

BIBLIOGRAPHY

Amati, M., et al. 2017. Where Should All the Trees Go? Investigating the Impact of Tree Canopy Cover on Socio-Economic Status and Wellbeing in LGA's. *Prepared for Hort Innovation by the Centre for Urban Research, RMIT University*.

Bodnaruk, E. W., et al. 2017. Where to Plant Urban Trees? A Spatially Explicit Methodology to Explore Ecosystem Service Tradeoffs. *Landscape and Urban Planning*, vol. 157, pp. 457–67.

Brandt, Leslie, et al. 2016. A Framework for Adapting Urban Forests to Climate Change. *Environmental Science & Policy*, vol. 66.

Brimbank City Council. 2016. *Urban Forest Strategy 2016 - 2046*.

City of Chicago. 2008. *Chicago Climate Action Plan*.

City of Greater Geelong. 2015. *Urban Forest Strategy 2015-2025*.

City of Melbourne. *Melbourne's Urban Forest*.

City of Melbourne. *Tree Valuations in the City of Melbourne*.

City of Melbourne. *Urban Forest Strategy Making a Great City Greener 2012-2032*.

City of Melbourne. 2011. *Urban Forest Diversity Guidelines*.

City of Melbourne. *Urban Forest Strategy Making a Great City Greener 2012-2032*.

Coccolo, Silvia, et al. 2018. Thermal Comfort Maps to Estimate the Impact of Urban Greening on the Outdoor Human Comfort. *Urban Forestry & Urban Greening*, vol. 35.

Coutts, A., and N. Tapper. *Trees for a Cool City: Guidelines for Optimised Tree Placement*.

Cretikos, MA, et al. 2007. Mitigating the Health Impacts of a Natural Disaster-the June 2007 Long-Weekend Storm in the Hunter Region of New South Wales. *Medical Journal Australia*, vol. Dec 3-17, no. 187 (11-12), pp. 670–73.

Davies, Helen, et al. 2017. Challenges for Tree Officers to Enhance the Provision of Regulating Ecosystem Services from Urban Forests. *Environmental Research*, vol. 156, pp. 97–107.

Elmes, A. 2016. Effects of Urban Tree Canopy on Land Surface Temperature Magnitude and Timing. *ISPRS Journal of Photogrammetry and Remote Sensing*.

Endreny, T., et al. 2017. Implementing and Managing Urban Forests: A Much Needed Conservation Strategy to Increase Ecosystem Services and Urban Wellbeing. *Ecological Modelling*, vol. 360, pp. 328–35.

Gallagher, L. 2015. *Beyond Green Streets Mitigating Climate Change through Residential Streetscape Design*.

Gallagher, L. 2014. "Cooling Parramatta City" Scoping Paper. *Prepared by Gallagher Studio for Parramatta City Council*.

Gallagher Studio. 2019. Stakeholder Workshop Minutes - Hobsons Bay City Council 2 December 2019.

Greener Spaces Better Places. *How to Grow an Urban Forest*.

Hart, M., and D. Sailor. 2009. Quantifying the Influence of Land-Use and Surface Characteristics on Spatial Variability in the Urban Heat Island. *Theoretical Applied Climatology*, vol. 95, pp. 397–406.

Hobsons Bay City Council. 2008. *Heritage Streets + Laneways Policy and Management Plan*.

Hobsons Bay City Council. 2019. *Hobsons Bay Activity Centres Strategy*.

Hobsons Bay City Council. *Tree Planting Guidelines*.

BIBLIOGRAPHY

Hobsons Bay City Council. 2018. *Know Your Activity Centres Strategy*.

Hurley, J., et al. 2019. Victoria State Government Department of Environment, Land, Water and Planning. *Melbourne Vegetation Cover 2018, Western Region*.

Hurley, J., et al. 2018. Victoria State Government Department of Environment, Land, Water and Planning. *Urban Vegetation Cover Analysis, Melbourne Metropolitan Region 2018, (Unpublished Report)*.

Jacobs, B., et al. 2014. Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment. *Prepared for Horticulture Australia Limited by the Institute for Sustainable Futures, University of Technology Sydney*.

Jasper, A. 2018. *Urban Forest Analysis Report Prepared for Hobsons Bay City Council*.

Klepper, B. *Urban Forestry Report Measuring Canopy Cover for Hobsons Bay City Council*.

Lardner, H. 2017. *Altona and Laverton Foreshore Heritage Precinct - Hobsons Bay Heritage Amended 2017 - Volume 3 - Heritage and Place Citations*.

Livesley, S., et al. GRC for Water Sensitive Cities. *Passive Irrigation of Street Trees to Improve Tree Health and Support Urban Cooling*.

Locke, Dexter, et al. 2010. Prioritizing Preferable Locations for Increasing Urban Tree Canopy in New York City. *Cities and the Environment (CATE)*, vol. 3.

Lowry, John H., et al. 2011. Determinants of Urban Tree Canopy in Residential Neighborhoods: Household Characteristics, Urban Form, and the Geophysical Landscape. *Urban Ecosystems*, vol. 15, no. 1, pp. 247–66.

Maribyrnong City Council. 2018. *Urban Forest Strategy*.

Mei, Yingdan, et al. 2017. Demand for Urban Tree Cover: A Two-Stage Hedonic Price Analysis in California. *Forest Policy and Economics*, vol. 83, no. C, Elsevier, pp. 29–35.

Mooney Valley City Council. *Moonee Valley 2040 Action Plan – Draft Urban Forest Plan Greening Our City*.

Moore, G. 2006. Urban Tree Valuation - A Current Perspective and Progress Report. *The 7th National Street Tree Symposium*.

Netusil, Noelwah R., et al. 2010. Estimating the Demand for Tree Canopy: A Second-Stage Hedonic Price Analysis in Portland, Oregon. *Land Economics*, vol. 86, no. 2, [Board of Regents of the University of Wisconsin System, University of Wisconsin Press], pp. 281–93.

Nilsson, K., et al. 2011. *Forests, Trees and Human Health*.

North, E., et al. 2017. The Influence of Sidewalk Replacement on Urban Street Tree Growth. *Urban Forestry & Urban Greening*, vol. 24.

Nowak, D., et al. 2014. Tree and Forest Effects on Air Quality and Human Health in the United States. *Environmental Pollution*, vol. 193, pp. 119–29.

Pandit, R., et al. Valuing Public and Private Urban Tree Canopy Cover. *Agricultural and Resource Economics*, pp. 453–70.

Pincetl, S., et al. 2012. Urban Tree Planting Programs, Function or Fashion? Los Angeles and Urban Tree Planting Campaigns. *GeoJournal*, vol. 78, no. 3, pp. 475–93.

Plant, L., et al. 2016. Discussion Paper No 563. School of Economics, University of Queensland, St Lucia, QLD 4072. *Property Value Returns on Investment in Street Trees: A Business Case for Collaborative Investment in Brisbane, Australia*.

Raum, Susanne. 2017. *The Ecosystem Approach, Ecosystem Services and Established Forestry Policy Approaches in the UK*.

Salmond, Jennifer, et al. 2016. Health and Climate Related Ecosystem Services Provided by Street Trees in the Urban Environment. *Environmental Health*, vol. 15.

BIBLIOGRAPHY

Schwarz, Kirsten, et al. 2015. Trees Grow on Money: Urban Tree Canopy Cover and Environmental Justice. *PloS One*, vol. 10, p. e0122051.

Seiferling, Ian, et al. 2017. Green Streets · Quantifying and Mapping Urban Trees with Street-Level Imagery and Computer Vision. *Landscape and Urban Planning*, vol. 165, pp. 93–101.

Shanahan, Danielle, et al. 2015. Toward Improved Public Health Outcomes From Urban Nature. *American Journal of Public Health*, vol. 105, pp. e1–8.

Shears, I. 2015. Urban Forest Strategy. *Australasian Parks and Leasure*.

Stearns, K., et al. 1993. Williamstown Council. City of *Williamstown Conservation Study 1993*.

Steenberg, James, et al. 2016. Forecasting Urban Forest Ecosystem Structure, Function, and Vulnerability. *Environmental Management*, vol. 59.

Sugiyama, Takemi, et al. 2008. Associations of Neighbourhood Greenness with Physical and Mental Health: Do Walking, Social Coherence and Local Social Interaction Explain the Relationships? *Journal of Epidemiology and Community Health*, vol. 62, p. e9.

Sun, C., et al. 2019. Clean Air and Urban Landscapes Hub. *Urban Vegetation, Urban Heat Islands and Heat Vulnerability Assessment in Melbourne, 2018*, p. 19.

Sweeney, K., et al. 2013. City of Sydney. *Urban Forest Strategy*, p. 80.

Tanhuanpää, Topi, et al. 2017. Assessing Above-Ground Biomass of Open-Grown Urban Trees: A Comparison between Existing Models and a Volume-Based Approach. *Urban Forestry & Urban Greening*, vol. 21, pp. 239–46.

The Nature Conservancy and Resilient Melbourne. 2019. *Living Melbourne: Our Metropolitan Urban Forest*.

Trees and Design Action Group. *Trees in the Townscape A Guide for Decision Makers*.

Ulmer, Jared, et al. 2016. Multiple Health Benefits of Urban Tree Canopy: The Mounting Evidence for a Green Prescription. *Health & Place*, vol. 42, pp. 54–62.

Upreti, Ruby, et al. 2017. Radiative Shading Effect of Urban Trees on Cooling the Regional Built Environment. *Urban Forestry & Urban Greening*, vol. 26.

Victoria State Government. 2016. *VicRoads Tree Policy*.

Zhou, Weiqi, et al. 2017. Effects of the Spatial Configuration of Trees on Urban Heat Mitigation: A Comparative Study. *Remote Sensing of Environment*, vol. 195.