4 Issues & Challenges

In addition to the underlying vulnerability of our current urban forest resulting from a lack of diversity, the overall health of the tree population has been impacted by lack of rainfall, water restrictions, extreme heat, and development expansion and consolidation. We also have a tree population that is ageing at the same point in time.

Three species dominate our total population: Elms, Plane Trees and River Red Gums. This exposes the population to a higher risk of ill health and mortality through pests, pathogens, extreme heat events and low rainfall futures.

There is pressure on all levels of government to plan for greater population, economic growth, expanded urban boundaries and densification to ensure that our cities remain liveable. Urban forests play a critical role in responding to these future challenges. Sound adaptation solutions will be those actions which can be considered to have multiple benefits. Effective adaptation in the built environment needs to account for the fact that green infrastructure solutions can be highly cost effective, and may have to take precedence over 'grey infrastructure' solutions.

Green infrastructure, including open space, green environmental corridors, canopy cover and ecosystem services are the most efficient tools that cities can utilise to remain healthy, robust and liveable.

The key challenges that Melbourne faces in terms of the vulnerability of its urban forest are:

- **ageing tree population**
- **diminishing availability of water**
- **climate change**
- **urban heat island effect**
- **population increase and urban intensification**

Examples of life stages of tree decline, highlighting degree of vulnerability, in various locations in the city

4.1 Ageing tree population

Many of Melbourne's trees, including those in our iconic boulevards and parks, are now well over 100 years old and approaching the end of their useful life. Elms planted in the late 1800s such as those in Fitzroy Gardens, Royal Parade, Flemington Road, Fawkner Park, Alexandra Avenue and St Kilda Road were planted in socially, culturally and environmentally different times. They have performed remarkably well to date in faring against droughts, urbanisation and changing cultural trends. However the older a tree becomes, the less tolerant it is to change.

The City of Melbourne currently manages the population of ageing trees, particularly our Elms, through regular assessments to determine which trees need to be treated or removed, and in turn planning when, and how and with what trees they will be replaced. Managing ageing trees requires careful consideration of some key challenges. Urban tree renewal is not simply about identifying when to replace old and dying trees, but is also about identifying the most resilient and appropriate replacement plan and engaging in a meaningful dialogue with a broad range of stakeholders and community members.

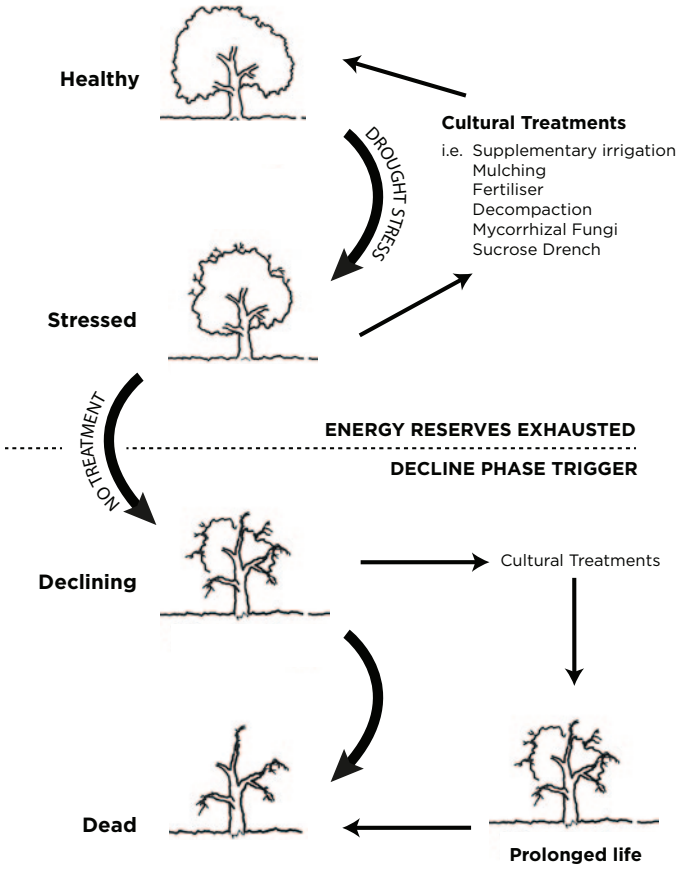
The key challenges that face Melbourne in terms of ageing trees are:

- An ageing tree population requires increased resources to manage and sustain. Over time, the environmental value of urban trees diminishes, they become hazardous and dangerous in the landscape. Having a high proportion of over-mature trees in the landscape carries an element of public risk (and cost) as they become hazardous and therefore must be managed accordingly.

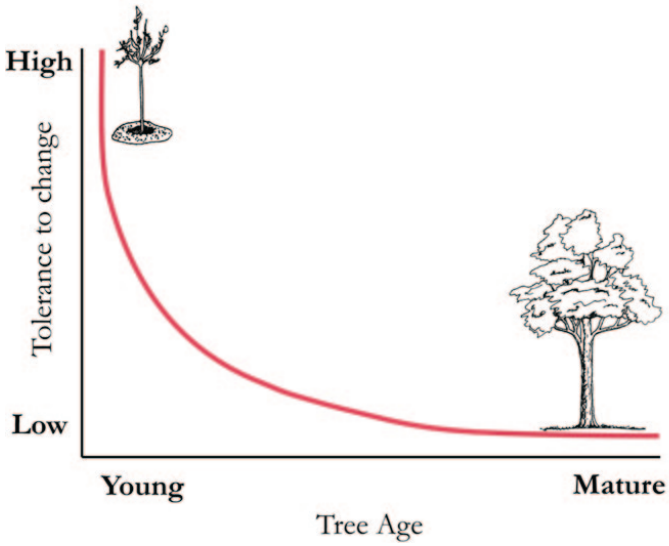
- Boulevards and avenues create wonderful vistas through our main streets and in Melbourne they are largely synonymous with broad-canopied deciduous trees such as Elms and Planes. This raises a critical issue that needs to be carefully managed in consultation with the community. To achieve these aesthesis , it is necessary to plant identically aged trees to maintain the visual consistency of the avenues and boulevards. This can pose challenges for the community when confronted by trees that will all die –or preferably will be replaced – at the same time.

- St Kilda Road and Royal Parade are examples of the afore-mentioned problem in Melbourne. They both require special care and extensive, thoughtful planning for their futures. The Elms are ageing and the Planes are declining as a result of past water restrictions and periods of extreme heat. Community and stakeholder collaboration will be crucial in determining how we manage the loss of these trees and plan for their subsequent replacement.

While the ageing population in some cases suggests subsequent landscape change, opportunities arise for us to now 'retrofit' these landscapes to ensure better conditions for our future trees. Such conditions that require improvement include those below ground (soil structure, ground water, and conflict with underground services) and above ground (access to stormwater, conflict with infrastructure, mulching and potential compaction).



Tree mortality spiral: once a tree is in a declining state of health it has passed the point of return back to good health



With increasing age, a tree's tolerance to change is greatly reduced

Fitzroy Gardens potential loss of avenues modelling from aerial perspective, showing existing conditions (above left) and potential devastating effect if Elm avenues were lost (above right)

Fitzroy Gardens potential loss of avenues modelling at ground plane, showing existing conditions (above left) and effect if Elm avenues were lost (above right)

Royal Parade potential loss of avenues modelling at ground plane, showing existing conditions (above left) and effect if Elm avenues were lost (above right)

4.2 Water and soil moisture

Water is the primary element needed for urban vegetation growth. The recent extended drought (1997-2010) and water restrictions have impacted severely on the health of Melbourne's urban forest. There has been a steep increase in tree mortality due to stress and dieback from lack of water. The useful life expectancy mapping in Section 3.3.2 shows that about 23 per cent of our trees will reach the end of their useful lives within a ten year period. Much of this is premature and is due to the longer term effects of low water availability on stressed trees that have been unable to return to a healthy state.

Adequate available soil moisture levels are critical for healthy vegetation growth. The extended period of low rainfall over 13 years has left soil moisture levels in the city morbidly low. The low levels have impacted severely on tree health throughout the municipality. In particular, trees in traditionally irrigated landscapes have been impacted by lower rainfall and decreased irrigation due to restrictions.

While 2010/2011 summer rains have been valuable, soil moisture levels remain depleted and this poses an ongoing threat to tree and vegetation health. A number of active and passive approaches are currently undertaken to recharge and replenish soil moisture and ensure they are maintained at levels to provide healthy growth.

The capture and reuse of stormwater is an important key to decreasing reliance on potable water and its lack of availability and increasing costs. The city that has traditionally shed water needs to capture, store and reuse. Impervious surfaces need to allow natural rainfall to enter the soil, a huge reservoir that is ready made to provide for a healthy forest.

Changes to irrigation practices, mulching, soil injection, water barrier and tanker watering have preserved the health of many trees. Tree health monitoring programs and measurement of soil moisture provide strategic guidance to direct resources and will be vital in ensuring the health of the future forest.

Mature trees deliver significant benefits including amelioration of the urban heat island effect both through shading of urban surfaces and atmospheric cooling through evapotranspiration. Maximising the potential for urban vegetation to mitigate against urban heat island through evapotranspiration highlights the need to maintain soil moisture.

Fundamentally the city has low levels of water permeability. Hard surfaces such as roads, footpaths and roofs expedite stormwater through an extensive drainage system to prevent flooding and direct it into Port Phillip Bay or the Yarra River. While this traditional approach is an innovative way to ensuring the functionality of the city to some extent, it has meant that natural rainfall has limited the opportunity to infiltrate the soil.

With expected long-term low water futures and a desired move away from unreliable and increasingly costly potable water, alternative water sources are needed to ensure healthy vegetation growth. Increased access to soil moisture also enables trees to actively transpire and assist in atmospheric cooling.

Clearly, the amount of stormwater flowing into the rivers and bay provides large potential for capturing, storing and re-using this run-off to meet the water requirements of a healthy future urban forest. This presents an array of challenges as well as opportunities:

- Storage of captured stormwater for reuse during periods of demand is challenging in built urban environments, but can be supported by wetlands, below-ground tanks and water sensitive urban design (see further 5.3.4). By using soil as a reservoir to store captured water has multiple benefits in addition to vegetation health, including improvement in stream health, reduced damage to infrastructure from soil movement and decreased flood damage.

- Ensuring thorough permeation of water through the entire soil profile is critical. Surface irrigation exacerbates the vulnerability of trees in particular by encouraging shallow root systems. Deep wetting of the soil profile encourages deeper root systems better able to access soil moisture throughout low rainfall periods.

- Ensuring that trees are not reliant on potable water – which runs the risk of being restricted when running at low levels – and yet still have access to adequate soil moisture, particularly during periods of low rainfall, is also crucial. We can learn from past practices in irrigation, particularly in parks, where supplemental irrigation via surface watering resulted in the development of shallow rooted, unstable trees wholly reliant on continued superficial irrigation.

Alexandra Avenue and riverfront with tree canopy in severe state of decline (Feb 2010)

Alexandra Avenue and riverfront with healthy tree canopy (Feb 2004)

4.3 Climate change

The Australian Government's most recent report on climate change, the Critical Decade, states unequivocally that it is now 'beyond doubt' that climate change is occurring. Whilst the rate of climate change is just becoming discernible now, it will be increasingly prominent in the coming decades. The risks to cities of more severe weather conditions will continue to increase, bringing with them high economic, social and environmental costs. This makes immediate climate change adaptation planning by governments an absolute priority.

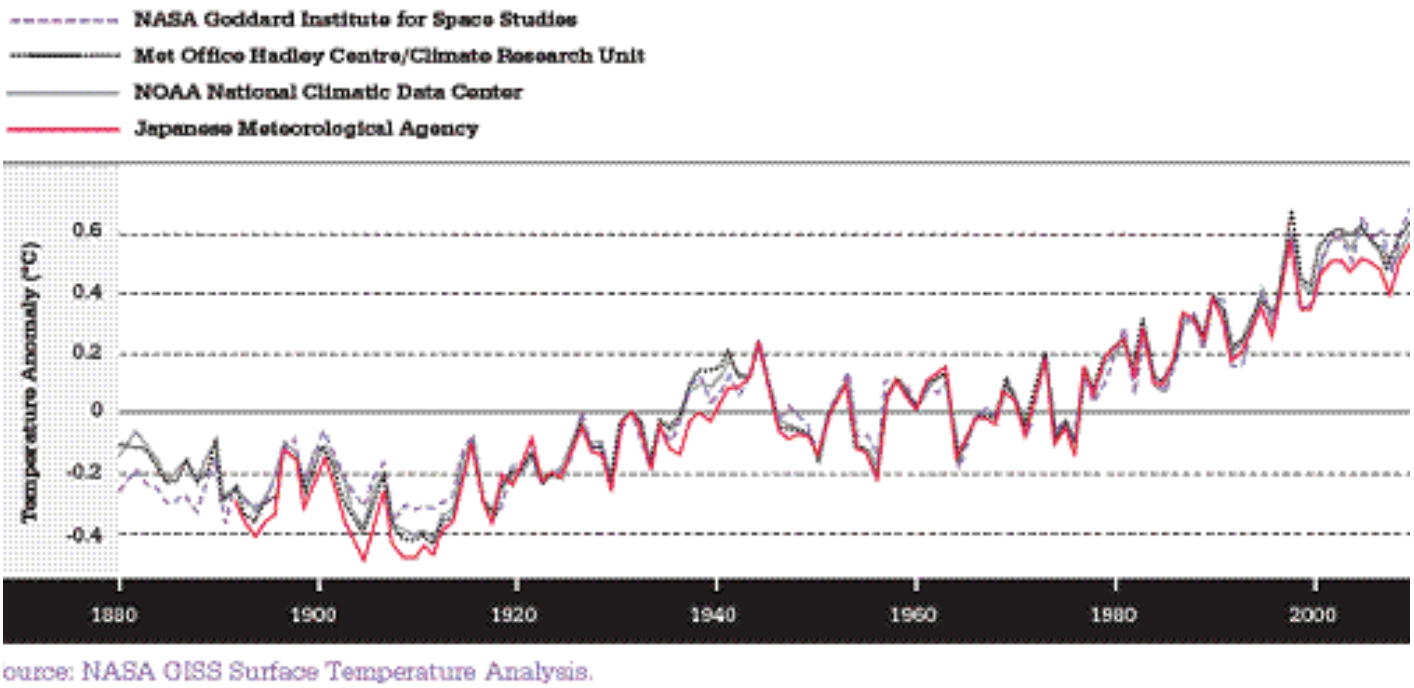
The most widely used indicator of climate change is the global mean, annual average, near-surface air temperature – commonly referred to as the global average temperature. The global average temperature has risen by about 0.17°C over the last three decades. More notably, the global average temperature from 2001-2010 was 0.46°C above the 1961–1990 average, making it the warmest decade on record.

The effects of climate change over coming decades will include warmer average temperatures, heatwaves, extreme storm events and lower average annual rainfall. We have already observed the damage and devastation caused by extreme heat and floods in Australia in recent years, and it is likely that these events will become more prevalent.

The Bureau of Meteorology and CSIRO climate change modelling predicts that Melbourne is likely to experience an increase in more days of extreme heat. The city already experiences on average nine days per annum over 35°C but by 2030 it is predicted this will increase to 11 days, and then increase again to 20 days by 2070.

Table 11: Climate changes predicted in Australia by 2070

Climate Variable		Now	Predicted by 2070
IPPCC (2007) Predictions for Melb			**Estimate of Change**
Temperature	Annual average temperature	Max 18.7oC Min 8.3oC	+2.6oC (1.8 to 3.7oC)
Extreme Temperature	Annual av. no. of hot days (over 35oC)	9 days	20 days (15 to 26 days)
Rainfall	Annual average rainfall	864mm	-11% (-24% to no change)
	Summer	166mm	-7% (-31 to +21%)
	Autumn	213mm	-5% (-24 to +16%)
	Winter	245mm	-11% (-26 to +4%)
	Spring	152mm	-21% (-41 to -1%)
Extreme Rainfall	Heavy rainfall intensity (99th percentile)	Not avail.	=5.9% (-24.9 to +48.9%)
Sea Level Rise	Average sea level rise	3.2mm per year	+110cm (CSIRO)



Surface air temperature trend from the 1800s to the present. The baseline for the analysis is the 1951-1980 average. Source: NASA GISS Surface Temperature Analysis.

The evidence that the Earth's surface is warming rapidly is now exceptionally strong, and beyond doubt. Evidence for changes in other aspects of the climate system is also strengthening. The primary cause of the observed warming and associated changes since the mid-20th century – human emissions of greenhouse gases – is also known with a high level of confidence.[39]

Projections for future changes in rainfall patterns are uncertain. It is likely that Melbourne will experience increasing extremes of lower average annual rainfall as well as extreme rainfall events. Rainfall patterns are likely to be more unpredictable, increasing risks of low for water availability during certain periods.

The high end CSIRO scenario predicts that current sea levels will increase by 1.1 metres at the end of the century. Inundation modelling shows that while few areas of the city will be vulnerable to permanent inundation at this level of increase, many areas in the municipality will be prone to inundation with the combination of extreme high tides and a 1.1 metre rise in current sea levels.

Impacts of climate change on the urban forest will occur in a number of ways:

- The susceptibility of vegetation to **increasing and emerging pests and diseases** will also challenge their ability to withstand these outbreaks and recover. Changes in climate can affect the life cycles of pest populations. Hotter summer temperatures can increase the development rate and reproductive potential of insect pests, while warmer winters will increase over-winter survival. Many pests and diseases will have extended geographical range as increases in temperature affect flight behaviour and vector spread. This also impacts the geographic distribution of pests and pathogens, which means forests not previously at risk can become vulnerable. Many pests will be able to extend their current geographical range as increases in temperature tend to affect flight behaviour and increase feeding. Recent observations in NSW pine plantations have found that drought-stressed trees are now suffering increased incidence of attack from insect stem borers, bark beetles and fungi.

- **Extreme weather** events directly impact on vegetation health, generally leading to reduction in canopy cover and overall decline. Heat extremes lead to foliage and trunk scorch and canopy desiccation. Storm events have the ability to shred foliage and uproot trees.

- **Lower rainfall** will result in increasing frequency of tree death and decline in response to frequent and severe drought.

- **Inundation** can lead to soil erosion, salinity, tree instability and damage to infrastructure. In southern Australia, increased frequency of extreme wet and dry periods may increase incidence of the root rot pathogen Phytophthora cinnamomi. Trees weakened by this disease have a reduced capacity to survive periods of drought.

39 The Critical Decade, Climate Commissions Report for the Commonwealth of Australia 2011

38 Protecting human health and safety during severe and extreme heat events: A national framework PWC for the Commonwealth Government November 2011

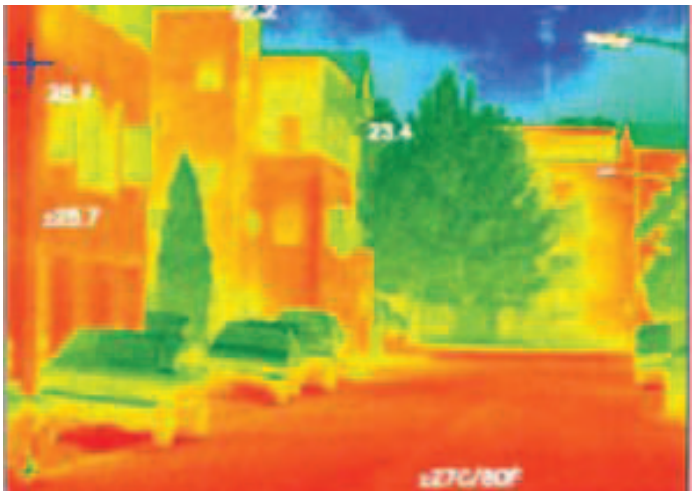
4.4 Urban heat island effect and extreme heat

The urban heat island effect (UHI) is a common phenomenon in cities worldwide that occurs when densely built urban areas become warmer than nearby suburban and regional areas, particularly after dark. After a hot day parts of the city can be four to seven degrees hotter than the surrounding areas. The urban heat island effect is present all year round, but it becomes a problem during the hotter months.

In periods of prolonged heat, the urban heat island effect increases pressure on the city. It also exacerbates the effects of heat stress particularly for vulnerable people, such as the elderly, the very young, and those with pre-existing medical conditions. In fact, heatwaves kill more Australians than any other natural disasters. heatwaves have led to considerable excess deaths in Melbourne, Adelaide, Brisbane, Sydney and Perth over the past 50 years.

Victoria's Chief Health Officer found that the heatwave preceding the Black Saturday fires in 2009 contributed to an increase above normal of 374 people's deaths in inner Melbourne[40] – almost double those who died as a result of the fires. Currently heat related deaths in Victoria are greater than the average annual road toll.

Projections indicate that by 2050 an extreme heat event in Melbourne alone could typically kill over one thousand people in a few days if we don't improve the way we forecast, prepare for and manage these events.[41] Individuals living in high-density areas are at greater risk during heat events as a result of the 'urban heat island' (UHI) effect.



Example of thermal imaging at streetscape level

This heat also contributes to the decline of certain tree species. Extreme heat, particularly if combined with low soil moisture, causes the foliage of some trees to scorch, which can lead to decline as happened with many of the City of Melbourne's plane trees during the extreme heat event in 2009.

The urban heat island effect has three main causes:

1. **Impervious surfaces:** Most urban development involves removal of vegetation and increase of hard, impervious surfaces such as buildings, roads and footpaths with high heat absorption capabilities. Asphalt and concrete trap and store heat from the sun, while solar radiation is reflected multiple times off building surfaces along street canyons, causing greater absorption of solar energy and a reduction in the reflective power of these surfaces.

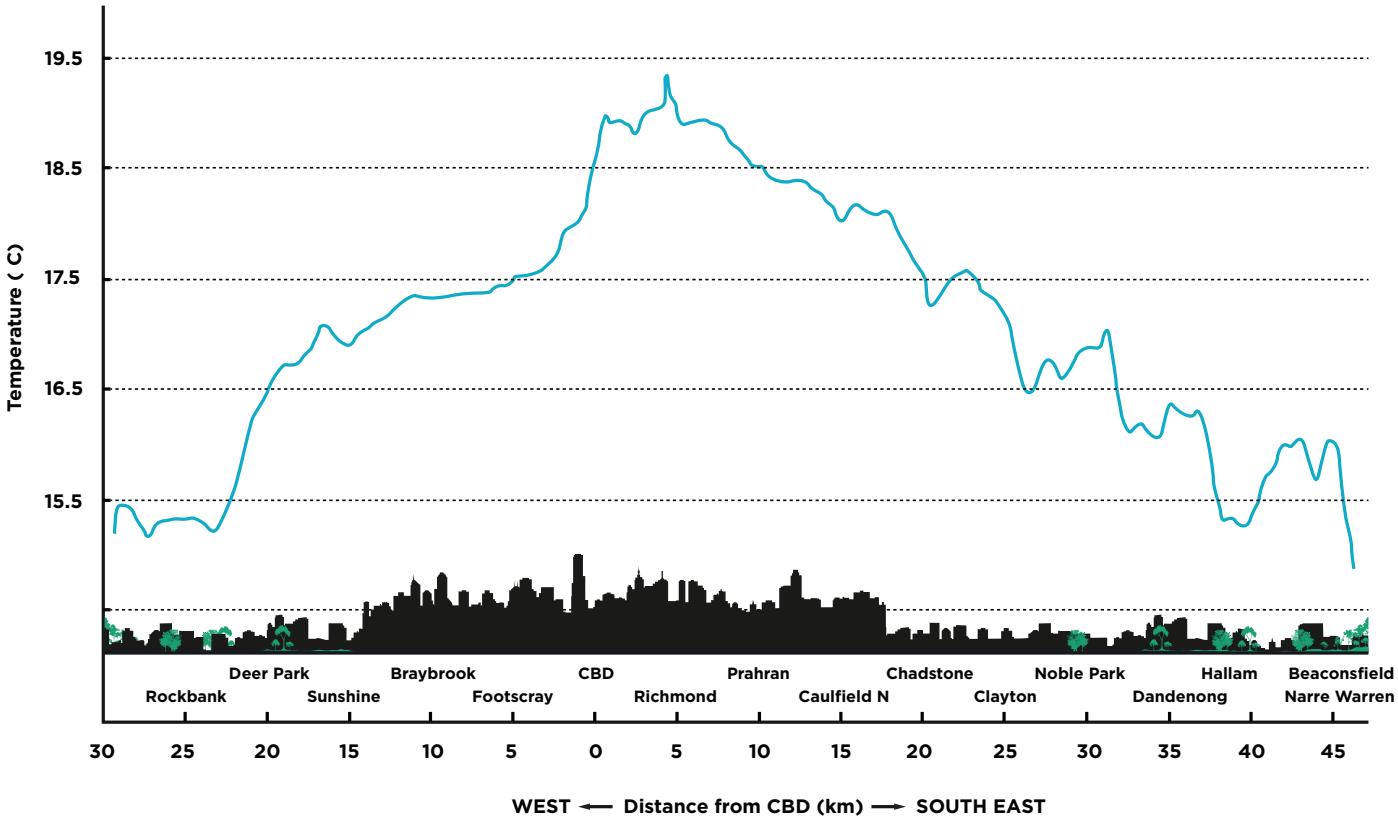
2. **Human activity:** The phenomenal increase in motorised transport (people and freight) is a major contributor to increased greenhouse gas emissions. In hot weather, the use of air conditioners also increases, generating more waste heat and putting pressure on the grid which can also lead to blackouts.

3. **Low vegetation coverage:** With less vegetation, cities receive less natural cooling from shade and evapotranspiration through foliage.

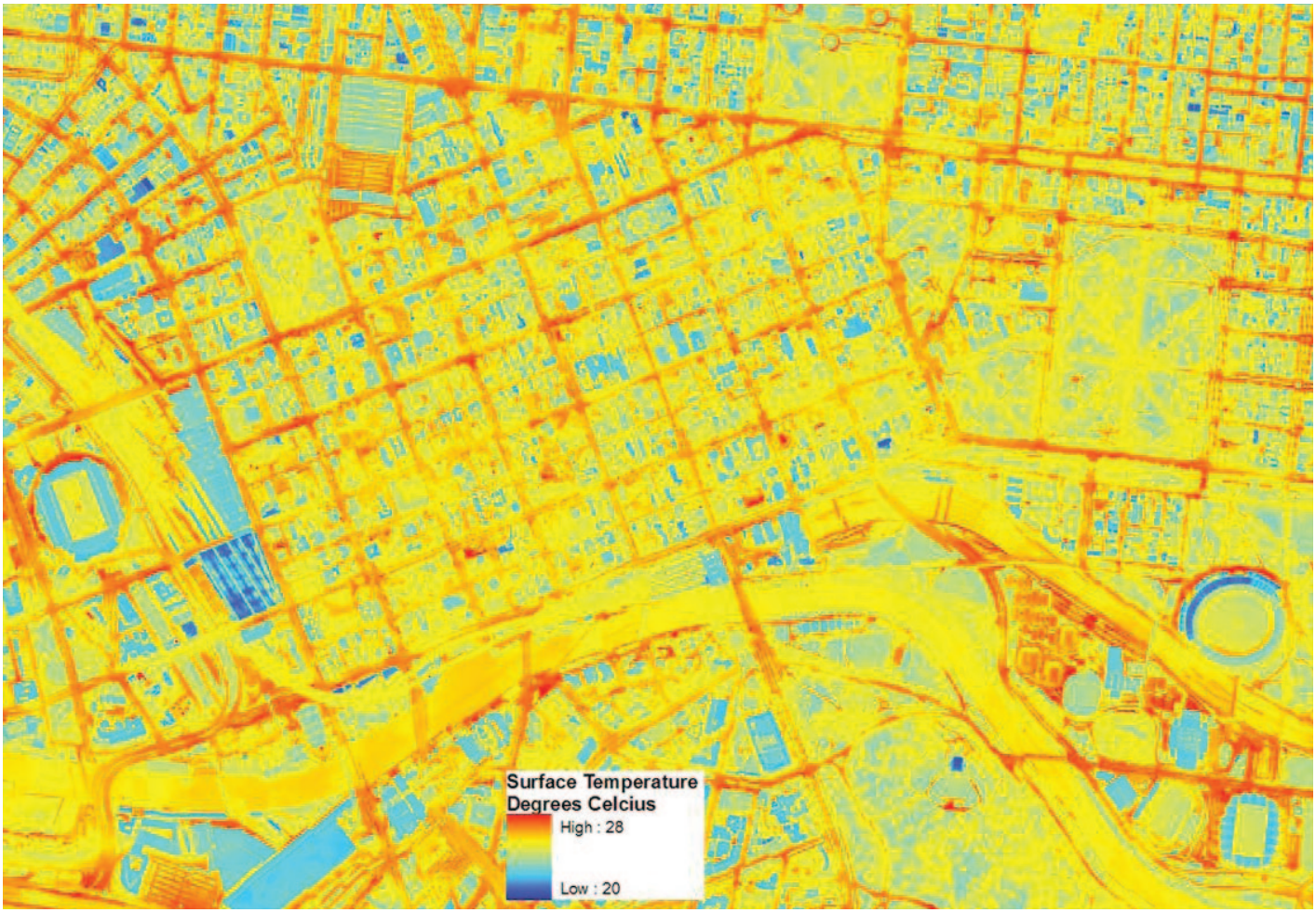
Urban forests have proven to be one of the most effective methods for mitigating heat retention in dense urban areas, particularly central business districts, through shading and evapotranspiration. However, there are several challenges we face in tackling the urban heat island, including:

- The current urban heat island effect will be exacerbated by the predicted changes in future climate.
- The existing tree canopy cumulatively covers 22 per cent of public streets and park areas. This means 78 per cent of municipal public streets and parks are without natural shade.
- It can take up to 20 years for a tree to mature and provide full canopy that will assist effectively in mitigating the urban heat island effect.
- Vegetation cover must be primarily composed of species that are able to withstand and succeed over the hotter conditions.
- Mitigating the urban heat island effect may mean increased water usage during periods of low rainfall to maintain the health of urban forests and maximise evapotranspiration.

40 January 2009 Heatwave in Victoria: an Assessment of Health Impacts, Victorian Department of Human Services, 2009
41 Protecting Human Health and Safety during Extreme Heat Events, Commonwealth Government and PWC, 2011



Mapping of the UHI for Melbourne taken in 2009



Thermal imaging - Melbourne central city

4.5 Population increase and urban intensification

In 2011, the City of Melbourne's residential population was 93,000. By 2030, it is projected that the population could reach 150,000 people, or potentially as many as 208,000 with the extra capacity available in underutilised parts of the City. The city's daily population is also growing. There are about 790,000 daily workers and visitors to the Central City with daily visitation expected to exceed one million by 2030. In 2006 there were approximately 74,000 daily tourist visitors to the municipality. By 2020 national and international visitors are expected to increase to around 250,000 visitors daily.[42]

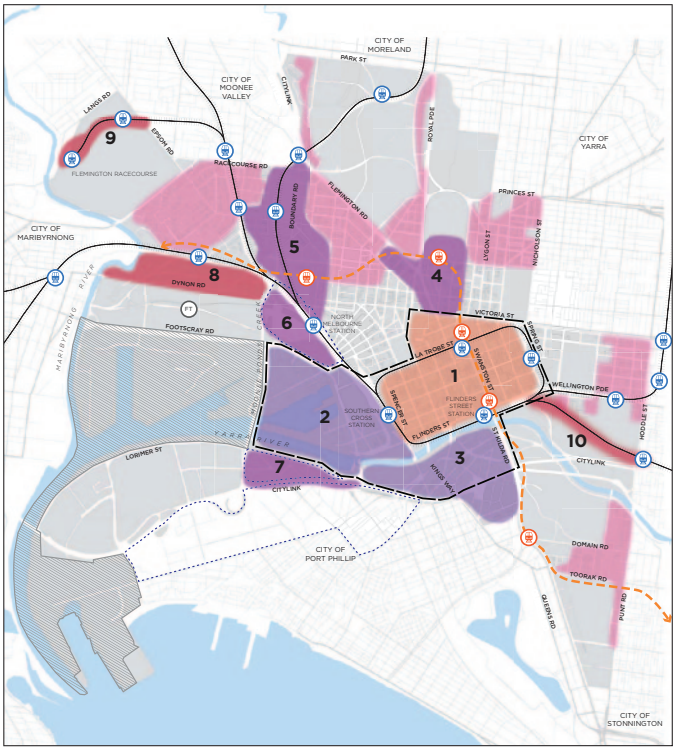
While metropolitan Melbourne has one of the largest per capita ecological footprints in the world – reflecting increasingly unsustainable trends of resources consumption, waste generation and greenhouse gas emissions – the City of Melbourne is one of the most compact, dense and mixed use parts of the metropolitan area, with the richest network of public transport services and generous reservations of public open space. These characteristics have efficiencies that can offer significant potential to drive down per capita energy use for building and transport services, to ultimately make the city more robust against the predicted impacts of climate change, particularly water scarcity and heatwaves.

In meeting the challenge of population increase and urban intensification, we need to acknowledge the following:

- Transforming the urban area will not only involve rebuilding roads, transport networks and services, but will also require rationalisation and better utilisation of existing infrastructure with a strong focus on expanding green infrastructure.
- This will need to be integrated with the application of good urban design principles, such as high quality public realm, clear definition between public and private space, active street frontages, sun and weather protection and, above all, incorporation of green infrastructure.
- Trees and other green infrastructure provide an important integrative element, not just acting as a buffer between the established and the developing areas. The urban forest will be central to delivering amenity and ecosystem services, and ensuring that the new growth and development of the city is functionally and visually integrated with the existing neighbouring urban fabric.

The City of Melbourne's Municipal Strategic Statement has established a framework for urban consolidation that will cater for the projected population increase as well as enable the city to transform toward a low carbon future. Large areas of the city that are currently redundant, underutilised or undervalued will be the Urban Renewal Areas subject to greatest intensity of development; areas of Ongoing Change where additional activity and vitality are required will enable ongoing growth on a site by site basis; while the character and identity of the remaining established neighbourhoods or Stable Areas – will be maintained.

Importantly, the stable areas will be protected from high density development and encouraged to become the 'green lungs' of the city through increased street tree plantings, water collection and purification, generating renewable energy and productive gardens.



	Hoddle Grid
1	*Hoddle Grid*
	Existing Urban Renewal Area
2	*Docklands*
3	*Southbank*
	Proposed Urban Renewal Area
4	*City North*
5	*Arden-Macaulay*
6	*E-Gate*
7	*Port Melbourne (Fishermans Bend)*
	Potential Urban Renewal Areas
8	*Dynon*
9	*Racecourse Rail Corridor*
10	*Jolimont Rail Corridor*
	Stable Residential Areas
	State Government proposed urban renewal area

Urban consolidation framework

42 Existing and projected figures from City of Melbourne, Municipal Strategic Statement :2-3

Sample visualisation showing the integrative role of landscape and the built environment in denser urban corridors - existing & future (Source: Transforming Australian Cities: 19)

4.6 Towards our Future Forest

How do we set out to achieve our vision of a healthy, diverse and resilient, urban forest that contributes to the health and wellbeing of our community and to the creation of a liveability of the city?

This Strategy sets out the priorities to guide all future decisions whilst responding to the three overarching themes of resilient landscapes, community health and wellbeing, and liveability and sustainability. The issues and challenges facing Melbourne that directly affect the Urban Forest have been outlined in tandem with a set of pragmatic solutions.

To achieve the forest of the future and leave a legacy for future generations requires a long term vision and a commitment to work in tree life cycles, not electoral cycles. Developing the urban forest requires expert input from multiple disciplines including planning, engineering, urban design, landscape architecture, economics, sustainability and most importantly from the general community.

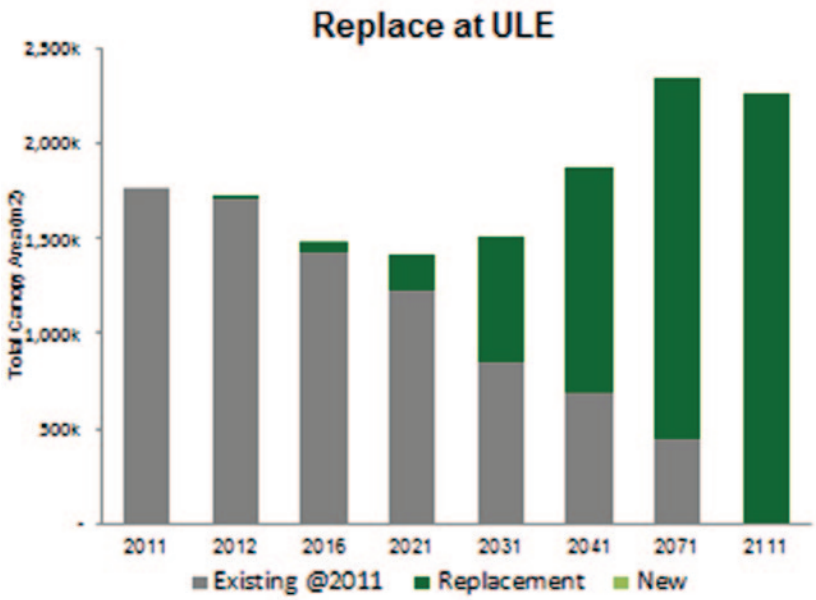
The community's sense of place and capacity for change needs to be captured and nurtured to ensure a dynamic approach in managing Melbourne's urban forest.

Tools and research guide the development of urban forest

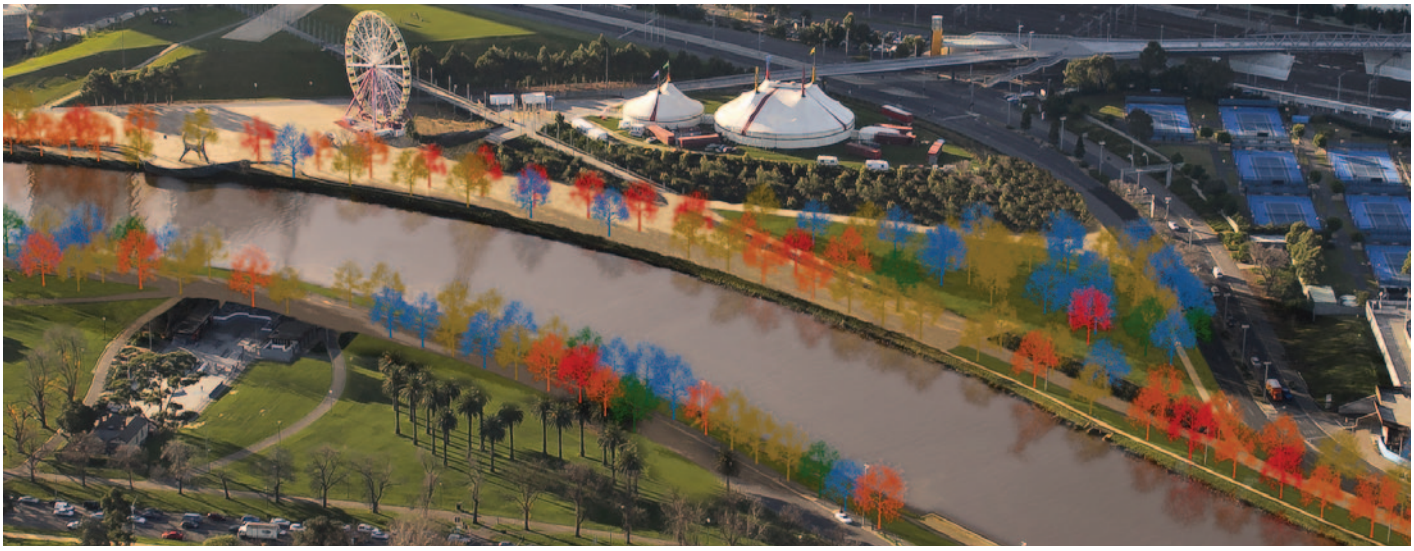
Taking the current composition of Melbourne's urban forest as a baseline (2012), we have established a series of processes and tools for measurement and modelling the future potential of our urban forest:

- On ground field data collections have provided a rich source of data relating to our trees and their environment.
- Spatial and temporal mapping using ArcGIS allows us to determine which trees we will lose, where, when and how much tree canopy will diminish. Geospatial tools such as Lidar, Quickbird, High Resolution Aerial Photography enable analysis of spatial heterogeneity, the structure and composition of vegetation, vegetation health and carbon storage.
- Thermal imaging highlights the hot and cool areas of our city which guides our tree planting decision making.
- A detailed urban heat island study has recommended canopy cover levels to mitigate heat retention in the City of Melbourne.
- US-based valuation model, i-Tree Eco provides a means to attribute dollar values to the environmental benefits of our trees.
- Weather stations installed around the city allow for monitoring the effects of tree canopy on streetscape thermal comfort levels.
- Tabling of ULE results and canopy cover has provided the opportunity to determine when and where we can start to plant trees to overcome the inevitable tree loss of canopy cover.

Using this knowledge we are able to benchmark key certain urban forest attributes to make sure we are on track for achieving our great vision.



Temporal mapping of loss and replacement of canopy cover



Existing conditions at Birrarung Marr and Yarra River southern bank showing existing ULE through colour coding (Colour representation shows: Red 0-5 years ULE; Orange 5-10 years ULE; Blue 10-20 years ULE; Green 20+ years ULE).

Modelling of Birrarung Marr and river bank in next 11-20+ years without replacement planting.

Modelling of Birrarung Marr where successional planting has been undertaking over the next 11-20+ years.

The above series of images clearly illustrate the importance of successional planing to compensate for the future loss of trees.

5 Principles & Strategies

The City of Melbourne's urban forest will be resilient, healthy and diverse. It will contribute to the health and wellbeing of our community and to the creation of a liveable city.

5.1 Our priorities

The challenges facing Melbourne's urban forest provide the City of Melbourne and its many diverse communities with a unique opportunity to genuinely connect with our urban forest.

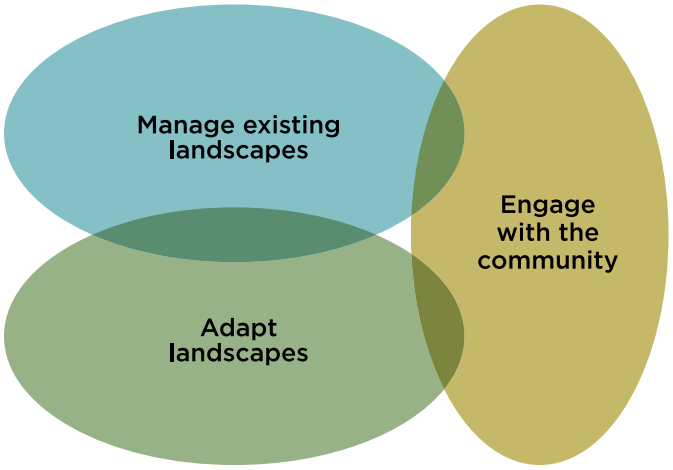
The City of Melbourne has a leading role to play in encouraging other councils, development agencies and landholders to enhance the city's urban forest. The principles and actions developed through this strategy have the capacity to be used and adapted across Melbourne, thereby reinforcing Greater Melbourne's urban forest.

Our community also has an important role to play in building a more resilient urban landscape through their actions and decisions at home, in their own gardens. Private green spaces across Melbourne are an important component of our urban ecology that contribute to neighbourhood wellbeing, connectedness to nature and biodiversity, and help our city adapt to changing climates. These private urban forests also need nurturing and growth.

Given the impact of the diminishing water supply for Melbourne's urban forest and the fact that many of the city's mature trees are ageing or in decline, the next ten years will be critical for how we adapt the landscape to make it more suited to Melbourne's future needs, and more resilient to the anticipated impacts of climate change and population and urban growth generally.

Vegetation is one of the key components of urban ecosystems. Various indicators highlight the relative health of cities such as biodiversity levels, vegetation species diversity, soil moisture levels, and air and water pollution levels. Setting achievable benchmarks for these components will ensure we stay on track to achieving our vision.

Before we quantify these benchmarks, we need to establish principles which will guide our decision making. These principles respond directly to the challenges and opportunities that face our urban forest when we consider to the need to manage our existing landscapes, adapt new landscapes and involve and engage with the community.



Three interrelated themes define our main priorities for the planning and management of our urban forest

5.2 Principles

The City of Melbourne will ensure that the planning, design and ongoing management of the urban forest will reflect the following principles:

Mitigate and adapt to climate change

- Build a resilient urban forest that can tolerate and continue to thrive in future climatic extremes
- Ensure a diversity of tree species and ages to maximise resilience against pests and diseases
- Increase overall vegetation biomass to assist in storage and sequestration of carbon

Reduce the urban heat island effect

- Build a functioning healthy urban forest canopy to provide shade and cooling to reduce heat absorption and emission by the built environment
- Develop public spaces to improve human thermal comfort and maximise health benefits
- Capture more stormwater to increase filtration into the soil and enable maximum evapotranspiration

Design for health and wellbeing

- Provide cool shaded spaces in summer; sunlight access in winter
- Plan and manage the urban forest to ensure longevity of green spaces for future generations
- Create well-designed public spaces to encourage outdoor activity, social connectedness, respite, exercise and general sense of wellbeing

Create healthier ecosystems

- Support healthy ecosystems in order to provide maximum benefits in terms of clean air, water and soils
- Expand and improve biological and structural diversity

Design for liveability and cultural integrity

- Design landscapes to reflect the cultural integrity, identity and character of Melbourne
- Lead by example in the creation of world class spaces, parks and streetscapes
- Design spaces for people to reconnect with nature Design spaces that create a sense of place and enable reflection and tranquillity

Become a water sensitive city

- Promote the use of innovative techniques for Water Sensitive Urban Design, such as rain gardens, bioswales, underground storage reservoirs and biofilters
- Use alternative water sources for irrigation to reduce potable water use
- Ease stormwater flows and peaks by replacing impervious surfaces with porous materials to reduce heat absorption and encourage soil moisture retention

Position Melbourne as a leader in urban forestry

- Create world class open spaces, parks and streetscapes
- Increase Australian-based urban forestry research
- Inform and involve the community in decision-making for landscape adaptation and change
- Increase the public profile and understanding of the attributes, role and benefits of the urban forest

5.3 Strategies

To achieve our vision by 2032 and beyond of a healthy and resilient urban forest that contributes to the health and wellbeing of our communities and to a liveable city, we need to create better urban environments for everyone. The principles defined above highlight the importance of a well-designed city, and the following strategies list how we go about creating these 'living spaces':

- **increase canopy cover**
- **increase urban forest diversity**
- **improve vegetation health**
- **improve soil moisture and water quality**
- **improve biodiversity**
- **inform and consult with the community.**

Each of these strategies have priority actions for implementation in order to achieve specific targets.

Visualisations showing the potential impact of increasing tree canopy cover and structural diversity of the urban forest in Southbank - City Road and Southbank generally - existing & future (Source: Southbank Structure Plan)

5.3.1 Increase canopy cover

Canopy cover is a key criteria by which we measure the urban forest's ability to produce benefits for the community and the environment. Large canopied trees provide greater environmental and health benefits than smaller canopies and, depending on the scale, a large tree can provide up to 75 per cent greater benefits.

Increasing the number of trees within our municipality is important, however we must plan properly to achieve the greatest environmental and health benefits. It is more important to monitor and improve the extent of canopy cover across the municipality instead of simply benchmarking the total number of trees. Analysis of aerial imagery combined with canopy cover modelling suggests that the municipality can accommodate a significant increase in canopy cover.

80 per cent of the City of Melbourne's public space is in streetscapes providing the best opportunities for increasing canopy cover. A recent study on the Urban Heat Island effect in Melbourne, recommends that one of the most cost efficient and effective mitigation strategies is to ensure a minimum canopy cover of 30 per cent with a leaf area index (a measure of shade density) of 5.3 within the municipality.

Thermal images taken of the city (refer Section 4.4) identify particular areas that absorb more heat than others and highlight the cooling effect of canopy cover and green spaces. This mapping also locates areas that are a high priority for increasing canopy cover.

The City of Melbourne in partnership with Monash University are monitoring the microclimatic conditions at streetscape level underneath different tree canopy configurations. Weather stations have been installed in Bourke Street in the CBD, and Gipps and George Streets, East Melbourne. Data from these stations highlights the temperature differentials between canopy shaded and open streetscapes. When this data is used in conjunction with thermal imagery, it provides the opportunity for increasing canopy cover to provide thermal comfort to people during periods of heat. This data also provides guidance around spatial patterns of canopy distribution.

The private realm occupies 68 per cent of the area of the municipality and therefore has the capacity to contribute significantly to the canopy of the urban forest. A study conducted by three Melbourne councils suggests that private realm trees have reduced in number considerably since the 1970s. This reduction is due largely to infill development, competing land uses and increases in prices of land. Protection and enhancement of the private realm vegetation is therefore an important component of the developing the urban forest strategy.

Modelling for the development of linear transport corridors into medium-rise high density routes demonstrates that development pressure on the surrounding suburbs can be alleviated. These areas may in turn act as the 'green wedges' for increased green infrastructure, both in streetscapes and in private gardens.

Above all, increasing canopy in these areas will have the greatest benefit in planning a healthy city (see further Section 4.5).

Target: City of Melbourne's Canopy Cover will be 40 per cent by 2040.

Actions:

- Conduct a thorough spatial analysis to identify areas of low canopy and include the selected areas in planting programs for the next 20 years.
- Provide best planting conditions possible for newly planted trees to ensure maximum canopy potential, including below ground spaces and water.
- Select the most appropriate vegetation type and species for each location given spatial and climatic constraints and neighbourhood character.
- Ensure that the overall urban design for places ensures that spaces and streets are best designed for our urban forest and for people.
- Review and update Council's Tree Precinct Plans which detail the locations and species for increasing canopy cover.
- Increase canopy cover where possible in the private realm.
- Ensure that management regimes over the urban forest are adaptive to reflect its dynamic nature.

Identification of new opportunities for tree plantings is central to increasing canopy cover throughout the municipality. In precincts such as North and West Melbourne with a 20 per cent canopy cover, streets are a priority for strategic tree planting.

Diagram showing how placement of three large trees with appropriate growing conditions can increase canopy cover in a streetscape while minimising conflicts with infrastructure, buildings and pedestrian spaces

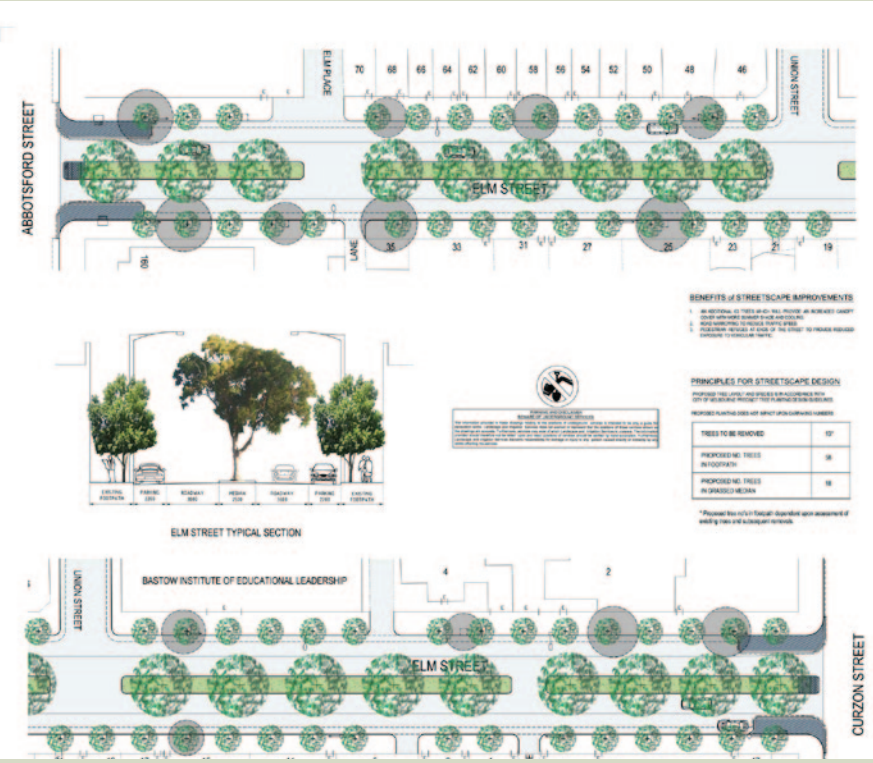
A newly planted Agathis robusta (Queensland Kauri) avenue in Fitzroy Gardens

Case Study

Increasing canopy cover in residential streets – Elm Street, North Melbourne

A project in Elm Street, North Melbourne, completed in 2011, will increase canopy cover from 18 to 65 per cent. This has been achieved through the creation of a new central median, providing an opportunity for 13 large canopy trees to be planted. This, combined with 26 smaller trees in the footpath, will within 20 years decrease summer temperatures in the streetscape by 3-4 degrees Celsius, compared to a non-treed street.

Extensive community consultation with residents and residents' association contributed to a successful outcome, and notably there was majority support for this project by demonstrating that increased tree planting would not impair the integrity or functionality of the street.



5.3.2 Increase urban forest diversity

The urban environment is highly modified which means conditions for plant growth are harsher than those conditions found in natural landscapes. Soils are more compact, root volumes are reduced, heating and shading can be more severe and regular disruption of root systems and canopies occur. Not every tree species copes with these conditions and as a consequence, tree populations in cities often contain relatively few species. Reliance on a small number of species is seen as presenting a risk to the urban forest and around the world, tree managers are investigating the diversity of their urban forests.

A lack of species diversity is regarded as leaving the urban forest more vulnerable to external threats. A lack of age diversity can be regarded as presenting a similar threat (see Section 4.0). Accordingly, a greater range of species with varied life expectancy provides greater resilience to pests and diseases and to the threats posed by climate change, reduces the risk of trees ageing at the same time, and supports biodiversity and healthy habitats.

When managing financial assets, diversification within asset classes is a basic rule for reducing vulnerability and risk. The same principle applies to our urban forest. A diverse urban forest constitutes many plant species with varying life expectancies, growth rates and growing conditions. In the natural landscape, a diverse ecosystem inclusive of water, soil, groundcovers, shrubs, tree roots, trunks, branches and canopies is fully functional and provides the best possible array of benefits.

Structural diversity in the urban landscape includes these different vegetation strata, as well as avenues in parks, street trees, green walls, and green roofs and balconies. Every plant has its own benefits: large deciduous trees provide summer shade and allow the winter sunlight to penetrate buildings and streets; native trees (including deadwood) promote biodiversity and habitat; smaller trees can be planted in areas that are not able to accommodate larger trees; shrubs and herbs in parks and riparian areas provide screening, visual amenity and habitat for fauna; climbers can cover walls for shading and protection; and green roofs reduce stormwater flows and improve insulation. The interactions between these various layers of the urban forest provide an opportunity for everyone to connect to nature, and for the different forms of green infrastructure to integrate and thereby increase the impact of their ecosystem services.

What we choose to plant now must have the resilience to tolerate hotter, drier conditions, and potentially also cope with major storm events. Similarly, our urban forest faces potential threats from disease such as Dutch Elm Disease, myrtle rust, plane tree canker stain and fireblight, and from pests such as elm leaf beetle, sycamore lace bug, emerald ash borer and fig psyllid. Diversifying the urban forest lowers the risk of incurring significant loss in any one particular individual or range of species from one or more of these threats.

There are areas within the municipality that are particularly vulnerable due to the dominance of a single species (or genus or family) within the urban forest. For example, Eucalyptus camaldulensis dominates the tree population in Royal Park, and is vulnerable to Myrtle Rust which has been identified Melbourne. Myrtle Rust has resulted in the rapid decline and death of some tree species within the Myrtaceae (e.g. Syzygium spp. and Agonis spp.), and is likely to have a negative impact on the health of other species including E. camaldulensis.

Melbourne has a number of iconic avenues of Elms along major boulevards such as St Kilda Rd and Royal Parade, and in parks such as the Fitzroy and Treasury Gardens. Elms are extremely vulnerable to Dutch Elm Disease which has wiped out Elms throughout the northern hemisphere.

Dutch Elm Disease has recently been found in New Zealand. Ever growing global trade means that it may reach Melbourne any time in the future. While a better understanding of the disease may help to mitigate its effects and improve management outcomes, a number of very important landscapes within Melbourne remain extremely vulnerable to catastrophic failure if and when Dutch Elm Disease arrives.

Melbourne's CBD is dominated by Plane Trees, which comprise over 75 per cent of the central cities forest. Plane Trees are vulnerable to extreme heat events, pests such Sycamore Lace Bug which has recently become established in Australia and diseases such as anthracnose, cinnamon fungus and plane tree canker stain.

While in many public landscapes, vulnerability can be reduced by gradually planting a more diverse urban forest, a number of these vulnerable landscapes are protected by other policies that may not allow simple species substitutions. In particular, native vegetation and heritage policies can constrain possible actions being taken to to reduce vulnerability of landscapes where these apply. Native vegetation policies protect the native tree communities in Royal Park which like much of the native vegetation in south eastern Australia is dominated by two genera (Eucalyptus and Acacia) and two families (the Myrtaceae and Fabaceae).

Changing demographic and cultural factors have been leading to increased public pressure to preserve, restore and cultivate native vegetation in public landscapes over the last 50 years. Native trees also play a critical role in broader biodiversity outcomes. Melbourne will undoubtedly continue to have a significant population of native trees into the future.

Heritage policies protect a number of important streetscapes and parks in Melbourne, in particular a number of avenues of Elms. The world-wide devastation caused by Dutch Elm Disease has left Melbourne's Elm population as one of the most significant in the world. Community groups also play an important role in the preservation of many heritage landscapes – the Friends of the Elms is an important and influential community advocacy group dedicated to the preservation of Melbourne's historic population of Elm Trees. These historic landscapes are particularly vulnerable due to the combination of the uniform old age of many of the trees, climate change and the severity of the threat from Dutch Elm Disease. Currently, tree replacement in many heritage landscapes insists on like-for-like replacement based on species.

Target: The City of Melbourne urban forest population will be composed of no more than 5 per cent of one tree species, no more than 10 per cent of one genus and no more than 20 per cent of any one family.

Over the past few decades, various models for the composition of the urban forest have been proposed. The City of Melbourne intends that the urban forest population will be composed of no more than 5 per cent of one tree species, no more than 10 per cent of one genus and no more than 20 per cent of any one family.

Where species choices are informed by indigenous vegetation policies, the species, genetic and spatial diversity will be maximised when planting where possible. New plantings should also include trees from families other than the Myrtaceae (e.g. Casuarinaceae). These guidelines may be revised as more information on the impact of Myrtle Rust on different species and genera becomes available and in respect of the development of knowledge of other pests and pathogens.

Where species choices are constrained by heritage policies, an appropriate response needs to be developed in consultation with key stakeholders such as Heritage Victoria and the Friends of the Elms and others.

New plantings must remain consistent with heritage values and have integrity to the character of each area. It is planned that character will be determined through the design of tree precinct plans and master plans to be developed through a collaborative and consultative process with the community.

Actions:

- Follow planting targets set out in the Urban Forest Diversity Guidelines.
- Undertake regular plantings across the municipality to reduce the risk of similar aged trees dying at the same time.
- Review and update Council's Tree Precinct Plans to achieve age, species and spatial diversity.
- Consistently monitor, treat and evaluate threats and attack from pest and pathogen as part of the tree maintenance program.
- Utilise a scientifically-based tree selection matrix when planting in different street and park typologies.
- Enhance the structural diversity in the urban forest through green walls, green roofs and green laneways, encourage design, funding and implementation where possible.
- Enhance vegetation strata diversity through the planting of shrubs, ground covers and grasses where appropriate.

New plantings of Eucalyptus, Cycads and a range of shrubs and groundcovers in Birrarung Marr - middle terrace

Case Study

Vulnerability and species in New York's urban forest

New York's Urban Forest consists of 5.2 million trees, including 592,000 street trees. The street trees alone have an asset value of $2.3 billion and an average replacement value of $3,938 per tree. In 1995 New York recognised that limited species diversity exposed the urban forest to catastrophic loss from extreme weather events, pests and diseases. London Plane, Norway Maple and Callery Pear comprised nearly 39 per cent of the street tree population with, for example, 44 per cent of all trees vulnerable to the Asian Long-Horned Beetle. Active diversification over the past 16 years through the Million Trees NYC program has seen an increased range of species planted in place of the dominant species. This has been successful in decreasing Norway Maples comprising 23 per cent of street trees to 13 per cent.

Five rows of newly established Lemon Scented Gums to replace the unsuccessful Poplars along Birdwood Avenue

5.3.3 Improve vegetation health

To maximise the ecosystem services and community health and financial benefits that the urban forest provides, it is imperative to ensure our trees and vegetation are healthy. Safeguarding the urban forest against extreme weather events such as drought, heat or flooding is vital for longterm forest health, particularly for our ageing trees (see Section 4.3). Integral to tree planning is ensuring that the most appropriate species is selected for each location, stock quality is assured, and best practice planting procedures are in place.

Tree planting in the City of Melbourne is followed by a two year maintenance program for newly planted trees. During this period it is vital to monitor stress and/or pest and disease attacks. Throughout the lifecycle of each of our trees, annual analyses are carried out to ensure that data collection supports their ongoing health and longevity.

Maintenance of our tree database regarding tree health, dieback, symptoms of stress, and pest and disease movements will highlight vulnerabilities and ensure refinement of management programs. Given the current vulnerability of the urban forest and relatively poor tree health affecting a substantial number of trees, replacement of impending loss while simultaneously increasing canopy presents many challenges.

The urban environment is highly modified which means conditions for plant growth are considerably harsher than those conditions found in a natural landscapes. It is therefore necessary that species selected for planting throughout the municipality are adaptable to current urban conditions as well as future urban conditions which are likely to be even harsher in a changed climate. An improved irrigation regime, more frequent health assessments, removal of dying and dead trees, and continuous replacement with healthy stock is already being implemented.

Target: 90 per cent of the City of Melbourne's tree population will be healthy by 2040.

Actions:

- Undertake annual health checks for every tree within the municipality.
- Reduce the number of stressed trees through regular watering, mulching and other cultural treatments, particularly over the summer periods.
- Select species that are robust and likely to cope with future climate changes and urbanisation.
- Implement best practice soil preparation before planting.
- Ensure the water needs of all vegetation are met, particularly during summer.
- Minimise conflict with above and below ground infrastructure.
- Create enhanced planting opportunities in streets, where possible, to allow for space for larger, healthier trees to grow.
- Remove asphalt and concrete where possible and replace with pervious surfaces to encourage healthy root growth for larger trees.

Healthy Golden Elms in King's Domain

Figs providing a healthy canopy cover for wind protection and shading at Yarra's Edge

Case Study

Street Tree Evaluation Project, Ohio.

In 1971, the Ohio Department of Natural Resources initiated a project that assessed the long term performance of 53 tree species in five Ohio cities. The comprehensive study, entitled 'Street Tree Evaluation Project' or STEP, was developed as a tool to assist in the planning and management of appropriate tree species in the variety of urban environmental conditions found across the state. At its onset, the trees were assessed for health and growth characteristics and the locations and photographs of each tree were documented.

In 1997, the potential values of the STEP project, established more than two decades before, were realised. Now, every ten years, survival data, tree measurements, and specific information on tree height, girth, and spread, along with a current photograph are collected. The information gathered has been able to inform urban forest planning and management by identifying optimal species to achieve various goals in various locations. Additionally, the four decades of documented change illustrates how different species have, over time, greatly affected the character of the individual streets.

The knowledge gained by such long term studies, and the ongoing attention and care given to the established and mature trees in these cities mean that the appearance, resilience and other important ecosystem services of the urban forest can be optimised.

5.3.4 Improve soil moisture and water quality

Cities have become experts in managing stormwater to prevent flooding. In Melbourne, we have paved over creeks and streams, diverted rivers, and installed millions of kilometres of pipelines to ensure that stormwater is diverted directly into Port Phillip Bay. This increase in impervious surfaces across the city has consequences for depleting soil moisture, irrespective of the amount of current or past rainfall levels, simply due to the inability of water to reach and permeate the soil.

Trees will seek out water wherever possible, penetrating deep into the groundwater if they need to, thereby also slowly also reducing groundwater levels. While traditional engineering solutions for water capture and discharge are efficient, extreme weather events have proven that certain areas throughout the city, including the central city, are still prone to heavy inundation during major storm events.

Introducing measures to capture and retain stormwater in the soil, and to increase water availability for tree roots, will allow water to filtrate back naturally into the soil in readiness for periods of low rainfall. The higher the level of moisture in the soil, the more trees are able to transpire at maximum efficiency, allowing for cooling of the urban environment and combating the urban heat island effect.

Trees have the added benefit of collecting phosphorus, nitrogen and heavy metals from our stormwater through their root systems, lowering the levels of stormwater pollution.

Traditionally, surface irrigation has been employed throughout most of our parks and gardens and has been regarded as a temporary response to minimise tree mortality during summer. However this merely has encouraged trees to develop superficial root systems close to the soil surface and does little to recharge groundwater resources.

A range of innovative tools is required to aid in increasing permeability of our urban soil structure: to recharge groundwater; to reduce the amount of stormwater flowing into waterways; and to improve water quality. This will directly contribute to tree health, ensuring that they provide the maximum benefits to support healthy landscapes and communities.

There are a range of Water Sensitive Urban Design (WSUD) measures that are being implemented throughout Australian cities and towns. These techniques include: roadside tree pits and bioswales, stormwater capture and storage systems beneath parks and streets, rain gardens and permeable paving. Implementation of these measures is generally adaptable to different locations and budgets. However it is fair to say that most landscape typologies, whether streets, laneways, parks, median strips, boulevards or individual trees, provide an opportunity for water sensitive design.

Target: Soil moisture levels will be maintained at levels to provide healthy growth of vegetation.

Actions:

- Action the works detailed in Total Watermark, City as a Catchment encouraging Melbourne to become a water sensitive city.
- Incorporate and expand water sensitive urban design (WSUD) measures wherever possible.
- Ensure that available water content of soils in irrigated landscapes does not fall below 50 per cent during vegetation growing seasons.
- Improve soil structures to allow for oxygenation and water movement for the benefit of tree roots.
- Replace asphalt and concrete with porous surfaces such as porous asphalt, turf, garden beds and rain gardens to reduce heat retention and encourage soil moisture retention.
- Seek alternative water sources for all major parks and gardens and treed boulevards, avenues, roads and streets.

Examples of WSUD tree pits in the central city and South Yarra allowing stormwater to increase soil moisture levels in tree root zones

Open water storage and purification at Trin Warren Tamboore in Royal Park, with enhanced ecological and habitat value

Case Study

Stormwater harvesting - Darling Street, East Melbourne

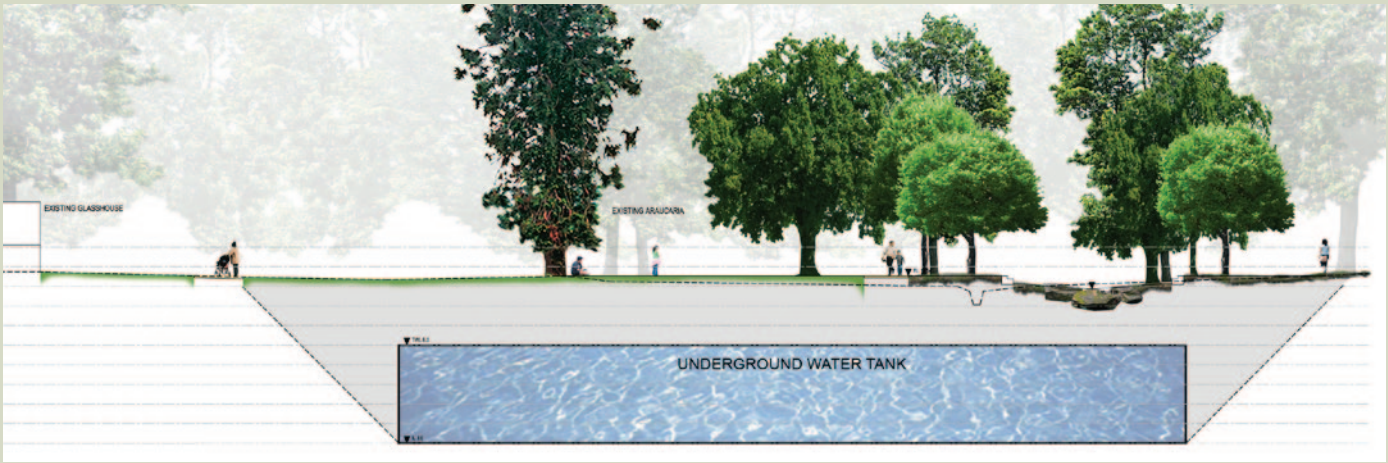
The stormwater harvesting project in Darling Street East Melbourne is a prototype for in-road stormwater capture and re-use. Completed in 2011 this system has been designed to capture and treat stormwater from surrounding streets to irrigate Darling Square, Powlett Reserve and median strips with trees in Grey, Simpson, Powlett and Albert Streets. This system has the potential to harvest an estimated 24 million litres of stormwater each year, which is the equivalent of saving more than 18 Olympic swimming pools worth of water annually. As well as capturing water for irrigation, this system prevents gross pollutants such as soil, silt. clay and litter, and can aid in reduction of local flooding. With funding from the Victorian Government and Melbourne Water, the system is being monitored to measure its ongoing success.

Darling Street stormwater harvesting project

Case Study

Stormwater harvesting - Fitzroy Gardens

The Fitzroy Gardens stormwater harvesting project will divert 69 mega litres per annum of stormwater. The treated stormwater will be stored in a 5 mega litre tank beneath the gardens and will supply fit-for-purpose water through the existing irrigation system to the Victorian Heritage listed Fitzroy Gardens and nearby Treasury Gardens.Drawing on a 67 hectare urban stormwater catchment, the project will remove gross pollutants and high nutrient levels from stormwater through a bio-retention basin. This will have significant positive outcomes on the health of the Yarra River. Scheduled for completion in 2013 the project is funded under the Federal Government's Water for the Future initiative. It will be one of the largest water projects ever undertaken by the City of Melbourne and is part of a suite of initiatives being undertaken across the city.



Fitzroy Gardens stormwater harvesting project illustration

5.3.5 Improve urban ecology

Urban ecosystems give rise to new habitat types which include green roofs and walls, gardens, reserves and parks. Over 40 per cent of nationally listed threatened ecological communities in Australia occur in urban areas. Loss of natural habitat, urbanisation, and air and water pollution have all impacted upon the survival of plant and animal species.

A 2009 VEAC study showcased ten major threats to biodiversity in Melbourne including: fragmented landscapes, connectivity loss due to major roads, urban pollution, human impacts (e.g. rubbish and trampling), predation from cats and dogs, and competition from other introduced species. With the potential expansion of urban growth into brown and green field sites, the potential loss of biodiversity from these threats becomes even greater, highlighting the need to seriously regard biodiversity in our city.

In terms of biodiversity in the urban landscape, we recognise that cities and biodiversity have often been mutually exclusive however research continues to demonstrate that urban areas can provide large opportunities for protecting and enhancing vulnerable species.

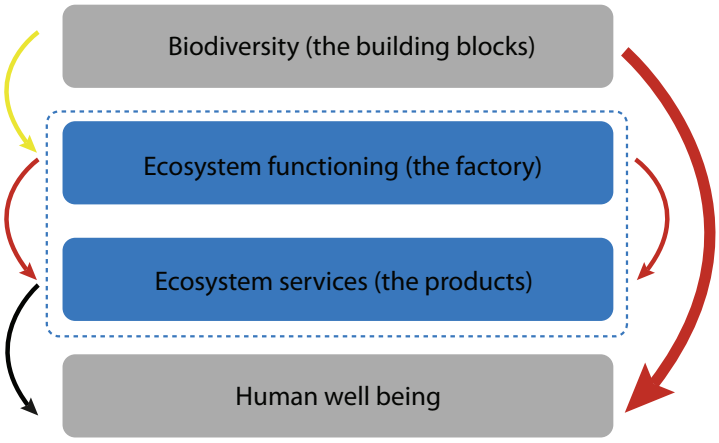
The urban forest plays a crucial role in providing habitat, food and protection for wildlife in addition to providing a diversity of plant species throughout the municipality. Healthy trees supported by adequate soil moisture and structural and biological diversity collectively contribute to healthy ecosystems. Public parks and gardens, golf courses, remnant vegetation and private gardens are all capable of providing habitat for a variety of species.

This is not to underestimate the impact that urbanisation has had on biodiversity. Our imperative is to ensure protection and enhancement of vulnerable species. As identified in Section 3.3.2, biodiversity in the City of Melbourne includes a wide range of wildlife species. Whilst certain species (e.g. Eastern Quoll) face severe loss or even extinction due to loss of habitat, others (e.g. Brush Tail Possum) have adapted all too well to urbanisation, to the extent of becoming overpopulated in many inner area parks.

Target: Protect and enhance urban ecology and biodiversity to contribute to the delivery of healthy ecosystem services.

Actions:

- Develop an Urban Ecology and Biodiversity Strategy in collaboration with Australian Research Centre for Urban Ecology (ARCUE, University of Melbourne)
- Consult with the community and key stakeholders to inform measure regarding the enhancement of biodiversity in the municipality
- Further integrate biodiversity and urban ecology values into the planning of parks, green spaces, precinct and waterways through Master Plans, Structure Plans, Precinct Plans and the Total Watermark–City as a Catchment Review.
- Increase the diversity of tree and other plant species to provide diversity of food sources, protection and habitat and to promote healthy ecosystems.
- Utilise water sensitive urban design to encourage biodiversity in our soils through the improvement of groundwater levels.
- Maintain ongoing relationships with key research organisations such as ARCUE and CSIRO Ecosystem Sciences.
- Develop programs to encourage the interaction between people and nature and to raise awareness.
- Enhance ecological connectivity through the provision of urban forest corridors along streetscapes and to form bio-links between green spaces.
- Develop productive urban landscapes – where possible in the public realm, but primarily through encouragement and incentives for private realm gardens.
- Provide habitat through dead trees where possible, ensuring health and safety for everyone.



Biodiversity and Ecosystem relationship

Case Study

Improving urban forest biodiversity – Adelaide

Adelaide's Urban Forest Biodiversity Program attempts to redress the loss of biodiversity across Adelaide. It has been delivered alongside two other programs: the Million Trees program and Backyards 4 Wildlife. Each program is aimed at improving the amount and type of vegetation across the city in both the public and private realms to provide more habitat, food and protection for Adelaide's native wildlife.

A study of Adelaide's biodiversity has found that only 12 per cent of the area's original vegetation remains which is recognised in being a contributor to the severe decline in native fauna and flora. The Government of South Australia along with the Federal Government has responded to improve the biological diversity of the city, recognising that biodiversity conservation is crucial in ensuring a healthy and sustainable local environment for future generations. Four key actions were taken by the SA Government to kick start this initiative:

- A spatial analysis identified areas of high conservation significance.
- Implementation of on ground restoration projects.
- Provision of education, training and resources for everyone to improve biodiversity.
- Raising awareness about the importance of biodiversity.

There are currently 14 projects taking place throughout Adelaide enhancing parks, waterways and corridors for biodiversity.

Providing a diverse range of species and combining all vegetation strata (trees, shrubs & groundovers) in the landscape improves habitat value for plants and wildlife

5.3.6 Engage with the community

The urban forest influences everyone in the community. Engaging the wider community involves not only informing them about the importance and multiple benefits of green infrastructure, but also highlighting the role it plays in ensuring Melbourne's liveability, sustainability and support of cultural identity.

The success of an urban forestry program the commitment of the citizens and local businesses who represent the community to be involved at different levels, all of whom bring something vital to the process.

Community support for the urban forest in the public realm can include: tree-related advocacy groups and trusts; other organisations or associations that lobby for more street trees and greenery in their neighbourhoods; and still others who demand open space and tree protection through better planning, new regulations, and public acquisition. They often provide the 'glue' to link open space networks within larger metropolitan areas, and can provide the political backbone behind municipal efforts to sustain public investment in green infrastructure and the urban forest.[43]

On a larger scale, business-driven civic leadership can incorporate urban forestry visibly into much broader planning initiatives and thus build its legitimacy as a public policy issue. Similarly, educational institutions at all levels should be involved in any long-term communications strategy for urban forestry.[44]

What we aim to achieve is for our urban landscape to be considered through conversations about the urban forest to inform 'narratives' about how Melbourne's cultural identity can be enhanced through revisioning, redesign and ultimately replanting. For example: Can we link Melbourne's increasing diversification of its landscapes to its multicultural plurality?7 The narratives should open the space for the community to connect with our urban forest, to find their sense of place whether reflective or spiritual, to allow the community to nurture and love our urban forest.

The City of Melbourne will be a strong advocate for the benefits of a healthy urban forest and continue through various media to seek the views of the wider community about how to protect, manage and enhance our urban forest asset for future generations. We will continue to build ongoing research and measurement into management innovations, and above all allow the local community to have their say in the way our landscapes are planned, designed and managed into the future.

43 Schwab: 28-29
44 C Konijnendijk, pers. comm, 2011

Target: The community will have a broader understanding of the importance of our urban forest, increase their connection to it and engage with its process of evolution.

Actions:

- Enable the community to 'have a say' in the design of landscapes of the future.
- Use innovative tools to engage and involve with the Urban Forest Strategy.
- Encourage 'diverse conversations' about the urban forest through a range of fora.
- Direct the emergence of urban forestry as an essential planning discipline.
- Align with other local municipalities to enhance the whole Melbourne urban forest.
- Encourage and support further research into Australian urban forestry.
- Create opportunities and co-benefits of producing this strategy: align with other strategies to ensure greater impact, increase fields of research, and develop relationships with private landholders.
- Work with traditional owners to develop community programs that increase knowledge of the cultural significance of landscapes in our environment.
- Develop health and wellbeing indicators to benchmark the role of our urban forests in contributing to human health.

Case study

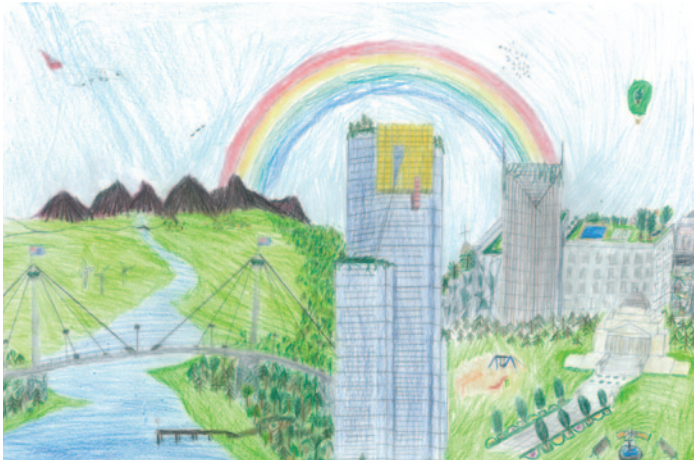
Engaging the community - New York

In 2006, Times Square in New York City was brought to life by banners inspired by the form or metaphor of the tree, compiled by 185 acclaimed artists from around the globe. The project, entitled 'The Urban Forest Project', was received and paraded as a visually stimulating, powerful community engagement event that both celebrated the urban forest, and stimulated discussions around sustainability and the environment.

Since its New York germination, 'The Urban Forest Project' has spread to other U.S cities of Albuquerque, Baltimore, Denver, Portland, Toledo, San Francisco, Tacoma and Washington, DC. In each city, local artists, designers and students have contributed their personal reflections on the tree to the outdoor exhibitions. The banners, inspired by and displayed in a unique local context of each city have proved a positive way to promote eco-city events and programs that exist in the local area, while opening up the community's imagination and motivation to stimulate new ones.

'The Urban Forest Project' and similar initiatives sprouting up alongside innovative approaches to the management of urban forests provide a platform from which to engage the public in urban forest planning and management strategies, to share narratives, and to celebrate art, community, and the environment.

Planting days, such as this at Royal Park, provide an opportunity for our community to be directly involved in the establishment and ongoing management of the urban forest



Winning designs from the City of Melbourne's 2011 Urban Forest Art and Design Competition

The socio-cultural dimension of place has to do with the 'inscription' of sense of place through cultural processes, social networks within place, as well as political and environmental involvement .... The cultural dimension refers to the exploration and recognition of symbols that social groups use to produce and reproduce narratives about their places, such as [urban] forests.

C Konijnendijk, *The Forest and the City*, 2008

Raingardens outside the Dame Elisabeth Murdoch Building at the Victorian College of the Arts on St Kilda Rd

The aspirational end of the spectrum: fully integrated architecture, art, urban design and green infrastructure - Hundertwasser's Waldspirale housing in Darmstadt, Germany

A city literally within a forest, Berlin

6 Implementation Framework

This strategy puts forward principles and strategies which will guide the long-term planning, development and management of the City of Melbourne's urban forest. It also outlines a set of targets to evaluate the success of implementation.

Evolution of the urban forest will need to arise from the basis of solid research, well-informed options and best practice implementation tools and processes. With these foundations, the City of Melbourne will advocate for the practice of urban forestry in Australia.

Creating a resilient and robust urban forest requires forward planning in a similar manner to municipal strategic planning. The management and development of our urban forest needs to undertaken with a long-term vision.

Planning, development and implementation of urban tree policy takes place at two levels: long-term (strategic and spatial) planning and shorter-term (project-focused). The success of the Urban Forest Strategy will rely on effective 'green governance' by the City of Melbourne, clear communications, and a widely understood implementation strategy that comprises programs that meet both short and long-term goals.

6.1 Green Governance

Green governance shapes the plans and decisions which influence the development urban forestry. A multitude of institutions, organisations and stakeholders are involved in shaping and making policy and management decisions that affect our urban forests.

Integrated planning, knowledge sharing and communication are critical components for successful green governance and they needs to occur on a range of levels;

- **Intra-Council integration** involves ensuring internal stakeholder and interdepartmental cooperation. A city scale, planners work directly with urban foresters to integrate policy, practices and analytical tools, coordinating input from many other departments related to managing growth.

- **Community and inter-professional integration** the role of non-public proponents becomes more influential by raising public and bi-partisan political awareness. We recognise the impact that changes in the urban forest have on the values of communities and individual, and must therefore maintain and enhance interaction with the community to ensure these values are considered during urban forest planning and decision making.

- **Inter-municipal integration** involves the need for policy makers to link together with other cities and local municipalities. At this scale, this calls for more systematic assessments of the urban forest across a larger bio-geographical area, beyond arbitrary political boundaries.

- Locally-led action on the urban forest potentially influences **national action.** The learning acquired from small scale autonomous urban forest projects can aid in steering policy-making and the quality and quantity of research across the country. The importance of comparable data would allow urban forests to be managed and have collective benchmarks established to ensure that national climate adaptation targets can be met.

- **International cooperation**. There is a need to network and integrate globally to drive uptake of the principles of contemporary urban forestry to achieve better outcomes for our cities as our urban environment continues to expand.

6.2 Priority implementation actions

Review and update Tree Precinct Plans

The Tree Precinct Plans are an important element in the implementation of the urban forest strategy. These plans will assess and define the character of each precinct in collaboration with the community. They will identify opportunities to guide future street tree planting programs and provide an overarching framework to reference future tree species selections.

These plans will be designed and developed through an extensive community engagement program, with a focus on collaboration. The aim of the plans will be to ensure tree population diversity and reinforce and enhance precinct character.

City of Melbourne has an existing set of tree precinct plans which were published in August 2002 and developed through extensive consultation with the community. The precinct plans focus on Melbourne's street trees and have three primary aims:

1. Protect and develop neighbourhood character
2. Assist in prioritising works and budgets
3. Support proactive replating to ensure a healthy stock of trees over the long term

A new set of precinct plans would substantially build upon the aims listed above, but they would also incorporate a green infrastructure approach to each precinct. GIS based mapping and analysis can be used to consider the coordination of all green elements in a precinct. These elements include:

- Urban character and heritage
- Street and open space trees
- Open space
- Water sensitive urban design and hydrology, stormwater, soil permeability.
- Soil and topography
- Street design
- Path networks
- Strategic integration with other council plans (i.e. built form, path networks, major infrastructure developments)

Each precinct plan will work through these elements and their interrelationships to determine the appropriate level and type of integration to establish a holistic green infrastructure approach.

The objectives of each plan should remain compliment the overall objectives of the urban forest:

- Increase tree canopy cover (how much by what year)
- Increase tree diversity (age and species)
- Increase the amount of "green" and "wet green (soil moisture)"
- Reduce the heat island effect

Specifics outputs should include:

- Demonstrate where to plant (spatial distribution), how to plant (design guidelines) and when to plant.
- Communicate how this transition will occur over the suburb and by each street.
- Provide an implementation plan for priority of works over the next 10 years.
- Provide design guidelines for integrated tree planning, WSUD and streetscape design.
- Provide recommended street tree species lists for each street.
- Provide a recommendation for the appropriate level of diversity of age and diversity.

Proposed timeframes for Precinct Plan implementation:

Year 1: July 2012 – June 2013
Carlton Tree Precinct Plan
East Melbourne & Jolimont Tree Precinct Plan
South Yarra Tree Precinct Plan
CBD Tree Precinct Plan

Year 2: July 2013 – June 2014
North & West Melbourne Tree Precinct Plan
Kensington Tree Precinct Plan
Docklands Tree Precinct Plan

Year 3: July 2013 – June 2015
Parkville Tree Precinct Plan
Southbank Tree Precinct Plan
Fishermans Bend Tree Precinct Plan

Tree Precinct Location Map

Develop Boulevard Master plans

In addition to the development of a new set of precinct plans, several master plans will need to be developed to guide high profile sites including St Kilda Rd, Flemington Rd and Elizabeth St.

Proposed timeframes for Boulevard Master Plan implementation:

Year 1: July 2012 – June 2013
St Kilda Rd Master Plan – Year 1 &2

Year 2: July 2013 – June 2014
Flemington Rd Master Plan Year 2 &3
St Kilda Rd Master Plan – Year 1 &2

Year 3: July 2014 – June 2015
Elizabeth St (Haymarket – Victoria St) Master Plan
Flemington Rd Master Plan Year 2 &3

Implement Urban Forest Diversity Guidelines

These guidelines have been developed to accompany this document. They provide the basis for selecting the right trees and other vegetation for our future urban forest. A scientifically-based matrix has been created allowing City of Melbourne to select a range of appropriate trees for each street typology within the municipality. The guidelines also stipulate diversity targets to be set across the total urban forest in terms of vegetation form, species, age and health. These guidelines should be used to inform capital works programming and the development of the tree precinct plans. The scientifically-based tree selection matrix and list should be review and updated by 2015.

Develop Urban Forest Community Engagement Programs

Community engagement programming will aim to include the broadest possible cross-section of the community, including federal, state and local governments, leaseholders, champions and environmental sector leaders, research and educational institutions, artists, industry forums, schools and developers.

The term 'urban forest' does not just encompass those green aspects of our city which are under the management of the City of Melbourne. In an ecological sense, all of the living components within the municipality, and spanning out to wider Melbourne, contribute to the function and benefits of the collective urban forest.

Unlike some forest systems in rural contexts, the attributes of our urban forest require coordination of many public and private land managers. In the City of Melbourne, a large percentage of land is under the management of independent organisations and private land owners. We need to better understand the current composition of the private realm, as future changes will significantly impact our functional, ecological and visual landscape, which will in turn influence the social and environmental benefits afforded by the urban forest.

Within our municipality, we have a diverse range of property types, spanning tiny apartments to large house and garden plots. We also have a community with diverse cultural, socio-economic, and education backgrounds. As Melbourne continues to increase in density the private realm to the urban forest will need to be fostered and promoted.

Valuing the urban forest

The City of Melbourne adopted the Mauer-Hoffman formula for assessing the monetary value of amenity trees in 1970. In 1990, Peter Yau developed the City of Melbourne amenity value formula, which council adopted for calculating the monetary value of urban trees. This has since been used successfully to acquire compensation for the loss of trees due to development has been adopted by many other local government authorities in Australia for appraising values of Urban Trees (Adelaide City Council).

Amenity values establish City of Melbourne's urban forest as having an approximate worth of $700 million. Valuing the urban forest solely on the basis of an amenity formula does not account for the environmental benefits provided by the urban forest.

The i-Tree Eco tool is a free, peer-reviewed software suite from the United States Department of Agriculture (USDA) Forest Service that provides urban and community forestry analysis and benefits assessment tools (www.itreetools.org/about.php). It provides a broad picture of the entire urban forest and is designed to use field data along with local hourly air pollution and meteorological data to quantify urban forest structure, environmental effects, and value to communities.

The i-Tree Eco tool will provide us with a more holistic dollar value of our urban forest. For example, New York has used i-tree to evaluate that for every dollar they spend on trees, they receive a return of $5.60.

In 2010, the Victorian Local Sustainability Accord provided funding to City of Melbourne, City of Port Phillip and City of Moonee Valley to develop and contextualise the i-tree Eco tool for Australian use. The National Urban Forest Alliance (NUFA) and Arboriculture Australia have partnered as joint custodians of the i-Tree Eco Australia to promote and develop tool's future use in Australia.

City of Melbourne has currently assessed over 1000 trees using the i-Tree Eco tool. Continued use and development of the i-Tree Eco tool will be critical to evaluating and measuring the benefits of our urban forest.

Develop Growing Green Guide for Melbourne

Green roofs, walls and facades have not yet been widely implemented in Melbourne, or indeed Australia. By contrast, cities across North America, Europe and Asia have widely embraced green roof technology and are encouraging and/or enforcing their installation through incentives and regulation.

In Australia we do not have policies or formal guidance as yet requiring the installation of green roofs/walls. Standards for best practice in green roof/wall/facade design for the Australian climate have not been developed and there is a strong demand for such standards.

A project has recently commenced to respond to this demand and its delivery will be a critical element in bolstering the further development and expanding the benefits of the urban forest. Growing Green Guide for Melbourne: A how-to guide for green roofs, walls and facades will be developed collaboratively through representatives from the IMAP partner councils - City of Melbourne, City of Port Phillip, City of Yarra and City of Stonington, as well as The University of Melbourne and the Department of Sustainability and Environment and other stakeholders.

The Growing Green Guide for Melbourne project will develop a practical tool (best practice guidelines) that will increase the knowledge and reduce the technical barriers of green roof wall and facade construction. The project will also include a policy options paper that can be readily utilised by councils, building developers and planners across Victoria. An opportunities assessment will be carried out to identify potential sites to develop green roofs, walls or facades across the four council partner localities.

Green roof on The Venny communal backyard, JJ Holland Park Kensington

Maintain and Develop Exceptional Tree Register

A component of the long term planning for the urban forest and liveability of Melbourne is the protection of trees on private property. A study undertaken by Treelogic has found that tree protection in the private realm is most effective via significant tree registers, as local laws generate a plethora of applications and flow on work, which in majority of cases are met with approval. As a result of this study, the City of Melbourne has undertaken an exceptional tree survey in the municipality and produced a register of exceptional trees which will be put forth for protection through a planning scheme amendment through the Melbourne Planning Scheme in mid to late 2012. Protection of exceptional trees in the private realm will mean that to significantly prune, lop or destroy a tree listed on the Exceptional Tree Register will require a planning permit.

The aim of the register is to recognise, celebrate and protect the exceptional trees that exist in the municipality in the private realm, which contribute to the Urban Forest, and city character as a whole.

An exceptional tree at the Melbourne Zoological Gardens, Canary Island Pine (Pinus canariensis)

6.3 Measurement, monitoring and review

The development of a resilient and robust urban forest requires the ongoing evaluation and assessment of the present resources, the benefits provided and its value, both economic and non-economic. This will enable more efficient management of the urban forest.

At present the primary data collected for the tree population has related to species, life expectancy and infrastructure constraints for its establishment and growth. A completion of this information would be a further characterization of the forest resource at the individual and landscape scale. The finer scale could include inventories of the urban forest, taking the opportunity to establish plots that could inform i-Tree Eco requirements.

To assess the composition, structure and function of the urban forest of the City of Melbourne will provide a way to assess the implementation of the urban forest strategy. At a larger scale a map of land cover and landscape patches and corridors of vegetation would give a general picture of how the city participates within the Greater Melbourne context.

Information development should focus on the following:

- Total area of the urban forest: values of canopy cover, density and vegetation per habitant, this including information from the public and the private realm.
- Urban forest composition, structure and age classes: species present, including some estimations of the private realm, DBH and height classes, and age classes.
- Urban forest landscape mapping: recognition of the corridors linking the open spaces and corridors making an important contribution to connectivity at the scale of Greater Melbourne (i.e. corridors connecting southeast to southwest suburbs).
- Urban forest for climate amelioration: assess the effect of trees on heat stress, how much the establishment of a proper tree can help reducing discomfort, sun exposure and energy savings. Effects on winter and summer, distinguishing the variance obtained from evergreen and deciduous trees. Determine characteristics of trees better for improving climate conditions and appropriate location for different type of trees depending on these services (i.e. evergreen trees preferred locations will be parks instead of streets).
- Urban forest as habitat: identify tree traits and species that could provide habitat to fauna.
- Urban forest productivity, health and vitality: obtain estimations of tree species growth and biomass. Assess tree death and damage because of pests and diseases and the effects of drought periods.
- Urban forest contribution on the carbon cycle: assess the urban forest carbon stored and if possible (i.e. i-Tree ECO) obtain carbon sequestration rates. Estimate the effect on climate change on the urban forest recognizing the effect of the 10 year drought on tree species productivity and health, for this a comparison of LIDAR 2000 to 2010 can provide some understanding.
- Urban forest contribution to air quality: through the results obtained from i-Tree ECO the effect of the urban forest can be determined, assessing the importance of trees especially in streets of high traffic. Additionally trees help for noise reduction which can be valued by the type of tree and distance to the closest street.
- Urban forest contribution to the conservation and maintenance of soil and water resources: obtain easy measurable values for soil properties such as pH, bulk density, water content and soil carbon. Estimate values for infiltration and drainage, could be obtain at a coarser scale.
- Urban forest contribution of the maintenance or enhancement of socioeconomic benefits: use of spaces for outdoor activities and recreation, assess the effects of treed areas in property values. Estimate effects on sense of place, cultural and historical heritage.
- Establish community connection: understand what are the benefits of the urban forest that the community actually perceives and what is the importance given to those benefits. Also understand the nuisances perceived by the community coming from the urban forest.
- Urban forest disservices: recognize the species that have a high allergenicity index (i.e. OPAL allergen index), are more prone to pest and diseases, have low ULE, and are higher emitters of volatile organic compounds (i-Tree ECO output).
- Economic value of the urban forest: the main benefits of the urban forest can be quantify in dollars, i.e. property values, carbon stored, energy savings, reduction on medical expenses related to heat stress, etc.
- Spatial distribution of urban forest ecosystem services: produce maps that can help communicating the benefits of the urban forest, the effects of the urban forest strategy implementation.
- Spatial analysis of the urban heat island: through the use of a road density map, a population density map (or building density map) in addition to a normalized difference vegetation (NDVI) map.
- Establish a thermal map relationship between urbanization, UHI and canopy cover for the City of Melbourne. This could help establishing priority areas for increasing canopy cover.

With this analysis and information a ongoing evaluation of how the services provided by the urban forest could be enhance and how the implementation of the urban forest strategy is affecting not only for climate change purposes but also those additional benefits obtained through a healthy and well managed urban forest.

6.4 Funding resources

True success in maintaining our urban forest depends on the continuing support of the **public sector, developers, corporations** and the **wider community**. The City of Melbourne recognises that effective implementation of green infrastructure throughout our urban environment depends ultimately on the coherent public policy supporting it – financially, administratively and legally – and that a long-term funding commitment is required over the next two decades.

Development of the urban forest is also an area of public planning where government does not need to tackle the job alone. Developers have always looked for a marketing edge for their properties. The best developers understand that building green means not just structural design, but the entire development site and its relationship to its surrounding context. Developer open space contributions are also an important means of supporting and advancing tree programs and other green infrastructure initiatives in newly developing areas.

Business partners can be powerful contributors to the expansion and success of urban forestry through financial support, planting and maintenance of trees on commercial property, and active support of civic organizations involved in forestry. Some businesses clearly have a direct stake in urban forestry as a function of their own enterprises. Others may be interested in offsetting environmental impacts, an area that is likely to grow as carbon credits become commoditised as a result of climate change policy.

Achieving funding stability is ultimately a matter of continuing to have the support of the public for City of Melbourne to remain committed to allocating sufficient funding for programs in perpetuity. Much of this hinges on communicating and disseminating information about the increasing benefits of Melbourne's urban forest in terms of stormwater pollution impact, electricity saved, carbon and water savings from lower energy use in buildings and lower air-conditioner and power plant use, biodiversity benefits and temperature reductions in city as a whole – not to mention the aesthetic enhancement of the city and wide-ranging social and economic advantages.

Project costs can be more easily justified when they can be linked to benefits derived from specific green infrastructure implementation strategies, and the provision of a robust cost benefit analysis for the urban forest will help ensure that it remains competitive as a high value land use amongst hard infrastructure and transport. In other words, stable support of the community is generated by a long-term track record of documenting and disseminating those benefits.

City Square, Swanston Street, Melbourne

Glossary

Adaptive management generally refers to the application of new knowledge in updates and changes to a program. In this approach, 'the best science, albeit incomplete, is brought to bear on an ecosystem, management is implemented under rigorously monitored conditions, and adaptations in management are made as the feedback from monitoring teaches us ore about the way the ecosystem behaves.' (Rowntree, 1995)

Ecosystem resilience is a measure of how much disturbance (like storms, fire or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged. [add from AILA policy]

Ecosystem Services are the benefits people obtain from ecosystem processes. These include water and air purification, flood control, erosion control, generation of fertile soils, detoxification of wastes, resistance to climate and other environmental changes, pollination, and aesthetic and cultural benefits that derive from nature.

Green infrastructure refers to 'an interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clear air and water, and provides a wide array of benefits to people and wildlife'. (Benedict & McMahon, 2006)

Natural Capital is an extension of the traditional economic notion of capital. The term was coined to represent the natural assets that economists, governments, and corporations tend to leave off the balance sheets. Natural capital can be non-renewable resources (e.g. fossil fuels and mineral deposits)' renewable resources (e.g. fish or timber) or ecosystem services (e.g. the generation of fertile soils, pollination, or purification of air and water).

Resilience is the capacity to deal with change and continue to develop.

Social Capital is a concept used in various fields, from economics and political science to sociology and natural resources management. Broadly, it refers to social relations and among individuals and the norms and social trust which they generate and which facilitate coordination and cooperation for mutual benefit.

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 crucial in maintaining options for future human development.

Social-ecological systems are linked systems of people and nature. The term emphasises that humans must be seen as a part of, not apart from, nature — that the delineation between social and ecological systems is artificial and arbitrary. Scholars have also used concepts like 'coupled human-environment systems', 'ecosocial systems' and 'socio-ecological systems' to illustrate the interplay between social and ecological systems. The term was coined by Fikret Berkes and Carl Folke in 1998.

Sustainable urban development provides a framework focused on creating urban communities where both the current and future needs of residents are met. There are two important principles - resilience and connectivity - that underpin sustainable urban development.

Urban forest Helms, 1998 from Schwab: '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'. Or US Forest Service, from Schwab: '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'.

Urban Heat Island Effect (UHI) As urban areas generally contain less permeable surfaces and vegetation than surrounding rural areas, urban regions tend to become warmer than their rural surroundings forming an "island" of higher temperatures in the landscape. Heat islands occur on the surface and in the atmosphere. Surface urban heat islands are typically present day and night, but tend to be strongest during the day when the sun is shining. In contrast, atmospheric urban heat islands are often weak during the late morning and throughout the day and become more pronounced after sunset due to the slow release of heat from urban infrastructure.

Urban sprawl is a phenomenon that plagues cities in both developing and industrial countries. It is an uncontrolled or unplanned extension of urban areas into the countryside that tends to result in an inefficient and wasteful use of land and its associated natural resources.

Useful Life Expectancy (ULE) is an estimated measure of how long a tree is likely to remain in the landscape based on health, amenity, environmental services contribution and risk to the community. It is not a measure of the biological life of the tree and it is not used as a timetable for scheduling tree removals.

Vulnerability refers to the propensity of social and ecological system to suffer harm from exposure to external stresses and shocks. Research on vulnerability can, for example, assess how large the risk is that people and ecosystems will be affected by climate changes and how sensitive they will be to such changes. Vulnerability is generally regarded as the antithesis of resilience.

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