Fishermans Bend Taskforce

Volume 1: Fishermans Bend Urban Ecology Study

September 2020

Scope and limitations

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Figure i. Biodiversity workshop attendees

The project team thank everyone who attended and contributed meaningfully to the study. We are grateful for the insightful comments provided by all attendees at the project workshops. The heat research was conducted by CRC for Water Sensitive Cities, Monash University. The biodiversity research was conducted by ICON Science Research Group and Sustainability & Urban Planning, RMIT University, with support from the Australian Government's National Environmental Science Program through the Clean Air and Urban Landscapes Hub and the Threatened Species Recovery, 010350. Project management, workshop facilitation, strategy development, and advice on wind, urban planning and landscape architecture was delivered by GHD.

Executive Summary

Introduction

The Fishermans Bend Framework (2018), sets a strong vision for biodiversity, climate resilience, liveability and water sensitivity. The Framework objectives relevant to this study are summarised in Section 1.2.

Urban ecology is a sub-set of ecology, which refers to the interplay between people, nature and the environment in urbanised areas.

This "urban ecology" study integrates **four** of the key areas that need to be addressed at Fishermans Bend to achieve the Framework goals:

- urban forest
- urban heat
- wind and;
- biodiversity.

There are also strong linkages between the strategies and solutions to address these areas, and other interfacing areas (e.g. water sensitive urban design and active transport).

The scope and associated method for this study involved: review of existing guidelines and strategies for all themes; development of modelling projections for all four themes to use as an evidence base; development of technical recommendations in relation to each of the four themes; working with stakeholders to develop integrated solutions and consideration of implementation; and the development of final recommendations and associated design guidance. This study makes recommendations for the design of both the public realm (streets, Public Spaces etc.) and private realm (building shape/height, private greening etc.)

The project team has combined all of the technical analysis and stakeholder engagement to develop urban ecology recommendations for Fishermans Bend.

The key features of these recommendations are as follows:

1. advice around what themes should be prioritised in which areas,
2. performance objectives and design guidance for the public and private realm,
3. flagship recommendations designed to highlight key features from the design guidance, and
4. priorities for further analysis.

Overarching design guidance

The project team proposes the following overarching design guidance:

Spatial prioritisation of corridors

The project team has mapped out the priority areas for heat, wind and biodiversity. This mapping exercise shows which design features should be prioritised where. It is recommended that: Figure i demonstrates which elements (heat, wind or biodiversity) should be prioritised where. Urban forest is not specifically highlighted as the urban forest Is one of the primary mechnisms for addressing both heat and biodiversity, as well contributing to wind management (in regards to locating vegetated wind-breaks).

In relation to the priority corridors the project team recommend various interventions as outlined throughout this document, some key recommendations include:

- In wind priority corridors all buildings include podiums and/or structural canopies (connected to buildings) that overhang footpaths to protect pedestrians
- In heat priority corridors tree canopy width and height should be maximised, with particular emphasis on green infrastructure (including green walls) on the southern side of East-West streets, and the eastern side of North-South streets, and an emphasis to retain stormwater in the landscape (tree pits, rain gardens, other flood storages) for cooling
- In biodiversity priority corridors the following should be maximised in corridors and adjacent private space: vegetation structure diversity (tall grasses, shrubs, short and tall trees), potential incompatible uses, and contiguous medians. Biodiversity Sensitive Urban Design principles should be applied to ensure resources are provided for diverse animal species, including shelter (e.g. dense, protective shrubs), food (e.g. flowers, fruits, seeds, pollen, nectar) and nesting sites/shelter (e.g. tree cavities), and water

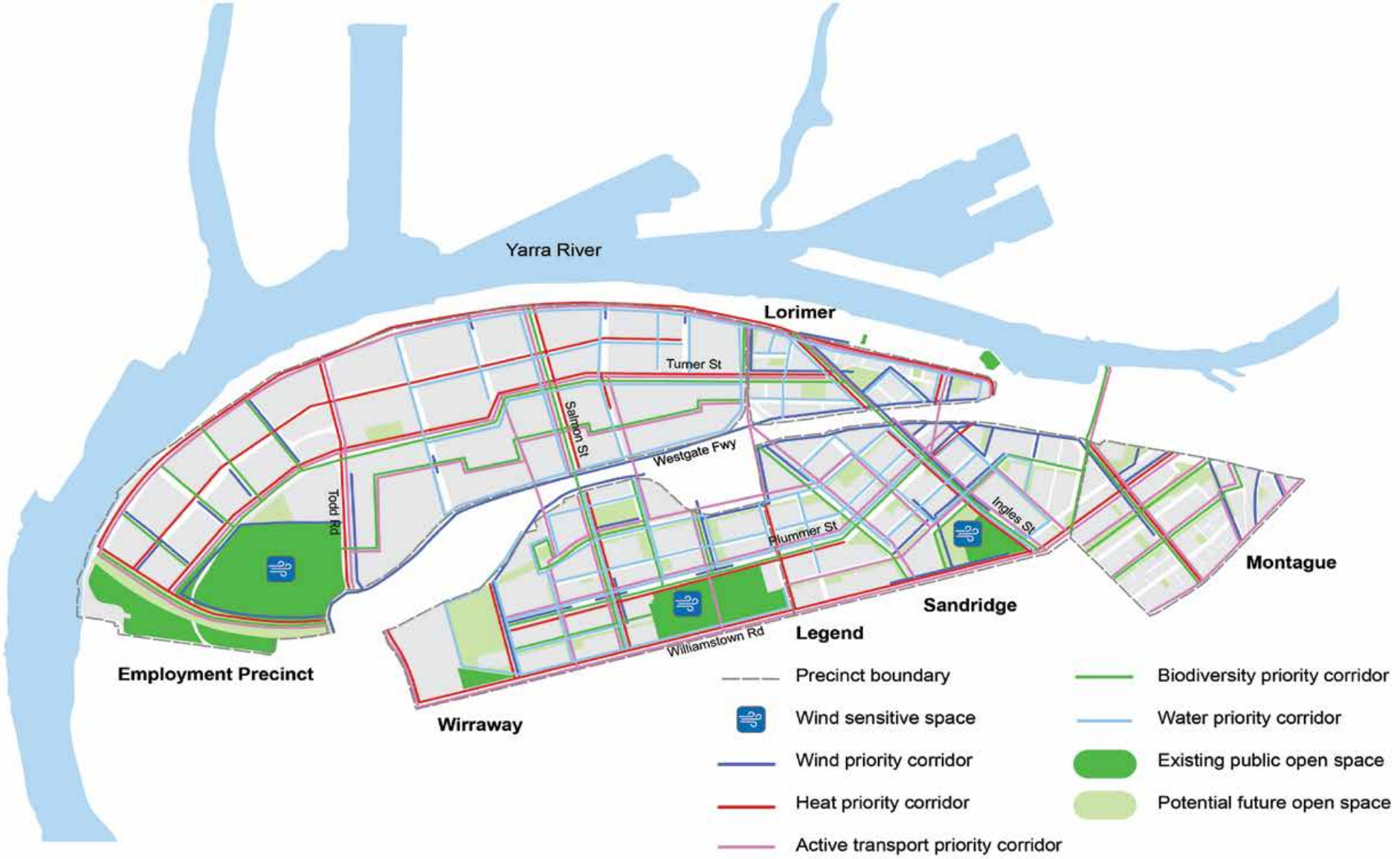

Figure ii. Spatial prioritisation of corridors across Fishermans Bend (Victorian State Government, 2018) (note: refer to Section 3.3 for explanation and individual maps on each theme)

Public space

In regards to public space the project team recommends the following:

- Irrigate vegetation with recycled water to modify the microclimate and avoid high temperatures
- Introduce wind breaks to strategic edges of public space via mounding and dense vegetation to buffer winds, and create comfortable spaces for recreation
- Park entries and movement network shall consider CPTED principles and avoid traversing through the wind breaks (which are likely to have lower visibility)
- Incorporate water features in public spaces, to offer diversity in experience and cool the urban environment
- Install eco-street lighting which have long wavelength LED lights. Provide lighting only along pedestrian and cycle routes, to minimise excessive disruption to areas of habitat. This could incorporate scheduled periods of darkness in appropriate places. This could be via motion sensors (in appropriate locations) to reduce excessive light spill, while still maintaining a safe level of lighting to the streetscape (Longcore, et al., 2018; Davies, et al., 2017)
- One segment of public space to be designated as a biodiversity area to provide a diversity of vegetation structure, habitat and resources for fauna. Where possible it is preferable to locate this biodiversity area near to the beginning of a biodiversity priority street corridor, but more than 3 m away from traffic. Minimum patch size of 15 square metres (approximately 2 car parks). This also informs the size of 'patch' where the biodiversity area exists on its own
- Biodiversity areas should have structurally diverse vegetation (multiple layers), be large and contiguous enough to accommodate wildlife. They are compatible with active transport and quiet recreation (not sports). Species selection for planting should be supervised by professional ecologists. Note: these areas are also accessible and encouraged for human passive recreation
- In spaces/corridors where biodiversity is not the primary focus, nature based solutions should still be selected as biodiverse designs can solve multiple objectives

Private realm

In regards to the private realm the project team recommends the following:

- Prioritise at grade vegetation (over elevated plantings) to promote human/biodiversity interactions, street level shading and public space. It is noted that some parts of Fishermans Bend already have a requirement for buildings to cover 70% or less of the lot (some less dense sections of Wirraway and Sandridge). Consider further application of this to other areas of the precinct
- Provide elevated (including but not limited to forecourt, podium and roof) green infrastructure to achieve shade/cooling, stormwater retention/treatment, biodiversity habitat, and spaces for humans to gather
- Develop an ecologically diverse species list for rooftop and podium landscapes specific to Fishermans Bend, that promotes flowering species on rooftop gardens for bee and butterfly pollination
- A mechanism should be developed (whether it be the City of Melbourne Green Factor or otherwise), that requires a minimum amount of private greening in new developments across all of Fishermans Bend, and suitably prioritises the above recommendations
- Developers should be encouraged to follow a Biodiversity Sensitive Urban Design framework prior to building
- Buildings in priority wind areas should incorporate the guidance outlined in the Management of Wind flagship recommendation
- Encourage developers to include urban agriculture within the private realm

Flagship recommendations

Flagship recommendations are not intended to be comprehensive applications of the above design guidance, but rather to (a) highlight and help build momentum towards key recommendations that might otherwise be "lost in the noise" of design guidance, and (b) fill perceived gaps in precinct planning. The project team proposes the following flagship recommendations:

A green link running through the Fishermans Bend National Employment and Innovation Cluster (NEIC) will act as a green movement corridor permeating through the otherwise large scale block structure while also serving a linear open space function

This link, made up of connected linear parks, is to include large canopy trees, diverse understorey vegetation, walking/cycling/seating, conveyance of stormwater, and limited vehicle access (for maintenance only). This link is designed to support active transport through a cool/shaded corridor, biodiversity connectivity, amenity, and contribute to the requirement for both new open space, and above ground stormwater conveyance, within the Employment Precinct. The Green Link is one element within the broader strategy of connecting pedestrians with biodiversity (as shown in Figure i), designed to connect other precincts towards Westgate Park (the largest and most ecologically established area in Fishermans Bend)

Diverse vegetation structure will be included in segments of all public space, all linear parks, some priority "biodiversity priority corridors", and private realm

A holistic approach to vegetation structure with the provision of adequate native understorey vegetation will be a key foundation for cultivating biodiversity in Fishermans Bend. It is advised that all public space in the precinct have designated minimum "biodiversity areas". Some streets should be designated as "biodiversity streets" (see Figure iii), which include a diverse understory of plants varying in height in connected nature strips. All linear parks should include native understory vegetation. In the private realm, native flowering plants should be included in gardens beds in all new gardens, including street frontages, podiums, rooftop gardens and other elevated green infrastructure. In all cases native vegetation should be selected that provides both habitat and resources

Water will be visible in the landscape by directing water to the urban forest first, before directing water to the drainage pipes

'A water sensitive community' is a key sustainability goal from The Fishermans Bend Framework and includes the objective to establish an integrated water system. It is recommended that the drainage plan be revised to redirect stormwater to rain gardens, above ground storages, and tree pits (as well as bioswales and artificial wetlands if any) first, before directing water to pipes. These ephemeral features should be complemented by the inclusion of some combination of permanent small water bodies, wetlands and/or raingardens in public spaces, particularly adjacent to understorey vegetation areas. Linear parks and the Green Link should include a combination of ephemeral and permanent water bodies. Where possible water features should include amphibian friendly edges

Management of wind

While the scope of this study does not include the assessment of all possible built form outcomes and their effects on wind in the built environment, various high level recommendations can be made to mitigate undesirable wind conditions within streets and open spaces. For all buildings this includes: encouraging the placement of balconies on southern faces, shielding of balconies with secondary operable facades, avoiding ground-floor openings (e.g. arcades without doors that extend the length of the building) in tall buildings. In streets identified as wind canyons these include: requirements for podiums, and structural canopies to protect sidewalks and entrances. For outdoor seating/eating areas consider use of porous/impervious screens/awnings to blocks winds. Other general wind guidance includes that for tall buildings with rectangular footprints, it is undesirable to have the wide face towards the North (prevailing wind), and it is undesirable to place short buildings directly upwind of tall buildings, and locations where these occur require particular emphasis on wind engineering solutions

Management of heat

The project team have conducted heat modelling on a set of case studies to identify areas which are likely to have high Human Thermal Comfort (HTC) temperatures, as well as test multiple tree canopy scenarios to determine their impact. The results showed that 45% of the modelled areas can be moved down from the "very strong" (feels like low 40s Celsius) to "strong" (feels like mid 30s Celsius) heat stress category, as canopy width and height is increased. It is recommended to prioritise maximising tree canopy over all other urban ecology recommendations in the corridors where a heat priority street coincides with an active transport street.

Recommended next steps

Recommendations for further analysis include:

- Consideration of inclusion of Biodiversity Sensitive Urban Design and greening within the design of catalyst projects, including university campuses, Turner St tram business case, and South East Water sewer mine
- Consideration of inclusion of a Living Levee, potentially with mangroves, within the required sea level rise levee (required in approximately 2050)
- Consideration of palatability of cat containment local laws (including requirement for residents to keep cats indoors and council round up of feral cats)
- Re-assessment of targets for tree canopy, and the development of new targets for (a) understory, (b) permeability, and (c) biodiversity. All of these targets may warrant a monitoring program to test their achievement over time. Note: spatial analysis undertaken through this study has provided data points to assist with the revision of tree canopy targets, by the indicating the spacing and size of trees required to meet different canopy targets, see Volume 2: Appendix B
- Additional targeted efforts to identify and protect existing significant trees and other habitats, particularly in the Employment Precinct, and even more so in the private realm of the Employment Precinct
- Consideration of additional biodiversity links, particularly in relation to inclusion of vegetated habitat corridors on pedestrian bridges, and potential amphibian underpasses
- Further work is required on planting palettes in collaboration with Westgate Biodiversity (Bili Nursery and Landcare), who for 20 years have been revegetating Westgate Park with ~320 species of locally indigenous plants

Conclusion

The analysis conducted, and recommendations developed as part of this strategy provide an evidence base and future directions for the more detailed Precinct Planning actions within Fishermans Bend. Overall it has been demonstrated that it is possible to deliver a precinct in Fishermans Bend that sets a new benchmark for sustainability and liveability, with iconic, walkable neighbourhoods where residents are protected from adverse effects of heat and wind, and both water and biodiversity are visible within the landscape.

Lastly we acknowledge in preparing this study that great enthusiasm, dedication and creativity has been applied by all involved to make the project an enjoyable and meaningful process. While we accept there will be challenges in prioritising competing interests it is understood that urban ecology rightly has a place in the early planning of liveable, vibrant and connected neighbourhoods. By bringing urban ecology to the forefront of urban design and aspiring for a city made up of greener, cooler corridors and built form, underpinned by traditional and contemporary ecological knowledge, we are changing the function of our cities for future generations.

Figure iii. Integrate nature into all public spaces

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Acknowledgements

Acknowledgement of Country

GHD and the project team proudly acknowledge Victoria's Aboriginal communities and their rich culture; and pays its respects to their Elders past and present. We acknowledge Aboriginal people as Australia's first peoples and as the Traditional Owners and custodians of the land and water on which we rely. We recognise and value the ongoing contribution of Aboriginal people and communities to Victorian life and how this enriches us. We embrace the spirit of reconciliation, working towards the equality of outcomes and ensuring an equal voice.

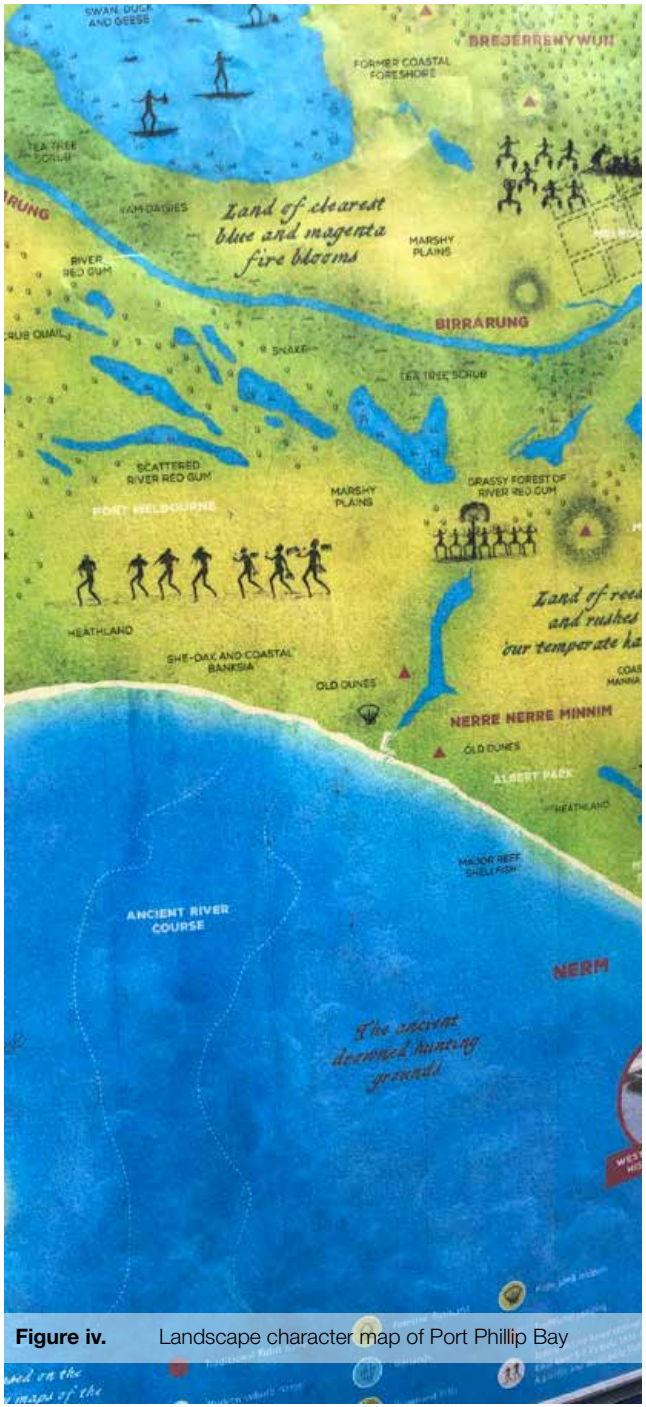


Figure iv. Landscape character map of Port Phillip Bay

1. Introduction

1.1 An urban ecology study for Fishermans Bend

What is urban ecology?

Ecology is generally understood as the interactions between living organisms, including humans, and their physical environment; it seeks to understand the vital connections between plants and animals and the world around them (Ecological Society of America, 2020).

Urban ecology is a sub-set of ecology, which refers to the interplay between people, nature and the environment in urbanised areas (Ecological Society of Australia, 2012). Urbanised areas are highly altered landscapes designed to support the inhabitation of large populations of people.

Urban areas are challenging environments for biodiversity and ecological processes. As the earth's population grows and industrialises, population densities within cities are increasing. It is estimated that 5 billion people will live in cities by 2030. Under a traditional western approach to urban development, densifying cities often perform poorly in regards to urban ecology, resulting in a "concrete jungle".

Within Melbourne, population growth and densification are resulting in reductions in urban canopy cover in most regions (DELWP canopy mapping 2014 and 2018), causing diminished performance in regards to human health and biodiversity outcomes. However densification and urban renewal also offer an opportunity to reimagine and redesign our cities, to create environments that help humans, plants and animals survive and thrive, through mutually beneficial interactions. The benefits of urban forestry are summarised in Figure 2.

This Fishermans Bend Urban Ecology Study (FBUES) focuses on heat, wind, and biodiversity outcomes, and how they can be influenced through urban forestry, public and private realm design. It has become known as an "urban ecology" study because it deals with the complex interplay between humans, flora, fauna, and the surrounding built and natural environments, Figure 1.

"A thriving place that is a leading example for environmental sustainability, liveability, connectivity, diversity and innovation"

Figure 1. What does urban ecology look like in Fishermans Bend?

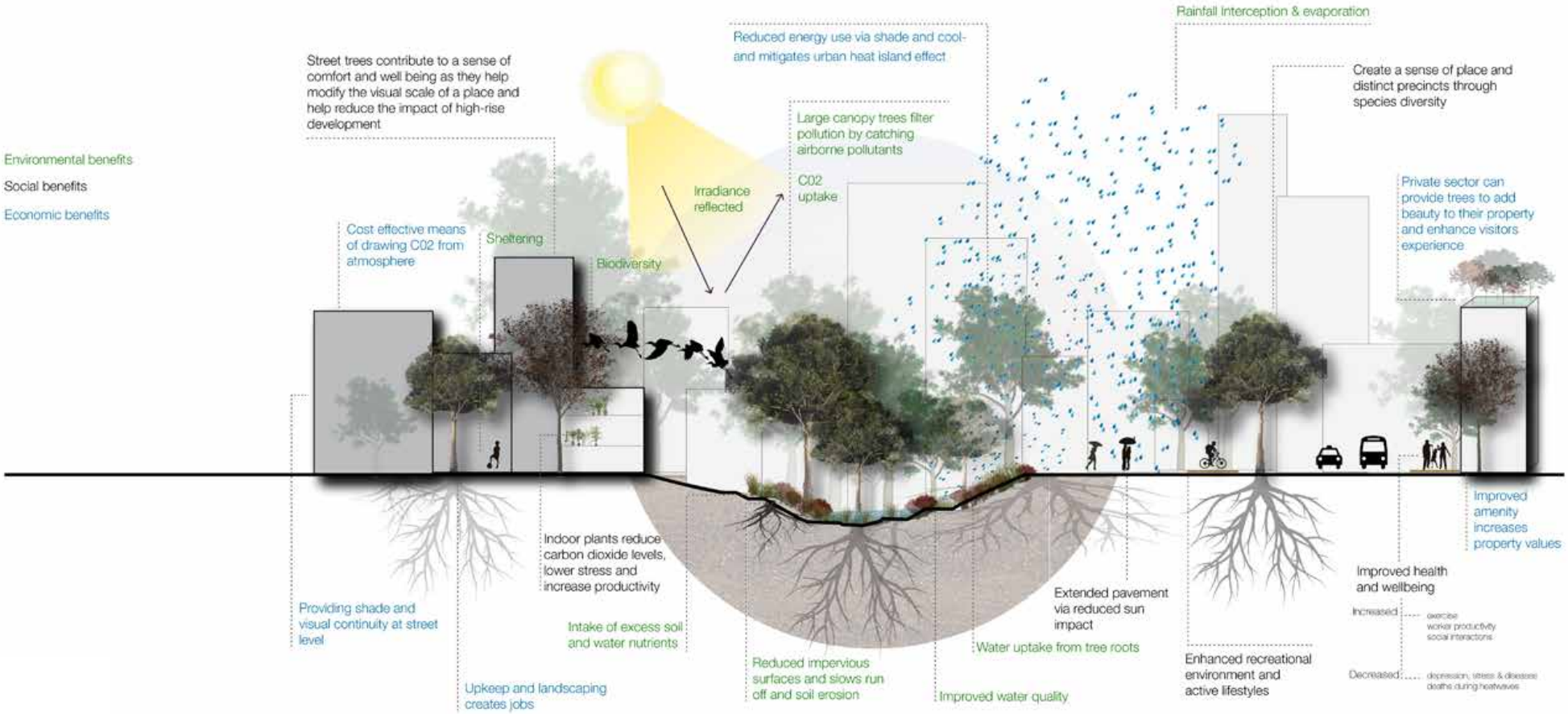


Figure 2. Benefits of urban ecology

Urban ecology elements considered in this study

This study addresses needs and interplays between the human-scale built environment with that of the natural environment. There are many dimensions to these dynamic interactions. Fundamental to underpinning the resilience of such a complex system is diversity of ecological functions and biophysical structure.

Urban design presents the integrative process for these elements. A key organising structure for a vibrant urban ecology in Fishermans Bend is its corridors – which will be expected to serve multiple functions, well beyond enabling access for pedestrians and vehicles. These corridors are precinct-scale biophysical structures that provide the connectivity between local scale design initiatives. These ecological functions include urban heat mitigation and enhancement of human thermal comfort, drainage and flood mitigation, nature (flora and fauna) conservation and biodiversity enhancement, active and passive recreation, community health and wellbeing.

In this study, the project team have identified **heat, wind** and **biodiversity** as key elements defining the future ecology and liveability of the Fishermans Bend, in large part to be delivered through a fine-grained and strategic urban forest plan and implementation. In other words, it is the urban forestry decisions (e.g. what to plant and where) which will significantly determine whether heat, biodiversity and wind objectives are achieved.

See Figure 3 for a description of, and the relationships between, the four themes considered in this Study.

This FBUES complements and integrates with the Fishermans Bend (i) water sensitive cities strategy; (ii) the urban development masterplan; (iii) 6-Star Green Communities certification; and (iv) Precinct Implementation Plans, all of which are developed separately.

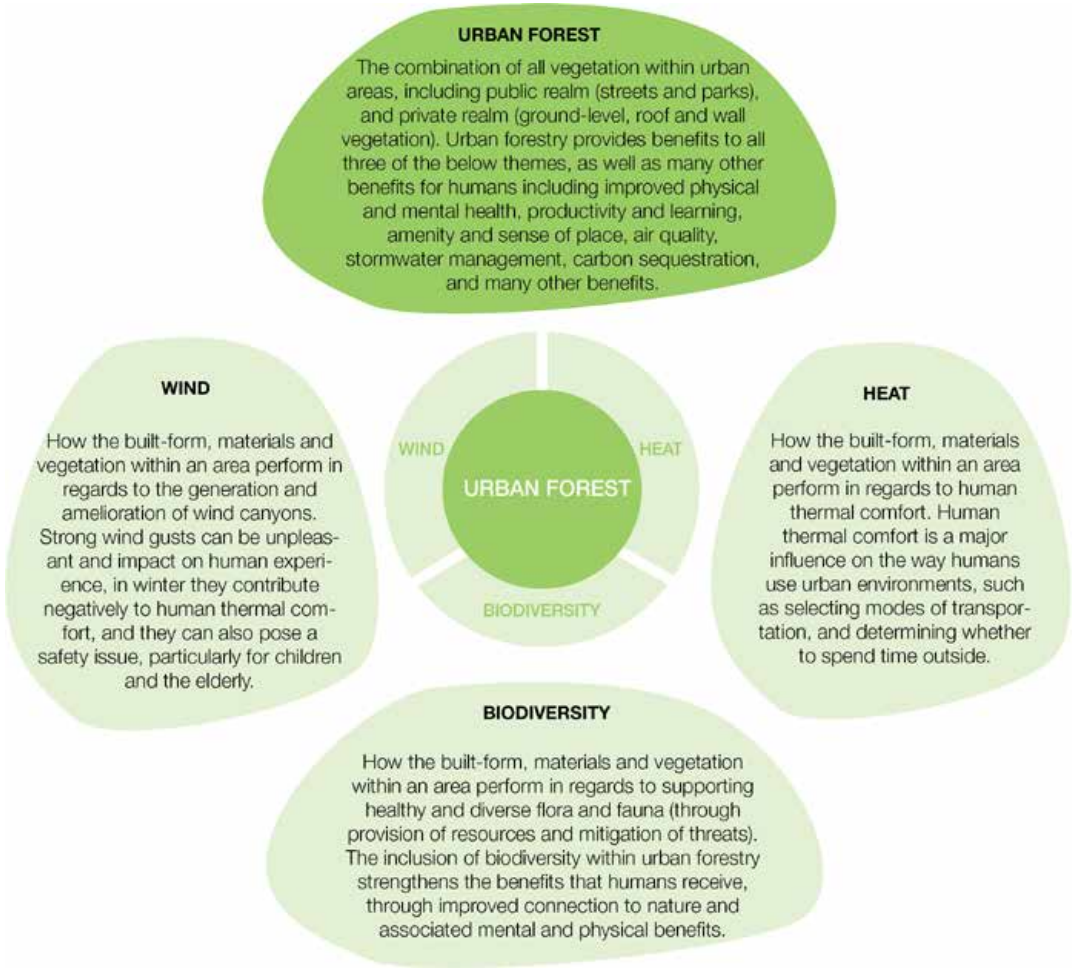


Figure 3. Relationship between the four investigation themes and urban forest

Urban ecology design responses considered

In developing the FBUES it is recognised that there are both synergistic and competing design requirements in addressing the themes of heat, wind and biodiversity. The assessments of the identified ecological elements have considered and commented on the following design parameters and associated issues:

Note: these are issues considered through the assessment rather than recommendations

Ensuring effective heat mitigation from a combination of shading, vegetation evapo-transpiration and evaporation of water bodies. Considerations include:

- Increasing the overall percentage of the public realm shaded by tree canopy, and prioritising the placement of trees around corridors with higher pedestrian movement, and higher exposure to radiation, in order to improve human thermal comfort;
- The integration of stormwater drainage into green spaces along road reserves to provide passive watering of vegetated spaces, and to contribute to maintaining high soil moisture to mitigate urban heat and;
- Regular watering of green spaces, particularly during warmers months, and potentially also prior to heat waves, to maintain high soil moisture to reduce the impact of heat on human comfort;

Providing **bio-connectivity** as a key feature to promote active transport, general biodiversity and fauna connectivity within transport corridors, offline pedestrianised corridors and linked public spaces, across all precincts. Bio-connectivity considerations include:

- As much structurally diverse vegetation as possible should be included, however it is the linkages and connections that create viable landscapes for wildlife. Providing quantitative targets for a site this large requires ongoing consultation with ecological professionals during planning & design stage. It also depends on the existing habitat available (which has still not been mapped) and how the provision of other services is being approached systematically. We strongly recommend further consultation as the development progresses;
- The integration of a network of corridors connected to a hierarchy of open spaces to provide an abundance and diversity of ecosystems;
- Strategic placement of diverse vegetated areas, permeable surfaces, swales or even small public spaces along areas designated for stormwater storage, is encouraged;
- Strategic placement of vegetation using Crime Prevention Through Environmental Design (CPTED) principles to enhance passive surveillance and community safety;
- Integration of biodiversity sensitive urban design into the build form, with a focus in the northern precincts where the opportunities are the greatest;
- Recognising Westgate Park as a strategic anchor and source of biodiversity for the area.

Influencing the **building design** and their consequent impact on corridors through improving the wind characteristics in the precincts of Fishermans Bend. Careful urban design, based on modelling of localised effect of building configuration, orientation and façade treatment, can have a positive effect on the liveability of the area. Wind mitigation considerations include:

- Building height, width, orientation in regards to dominant winds, and spatial arrangement;
- Building protections for balconies, podiums and other elevated spaces;
- Ground level protections including podiums, structural canopies, screens and awnings.

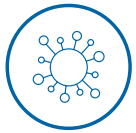
The ability to accommodate the competing design requirements will be determined by space available above and below ground (e.g. corridor width), land parcel parameters (including area, width, orientation etc, and available resources to support initiatives over and above Business As Usual.

Vision

Together with stakeholders, the project team have developed the following vision for urban ecology within Fishermans Bend.

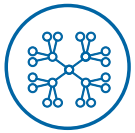
In May 2019 a workshop including stakeholders from the Victorian Government (DELWP), local Governments (City of Melbourne, City of Port Phillip), Traditional Owners (Boon Wurrung Foundation), local environment groups (Westgate Biodiversity, Port Phillip Eco Centre) and researchers (The University of Melbourne, RMIT University) identified these six biodiversity objectives. These objectives reflect a more accessible way of communicating the meaning of biodiversity to a broad audience, beyond the traditional measures typically used in ecology and conservation.

These objectives build on but go beyond the key goals articulated in the Fishermans Bend Framework, reflecting a level of ambition that is appropriate for the scale and potential of the site, which could be an exemplar of world's best practice in sustainable urban development.



A place that honours Indigenous culture

The habitats of this area reflect Indigenous knowledge and stories in their design, naming and function. This overarching objective guides all other objectives.



A place for the senses

Habitat areas offer scents, colours and sensations, which bring daily delight but also opportunities to feel relief and escape from the 'concrete jungle'.

A place with seven seasons

Constant seasonal change is reflected in our flora and fauna, how we use places, and how water appears in the landscape.

A place of shifting waters

Water is part of the landscape – including freshwater and brackish, ephemeral and permanent.

A place known by its diverse ecosystems

Local ecosystems and species are a core part of each precinct's identity and function. Local habitat helps you know where you are and where you're going.

A place that's comfortable and beautiful in any weather

Street and public space design and species selection offers a range of microclimates – from shaded to open, from wet to dry and from breezy to sheltered.

1.2 Fishermans Bend Context

This study takes into account the intended character of each of the Fishermans Bend Precincts (refer Figure 4) which are outlined in Volume 2 Appendix A.

One element of the intended character of each precinct is the maximum building height that is allowed in each, as illustrated in Figure 5.

Figure 4. Fishermans Bend Precincts

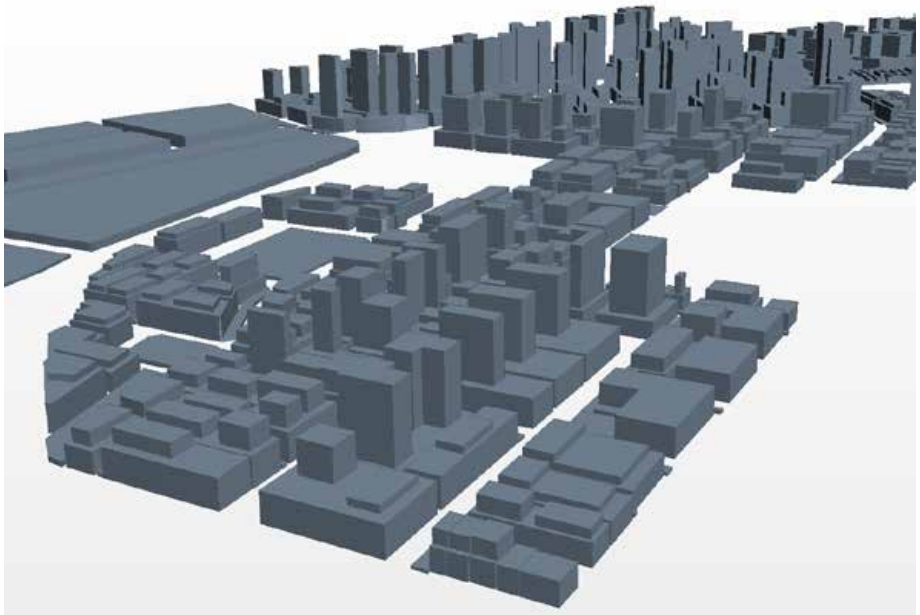


Figure 5. Different building shapes and heights across Fishermans Bend

Relevant objectives from Fishermans Bend Framework

The Fishermans Bend Framework Sustainability Goals guide all future decision making in Fishermans Bend and provides the benchmarks against which the urban ecology study must be tested. The relevant objectives from the Fishermans Bend Framework are shown in Table 1.

#	Objective
1	**Connected and liveable community**
1.9.4	Diversity of high-quality publicly accessible spaces
1.10.1	Minimum communal private open space area in non-core Wirraway and Sandridge
1.10.2	Inclusion of private open space in all developments
1.12.1	Range of height limits
1.12.2	Built form provisions
1.12.3	Design standards for safe enjoyable and pedestrian-friendly private external spaces
1.13.2	Development standards for scale, height, set-backs and interfaces
1.13.3	Private realm character (separation and set-backs)
1.13.7	Set-back definition above the street wall according to building height
3	**Inclusive and healthy community**
3	Open space within 200 m of residences
3.3	Community involvement in open space design
3.6.1	Redesign and/or expand major existing open spaces
3.6.2	School-owned open space as opportunity during weekends
3.6.3	Opportunity for access to private and leased open space
3.6.4	Increase use of encumbered land as open space
3.7.1	Open spaces as informal meeting places
3.7.2	Recreational walking and cycling trail along linear parks and streets (connecting to Yarra, Bay and Capital City Trail)
3.7.3	Dog off-leash areas in open space
3.7.4	Playgrounds within 400 m of residences
3.7.5	Locate new open spaces to achieve solar access and amenity
3.7.7	Retain controls to protect pedestrians for negative wind effects created by new buildings
3.7.8	Network of open spaces of varying sizes
3.7.10	Design open spaces to have passive surveillance
3.8.2	Identify Aboriginal cultural associations with original topography of area
3.10.5	Establish how caring for country can be applied in an urban context
4	**Climate resilient community**
4	Fishermans Bend no hotter than the CBD
4.1.1	Design standards for private realm shading, cool and green roofs, and albedo treatments
4.1.2	Shading and vegetation in public spaces
4.2.1	Well designed and managed green roofs and walls
4.2.2	Deep soil planting in new developments and public spaces
4.3	canopy cover of 50% in public spaces by 2050
4.3.1	Vegetation species selection mindful of future climates, diversity and resilience
4.3.2	New streets designed for large healthy trees, including irrigation with recycled water
5	**A water sensitive community**
5.1.1	Treat and reuse stormwater
5.1.4	Holistic strategy for drainage
5.1.5	Make water visible in the landscape
6	**A biodiverse community**
6	good health in 90% of trees by 2050
6	greater diversity of plants and fauna than 2017 levels
6.1.1	Protect existing biodiversity in design of public spaces
6.1.2	Open space and streets as mosaic of habitats
6.1.3	Green infrastructure in private realm
6.1.4	Native trees where suitable for large canopies, exotic species selection to include resources (flowers, pollen, nectar and rough bark)
6.2.1	Designated areas of complex vegetation
6.2.2	Open spaces designed to enhance human connection with biodiversity
6.2.3	Engage the community in biodiversity
6.2.4	Improve soil and water health in streets and public space
6.2.5	Maximise resources for biodiversity in open spaces, such as habitat logs, artificial habitat, mulch and water features

Table 1. Relevant objectives from Fishermans Bend Framework

A network of experiences, journeys & corridors

The Public Space Strategy for Fishermans Bend identifies the development as ‘A city within a park’ with existing and proposed public spaces, linear parks, green walls, roof gardens and tree planting interwoven into the built form and street structure. This all contributes to public perception of visual and physical connections, social capacity and healthy communities through the five precinct areas. These are shown in Figure 6.

This is also important when defining the landscape character of each precinct. How people will want to move through the network of corridors is inter-related to the program and character of the place. For example Sandridge shall be a family friendly suburb and so the corridors show need to provide for day and evening safety and accessibility.

Figure 6. Existing and proposed public space and trees

Joining the dots

The FBUES sits within a collection of strategic documents relating to Fishermans Bend. The Study draws on existing policies, strategies and projects developed by City of Port Phillip (CoPP), City of Melbourne (CoM), Victorian Government and non for profit organisations, refer Figure 7. It is intended to reinforce and support the work undertaken to date, and build on their foundations to guide the development of Fishermans Bend.

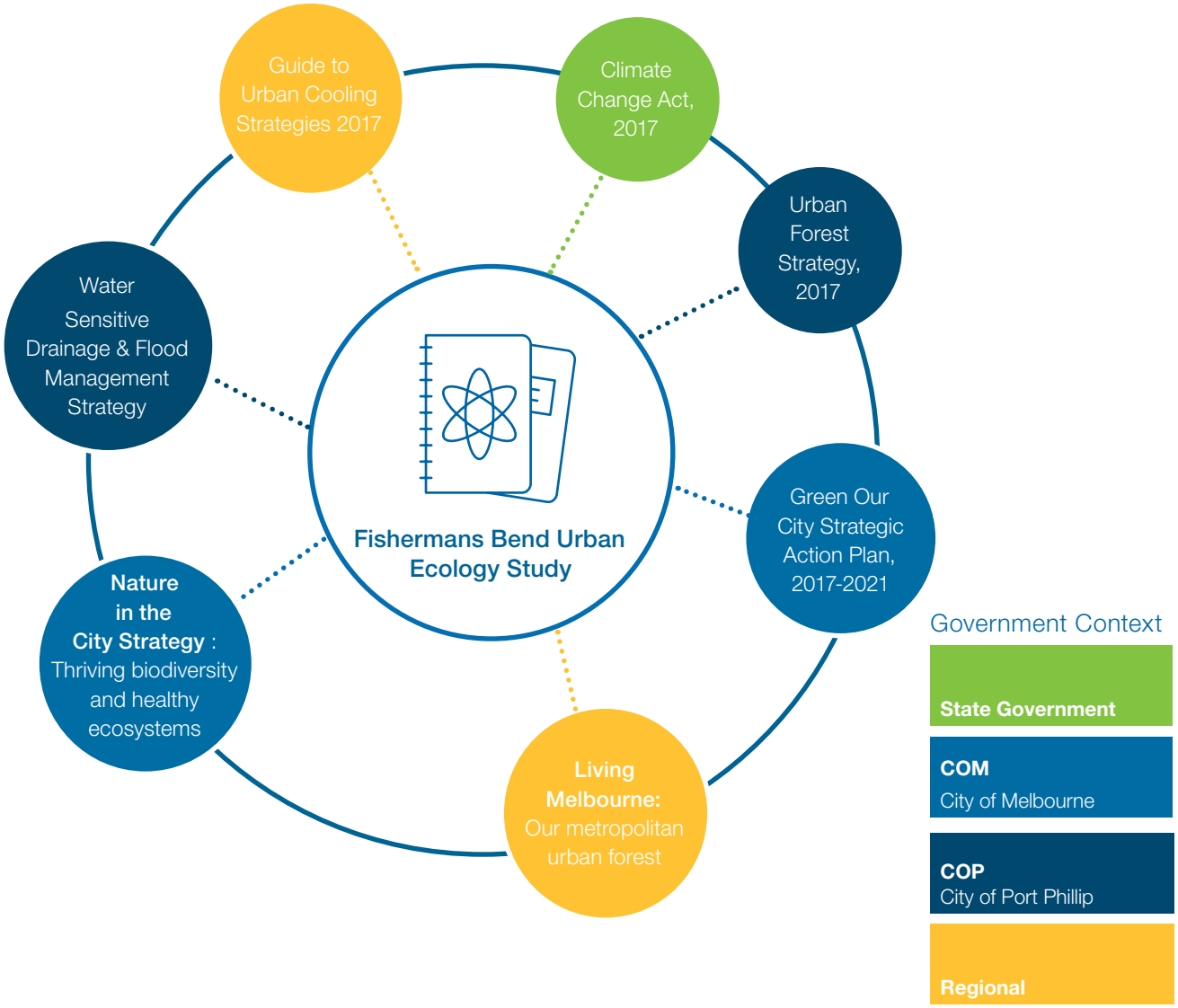


Figure 7. Joining the dots to deliver on the objectives set out in the Fishermans Bend Framework

1.3 Study scope and purpose

Purpose of the study

The purpose of this study is to improve the urban ecology in Fishermans Bend and deliver on the sustainability goals of the Fishermans Bend Framework (2018), which set a strong vision for biodiversity, climate resilience, liveability and water sensitivity. The FBUES seeks to challenge the way we think about urban design when it comes to competing interests and the fine balance between environmental, social and economic performance requirements.

Study objectives

The Study objectives were based on the following aspirations set out by the Project Working Group (Fishermans Bend Taskforce, City of Melbourne and City of Port Phillip) and Project Team (GHD, CRC-WSC and RMIT) and are to:

- Apply research and critical thinking to support the vision of the Fishermans Bend Framework and guide the development of Precinct Implementation Plans for each of the Fishermans Bend precinct
- Think outside the box' to unlock the potential for a city precinct that is cooler, comfortable and biodiverse
- Guide development outcomes through informing future decision making around planning scheme, built form controls, open space network
- Be mindful of the economic drivers underpinning the urban renewal development and the targets for population growth, job procurement and infrastructure construction
- Create methods and lessons for potential application in other priority urban renewal development areas
- Continue to build positive relationships between stakeholders, including community groups such as Westgate Park Biodiversity, and the Indigenous community (the team appreciated the involvement of Gheran Steele, member of the Boon Wurrung Foundation Traditional Owner and also acknowledge the Aboriginal Cultural Values Interpretation Strategy (Extent Heritage Advisors, 2017))

Scope of the study

This study integrates four of the key themes of urban ecology that need to be addressed at Fishermans Bend to achieve the framework sustainability goals: **urban heat, wind, biodiversity** and how they relate to **urban forestry**.

The scope of this study was to:

- Review existing guidelines and strategies for all themes, including identification of key drivers, variables and potential solutions
- Reviewing an existing 3D model for development at 2050
- Develop modelling projections for all four themes to use as an evidence base
- Develop technical recommendations in relation to each of the four themes
- Work with stakeholders to develop integrated solutions aimed at whole of community outcomes
- Work with stakeholders to explore implementation considerations for the integrated solutions
- Develop final recommendations and associated design guidance, in relation to the objectives set out in the Fishermans Bend Framework

Scope of the recommendations

This study is intended to make recommendations for the design of:

- Public realm: streets, open spaces, linear parks and associated infrastructure
- Private realm: building facades and design of forecourts, podiums, balconies

1.4 The project team

The project team is made up of several parts, including multiple teams at GHD, RMIT, and the CRC for Water Sensitive Cities, as shown in the following diagram (refer to Figure 8).

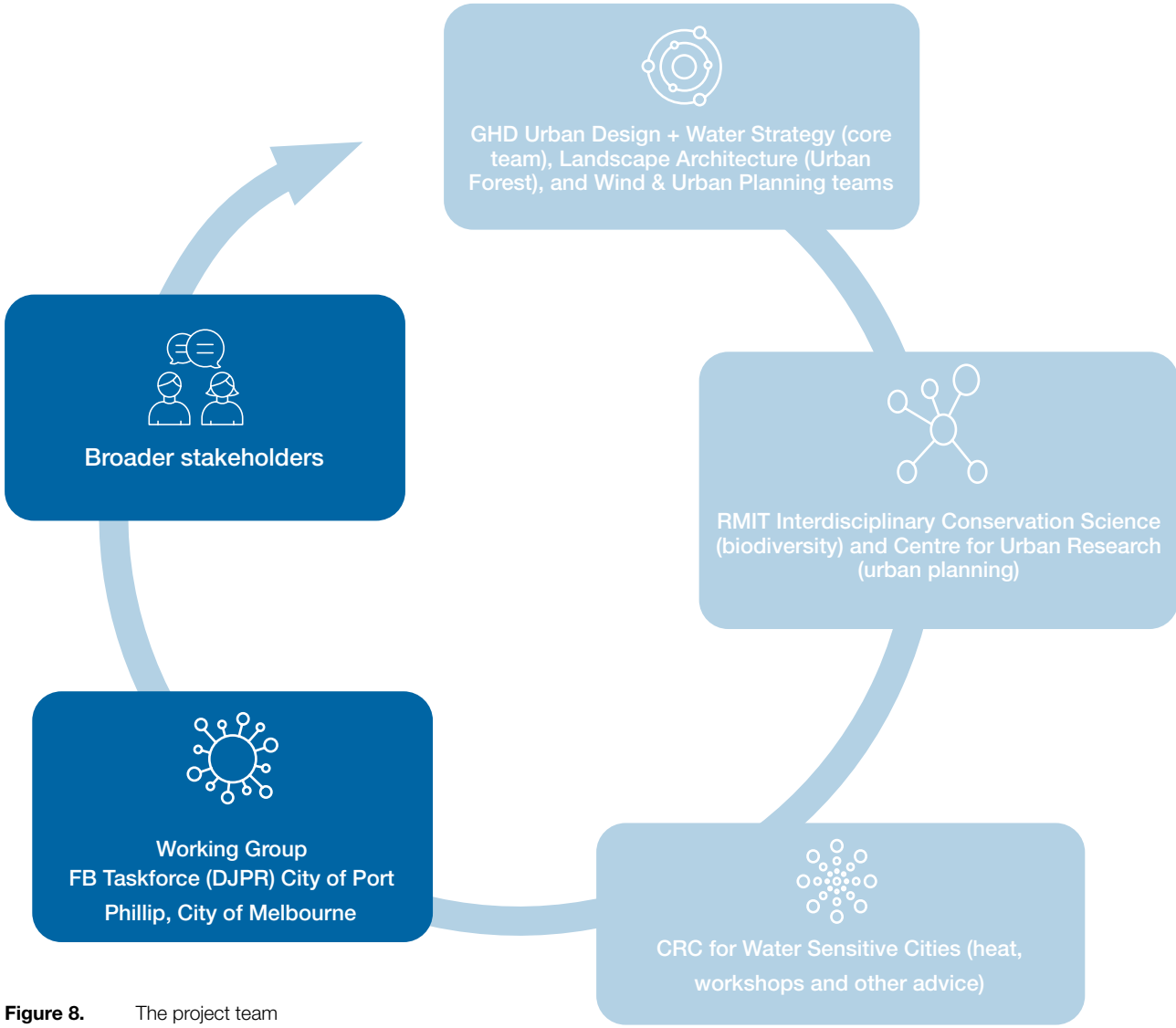


Figure 8. The project team

1.5 How to read this study

A study separated into two volumes

The outcomes of this Study have been captured in two Volumes. The intention of Volume 1 (the current document) is to share the introduction, method, recommendations and next steps. Volume 2 contains additional context, background on each theme, and the technical assessment and results on each theme. This means that to read the full study, it is necessary to read both volumes in conjunction, as indicated in Figure 9.

Intentional repetition

The project team has also made an editorial decision as follows: to the extent possible each section within the recommendations should be stand-alone and able to convey the relevant information to the reader without assuming they have read other sections of the report. This means that there is a significant amount of repetition for a reader that reads all of Volume 1 and Volume 2 in sequence. It is considered that the advantage of assisting future planners/policy makers with efficiently finding relevant guidance outweighs the disadvantage of the inconvenience of repetition for the more diligent reader.

Design guidance vs flagship recommendations

Flagship recommendations are not intended to be comprehensive applications of the design guidance, but rather to (a) highlight and help build momentum towards key recommendations that might otherwise be "lost in the noise" of design guidance, and (b) fill perceived gaps in precinct planning. In this way the flagship recommendations can be seen as signposts that help the reader to navigate and make sense of the broader design guidance.

This is consistent with the origins and meaning of the term flagship, which refers to the most important vessel in the fleet, carrying the commander, which guides the movements of the other ships.

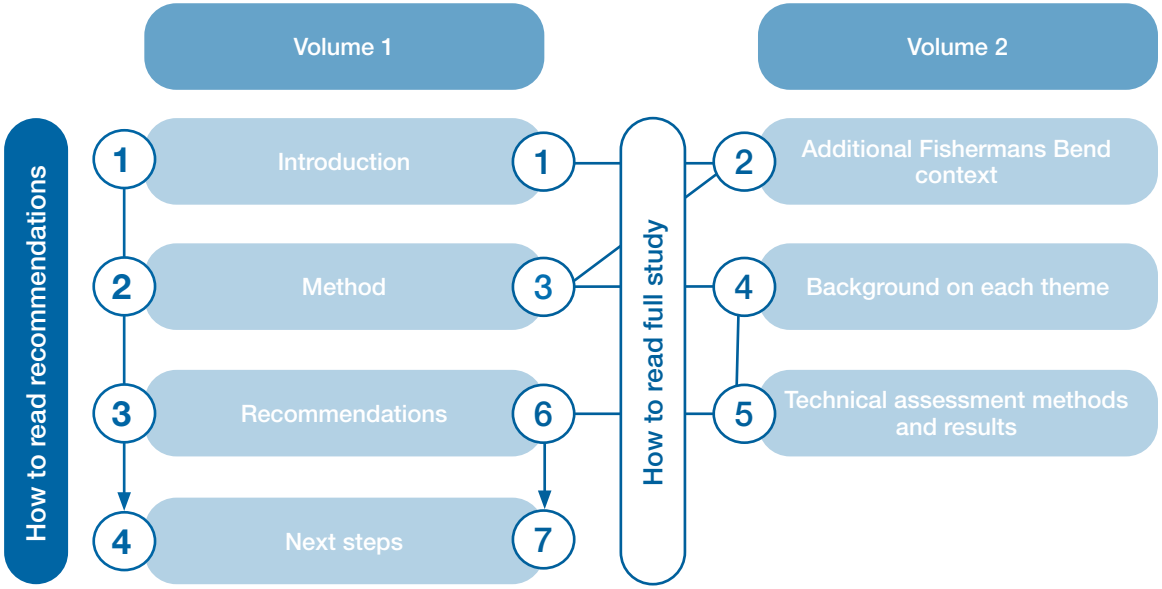


Figure 9. Structure of Volume 1 and Volume 2

2. Method and summary of results

2.1 Overarching methodology

A summary of the methodology applied to the development of this study is shown in Figure 10. The project has involved technical modelling/mapping, and development of theme-specific recommendations, for each of the four themes. This technical work has been complemented by four workshops, two before the technical analysis to set objectives, and two after the analysis to test solutions with stakeholders and collectively determine integrated recommendations. A photo from Solutions Workshop (Workshop 3), is included in Figure 11.

Figure 11. Fishermans Bend Ecology Study workshops (including Tony Wong from the CRC for Water Sensitive Cities reflecting on the results of the analysis)

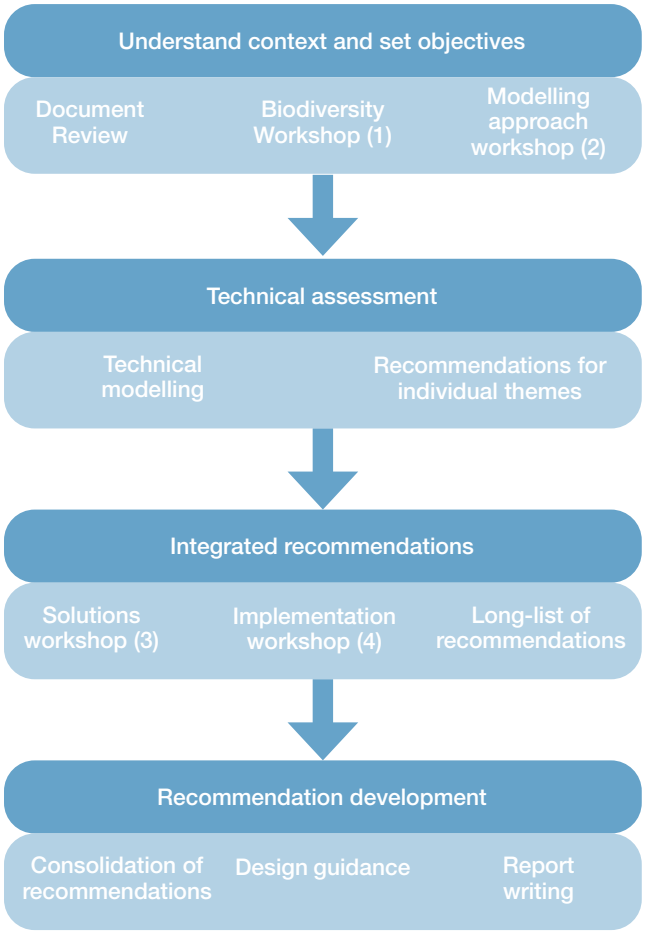


Figure 10. Overarching methodology for developing the study

2.2 How we approached the study

From the inception of the Study the project team anticipated there would be competing objectives when assessing the themes. Priority corridors have been selected as examples to demonstrate how the impacts of particular urban ecology themes can be addressed through physical interventions.

For example the role and function of an active recreation park such as North Port Oval needs to balance the need for active recreation, amenity, safety of users, tree canopy targets and provision of biodiverse landscapes. All of these features require certain spatial requirements, and so we have used the overarching design guidance and typical cross sections to begin to explore what these places may look like. We accept there will be differing approaches to maintenance, asset management, and access in these scenarios, but that is required to ultimately deliver a balanced open space design approach and optimises human activity.

2.3 Summary of technical assessments

A full report of the technical project assessments completed over the course of this study is included in Volume 2: Appendix B. Primary technical methods of analysis and results for this project are summarised in the following sections. When carrying out our investigations and critical thinking the project team have made several assumptions to inform the process. The breadth of the Study has meant assumptions were applied to the modelling to set key parameters. The main assumptions applied were:

- Scenarios were developed based on projections at 2050
- Future canopy cover targets were assessed on a nominal street tree spacing of 10 m

Urban forest method and results

Spatial projection of multiple tree canopy scenarios (with consistent tree numbers but varied canopy width and height) was conducted to estimate the proportion of the public realm that could potentially be covered by canopy. This assessment involved the identification of 12 street typologies, and determination of how many rows of trees would likely be located within each. Then three scenarios for tree height and width were developed, to represent both the different choices that may be made around tree species, as well as the resulting tree health.

The results of this analysis showed that the low tree canopy scenario resulted in 18%, the median scenario resulted in 33%, and the high scenario resulted in 49% of the public realm covered by canopy (refer Table 2). These tree canopy scenarios were then used as the basis for the heat modelling.

Biodiversity modelling method and results

Biodiversity connectivity was considered by selecting relevant target species (with stakeholders). These were selected as: Superb fairy-wren, Growling grass frog, Blue-banded bee, Blue-tongued lizard, Brolga, Fungi, and White mangrove. Two indicator species were the subject of detailed connectivity modelling (Superb fairy-wren and Growling grass frog), which involved identification of key habitat/resources, development and resistance modelling of existing, base-case (including initial street plans and the median tree-cover scenario) and best-case habitat maps (produced following a Biodiversity Sensitive Urban Design, protocol).

This analysis found that connectivity was greatly improved by the inclusion of new green spaces, understory vegetation in linear parks, local streets and in green spaces, green elements on pedestrian bridges over freeway, a proposed car-free green link/spine through the Employment Precinct, and the inclusion of new water features in key public spaces.

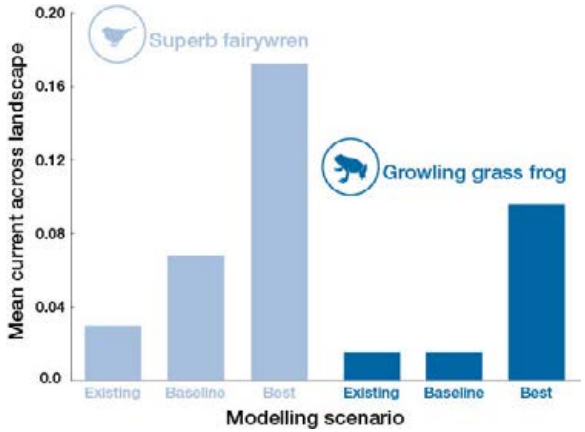


Figure 12. Comparison of existing, base and best-case connectivity for two species

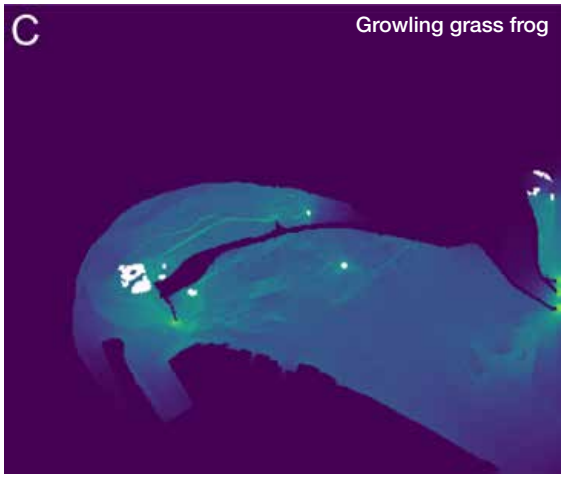


Figure 13. Connectivity analysis: The overall connectivity for Fishermans Bend when designing the precinct to maximise the benefits for biodiversity

Wind modelling method and results

Computational Fluid Dynamics modelling (using Star CCM+) was undertaken, using a 3D model provided by the Fishermans Bend taskforce and meteorological outputs from the decommissioned 'Old Harbour Control' centre (under Bolte Bridge). This analysis was used to determine which streets and open spaces in Fishermans Bend will regularly experience "wind canyons", which we have defined as greater than 10 m/s wind gusts at 2 m above ground (the point at which pedestrians will experience discomfort).

Results show that the North winds dominate in all cases, followed by the South and Westerly winds, for gusts and wind driven rain (refer Figure 14). This analysis also shows the causes of wind canyon creation, which found that the primary cause of wind canyon creation was the "downwash effect" (when wind is sucked down gradually towards ground level after passing over a building, or wind hits a tall building and is diverted directly towards ground level). It was found that "street level ingress" (when wind enters the street directly), was less of a factor. What this means is that blocking wind entry to streets is relatively ineffective, and use of podiums and covering footpaths from above with structural canopies is relatively more effective.

The streets that are likely to experience regular wind canyons have been mapped across all of Fishermans Bend and used do determine which street corridors are sensitive to wind.

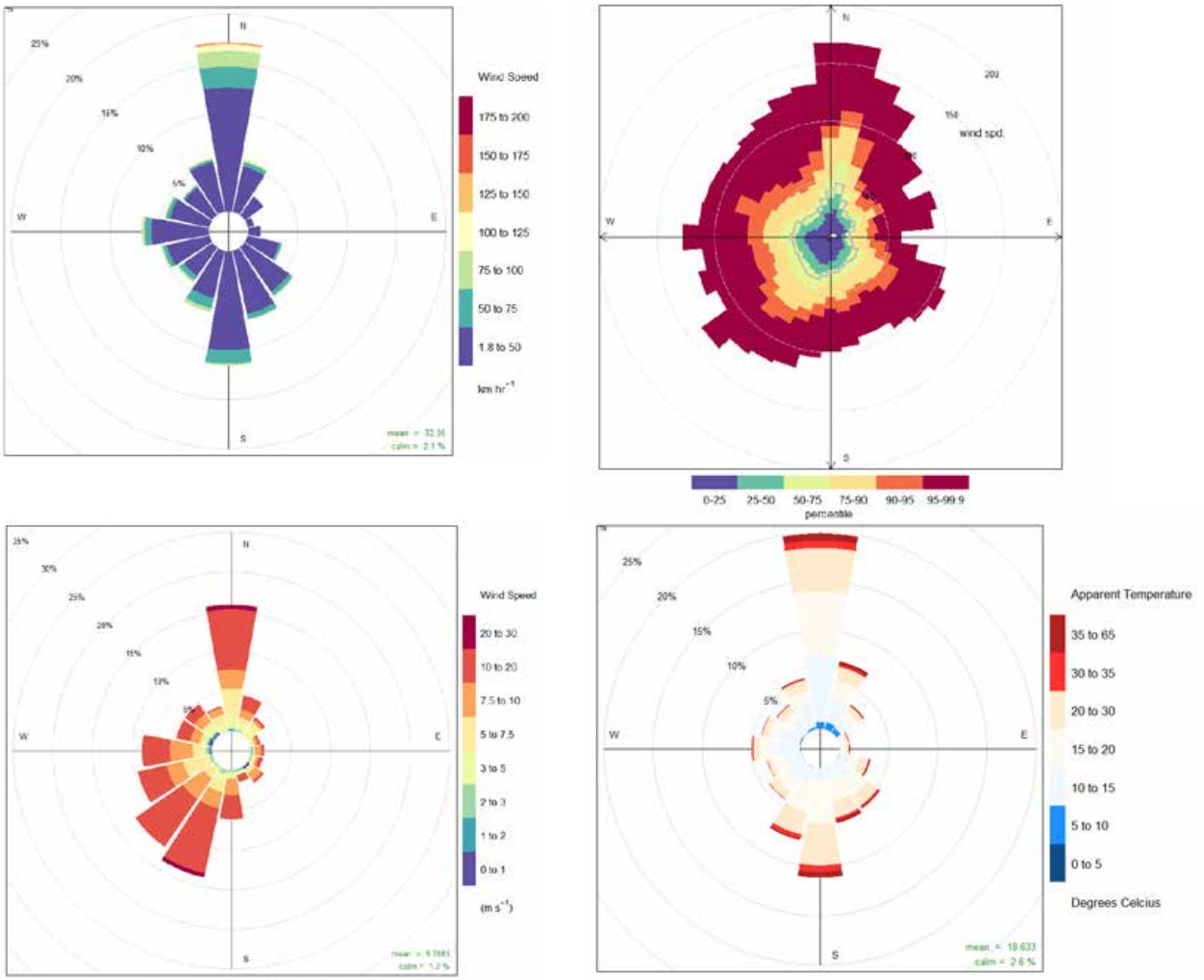


Figure 14. Frequency of wind counts per direction (%) (top left), Frequency and intensity of wind gusts per direction (top right), frequency and intensity of wind-driven rain (bottom left), apparent temperature (bottom left)

Heat modelling method and results

Analysis included consideration of the impact of different tree canopy widths and heights on pedestrian Human Thermal Comfort in six case study areas, using the UMEP model (SOLWEIG module). The modelling was performed for 2 pm on February 12 of a typical hot summer day in 2050. Note: the analysis only considered outcomes in the public realm (streets/open space), but the benefits shown would apply equally to the impact of tree canopy shading in the private realm.

This analysis showed that increasing tree canopy cover has a significant impact in regards to reducing the human experience of extreme heat in the public realm, and that tree canopy should be prioritised in wide streets (particularly east west, and particularly in active transport corridors). The results showed that 45% of the modelled areas can be moved down from the “very strong” (feels like low 40s Celsius) to “strong” (feels like mid 30s Celsius) heat stress category, as canopy width and height was increased (refer Figure 15).

These results show that the impact on human thermal comfort from increasing canopy is significant and must to be addressed in precinct planning.

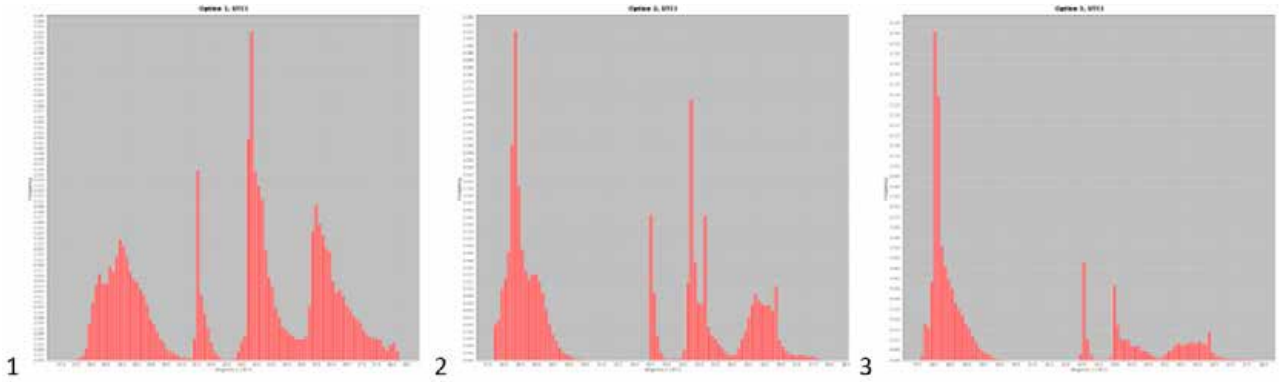


Figure 15. Shifting temperature distribution across the three scenarios (percentage of area with extreme temperatures dropping as canopy increases)

	Public realm (m2)	Scenario 1 (smaller canopy)	Scenario 2 (medium canopy)	Scenario 3 (larger canopy)
Area (m2)	2,308,437	418,937	756,970	1,133,182
% of total public realm area		18 %	33 %	49 %

Table 2. Percentage of public realm covered by canopy in low, median and high tree canopy scenarios

2.4 Summary of key issues emerging from stakeholder workshops

A full report of the stakeholder engagement findings completed over the course of this study is included in Volume 2: Appendix C. A brief summary is included below.

Identified trade-offs

Overall both the analysis and subsequent stakeholder input found that solutions for individual themes were largely complimentary. However some trade-offs were identified as follows:

- **Level of tree canopy in public space**

  Biodiversity objectives suggest 50% canopy cover in public space as an absolute maximum, likewise recreation objectives likely require an even lower canopy cover, and solar access is also important in winter. However heat modelling recommends as much canopy as possible. These competing objectives must be balanced against each other when undertaking functional design of public spaces

- **Tree species selection**

  Some stakeholders believe there is conflict in species selection between natives and exotics, but many other stakeholders felt that due to species diversity objectives, and a desire for a diversity of spaces and micro-climates, that this is not a conflict. The solution to this problem therefore lies in diversity

- **Biodiverse public space**

  Biodiverse rich urban landscapes are a new introduction to the typical brownfield urban parkland and therefore will need to be planned, designed, maintained and experienced in different ways to optimise biodiversity outcomes as well as open space for human wellbeing. *Note: biodiversity zones in this study refer to vegetation/ design choices and does not exclude humans from entering/enjoying these spaces for passive recreation*

- **New public space around Westgate Park**

  Creating any new public space takes up land that could otherwise be used for development. There are some biodiversity benefits from creating new public spaces close to Westgate Park, but this is not ideal from many other perspectives. For example, converting the Go-Kart centre in the Employment Precinct to extend habitat in Westgate Park has benefits from an amphibian habitat perspective, however is not preferable to introduce new recreation offerings due to competing objectives. It therefore is preferable to locate new public spaces further away from Westgate Park.

Identified barriers and gaps of the planning system

As part of the planning implementation workshop there were several noted issues and barriers within the planning space that may influence the uptake of urban ecology recommendations. The common planning barriers (both perceived and real) to achieving urban ecology within Fishermans Bend are listed below. Further effort should be taken to understand and address these barriers as part of implementing the recommendations as listed in this report. They are:

- Cost implications on developers within Fishermans Bend
- Difficulty for developers to understand all the mandatory and discretionary planning requirements for developing within Fishermans Bend
- Potentially confusing inter-connections and overlaps between ESD and GI planning controls
- Multiple tools on the market that can assess ESD and GI. Planning schemes and decision guidelines need to be performance based rather than prescriptive so the system can withstand changing technology and innovation opportunities
- The need to understand how proposed statewide ESD policies, Better Apartment Guidelines and other important policy may impact on any proposed Fisherman's Bend controls
- Lack of tangible built examples of how biodiversity can be envisioned, achieved and maintained within urban redevelopment settings in Melbourne

2.5 Structure of final recommendations

The structure of the final recommendations (which are described in the following sections) is outlined in Figure 16.

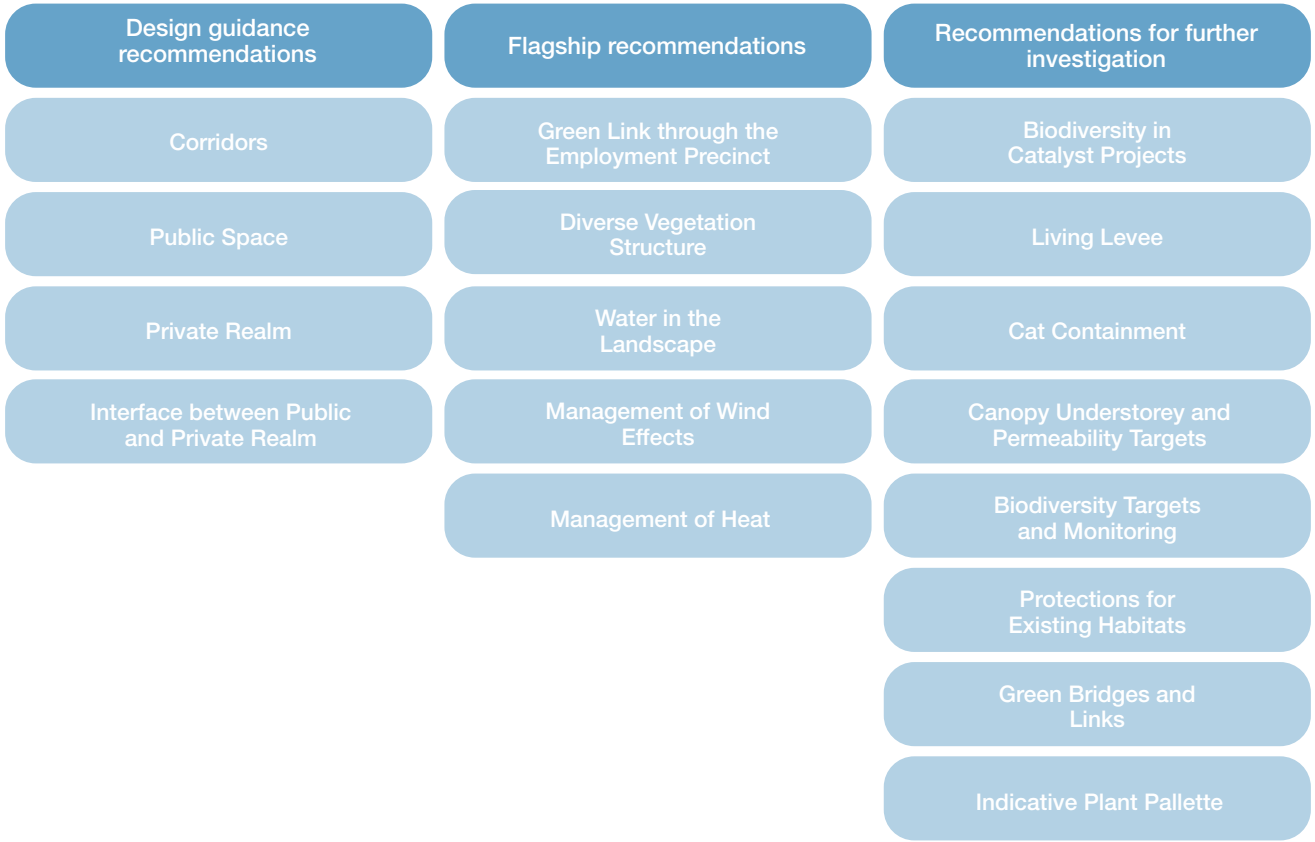


Figure 16. Structure of final recommendations

3. Overarching design guidance

3.1 Overview

The overarching design guidance informs the application of urban ecology principles at Fishermans Bend. This guidance is to be used by Council and the Taskforce to guide and inform decision making related to the look, feel, function and strategic intent of the Fishermans Bend Precinct Implementation Plans (PIP).

The design considerations are grouped around the following place based categories:

- Corridor
- Public space
- Private realm
- Interface between the private and public realm
- Delivering the precincts

The guidance provides 'rules of thumb' to support and build on the existing body of work developed for Fishermans Bend, and to deliver on the objectives and strategies identified in the Fishermans Bend Framework. Advice has therefore been limited to key areas that support the objectives and to assist in achieving the sustainability goals of the Framework.

The overarching design guidance for this study was influenced by:

- Fishermans Bend Framework and intended precinct characters
- Heat, biodiversity, wind and urban forest modelling undertaken as part of this study (detailed in Volume 2: Appendix B)
- National, state, and local government policies
- Aboriginal Cultural Values Interpretation Strategy

3.2 Weaving First Australians knowledge into the urban environment

The Fishermans Bend Framework clearly states a commitment to embedding Aboriginal traditional ecological knowledge into the ongoing design of Fishermans Bend. By integrating these with contemporary ecological knowledge we can deliver better environmental outcomes and make Fishermans Bend more resilient, sustainable and inclusive.

The key principles identified in the Aboriginal Cultural Values Interpretation Strategy are:

- Dynamic history and creation stories around the formation of Fishermans Bend
- Identity, Ownership and Survival
- Emerald Hill
- Resources of the Land and Water
- Cultural Routes through the Area
- Role of Aboriginal Women
- Significant Elders Past
- Contemporary History and Relationships to the Wider City
- 20th Century Living and Working in Fishermans Bend
- Coming Back from the Missions
- Recreation

The conversations and stories shared by the Boon Wurrung Foundation Traditional Owner representative during our project confirmed Aboriginal traditional ecological knowledge and cultural understanding of the connections between people and place should not be viewed in isolation when considering urban design and placemaking. Rather, these principles will be embedded into the design guidance of the FBUES and offer a unified message. For this reason we are deliberately not calling out specific actions or urban landscape initiatives.

3.3 Corridor design

Corridor design focuses on connectivity through Fishermans Bend for people, water, flora and fauna. The current section provides guidance on a range of corridor specific considerations.

Mapping of priority corridors

Snapshot of overlapping priorities along corridors

The FBUES themes of heat, wind and biodiversity are prioritised along different corridors in Figure 17. The fourth theme of urban forest is not specifically highlighted, as it is urban forest outcomes which will largely determine the outcomes for the other three themes. This is due to the fact that the urban forest is the primary mechanism for addressing both heat and biodiversity, as well as wind to some extent (in regards to vegetated wind-breaks). Therefore it can be considered that any corridor that prioritises heat, wind or biodiversity, is also highlighting the urban forest as a priority. In other words the urban forest, and tree canopy, is prioritised across the vast majority of streets.

Within the following please note that:

- Priority corridors for different themes have been identified through modelling, the methods used for this modelling are described in Volume 2: appendix B
- Corridor guidance is for public realm only (streets and all public space)
- Private realm is also important and is addressed in Section 3.5, however the modelling methodology applied within the Study (see Volume 2: appendix B for details) to assess heat, biodiversity and wind was not informed by any architectural details of forecourts, courtyards, walkways or any other potential corridors through future private property (as these are not yet determined), and therefore it was not possible to coordinate corridors across private properties

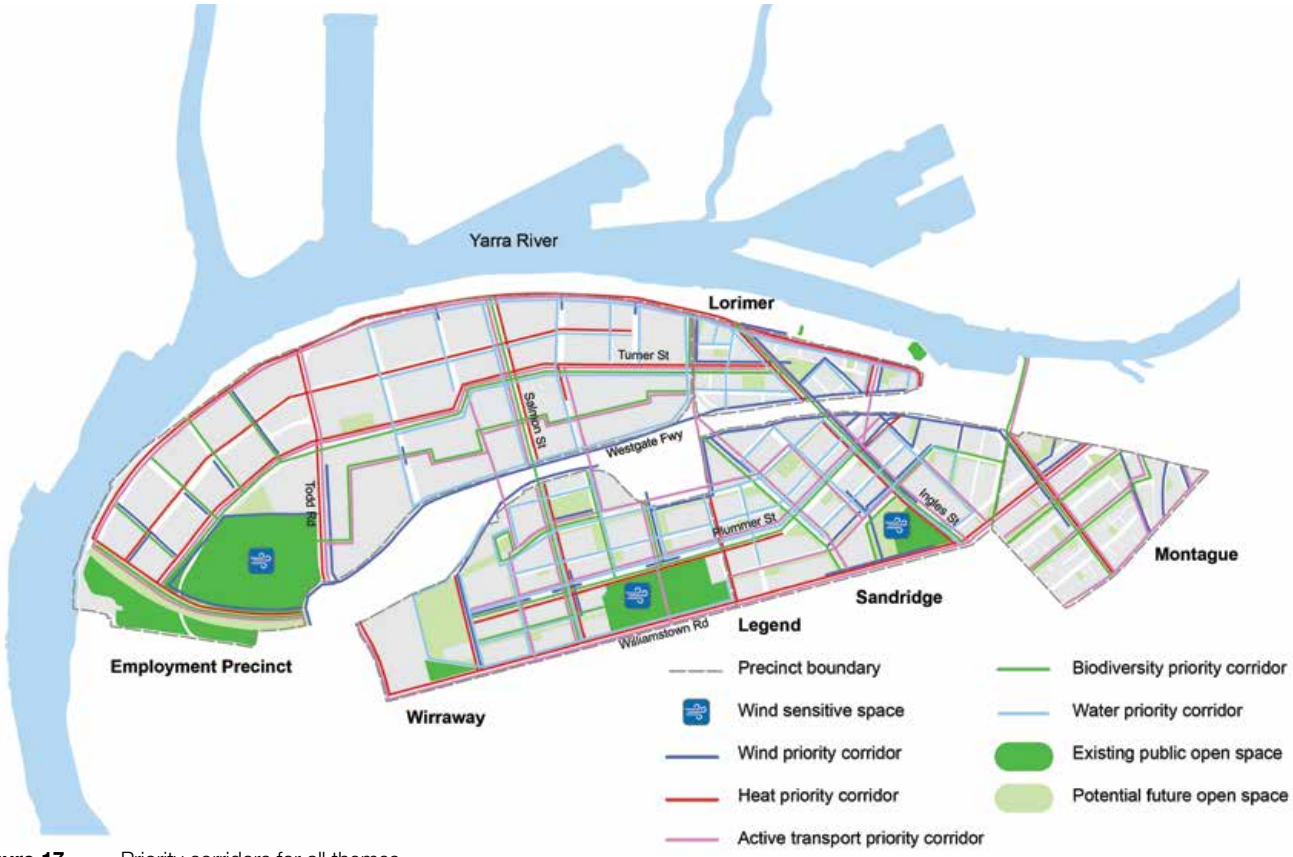


Figure 17. Priority corridors for all themes

Note: Just because an area/street does not have biodiversity as a "priority" does not mean that BSUD cannot be considered. For example, when choosing vegetation for wind-mitigation plant species selection should still provide flowers/fruits to act as food resources for insects and birds. Also if a non-native tree species is chosen to mitigate heat, BSUD can still be implemented by the addition of mistletoes and artificial hollows to create new opportunities for habitat.

Wind priority corridors

Through undertaking CFD modelling the project team has mapped all of the streets and public space within which greater than 10 m/s winds are expected more than 5% of the time, when the wind is blowing from the three most prominent wind directions (North, West, South). These identified streets and open spaces are therefore identified as “wind priority corridors”. In wind priority corridors (see Figure 18) all buildings should include podiums and/or structural canopies (connected to buildings) that overhang footpaths. More details on interventions in these corridors is provided in Section 4.4.

Figure 18. Priority corridors for wind

Heat priority corridors

Through UMEP modelling the project team have identified the types of streets that will be particularly sensitive to heat. These are typically wide streets with short buildings, and in particular those with an east/west orientation. The identified corridors are therefore identified as “heat priority corridors” where tree canopy would need to be maximised in order to mitigate heat. In heat priority corridors (Figure 19) tree canopy width and height should be maximised, in some cases with particular emphasis on green infrastructure on the southern side of East-West streets, and the eastern side of North-South streets. More details on interventions in these corridors is provided in Sections 0, 4.5 and in Volume 2: Appendix B.

This should be viewed in conjunction with active transport priority corridors, see Figure 20. It is important to cross reference the heat priority corridors against the active transport priority corridors, because investment in tree canopy should be targeted first towards the areas which are expected to have higher pedestrian and cycle traffic.

Figure 19. Priority corridors for heat

Active transport priority corridors

These corridors are already pre-determined in the Fishermans Bend Framework, however it is important to consider where and how people will move throughout each precinct to determine interventions that improve human thermal comfort. These streets, similar to those identified in Water sensitive priority corridors, will have additional competing objectives when it comes to available space for landscaping and tree planting.

Note: one new addition has been made to the street corridors, which is the newly proposed Green Link described in Section 4.

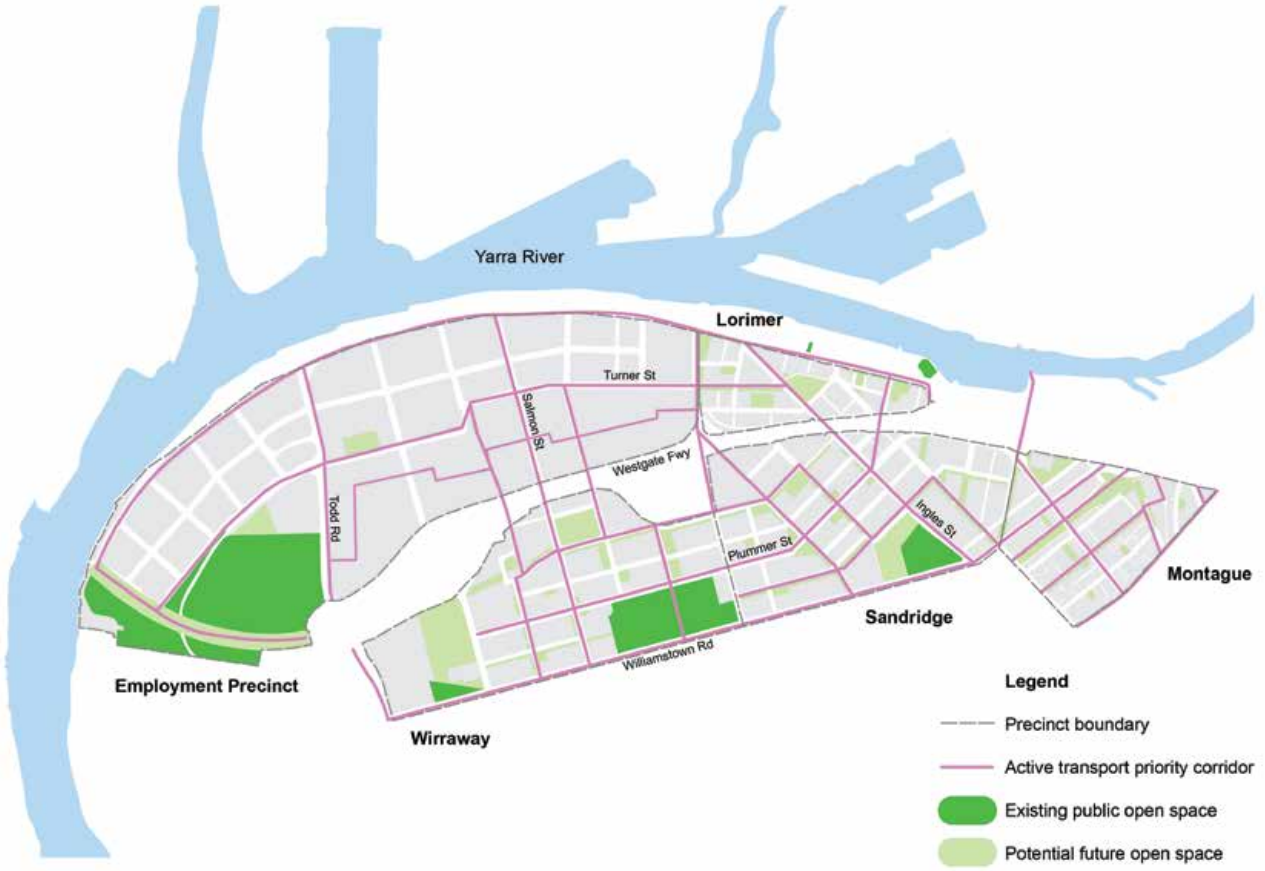


Figure 20. Priority corridors for active transport (including the new Green Link proposed in Section 4)

Biodiversity priority corridors

Through a combination of ecological connectivity modelling, and an internal design-led mapping exercise, the project team have identified a preferred network of priority streets to support biodiversity outcomes, and particularly connectivity between public spaces. These streets and public spaces are therefore identified as **“biodiversity priority corridors”.**

Note: one new addition has been made to the street corridors, which is the newly proposed Green Link described in Section 4.1.

In biodiversity priority corridors (see Figure 21) the following should be maximised in corridors and adjacent private realm, assessing compatible/incompatible uses: vegetation structure diversity (tall grasses, shrubs, short and tall trees), connected medians, native vegetation that provides multiple resources for animal species, including shelter (e.g. dense, protective shrubs), food (e.g. flowers/fruits) and nesting sites (e.g. tree cavities). More details on interventions in these corridors is provided in Sections 0, in Volume 2: Appendix B, and Volume 2: Appendix E.

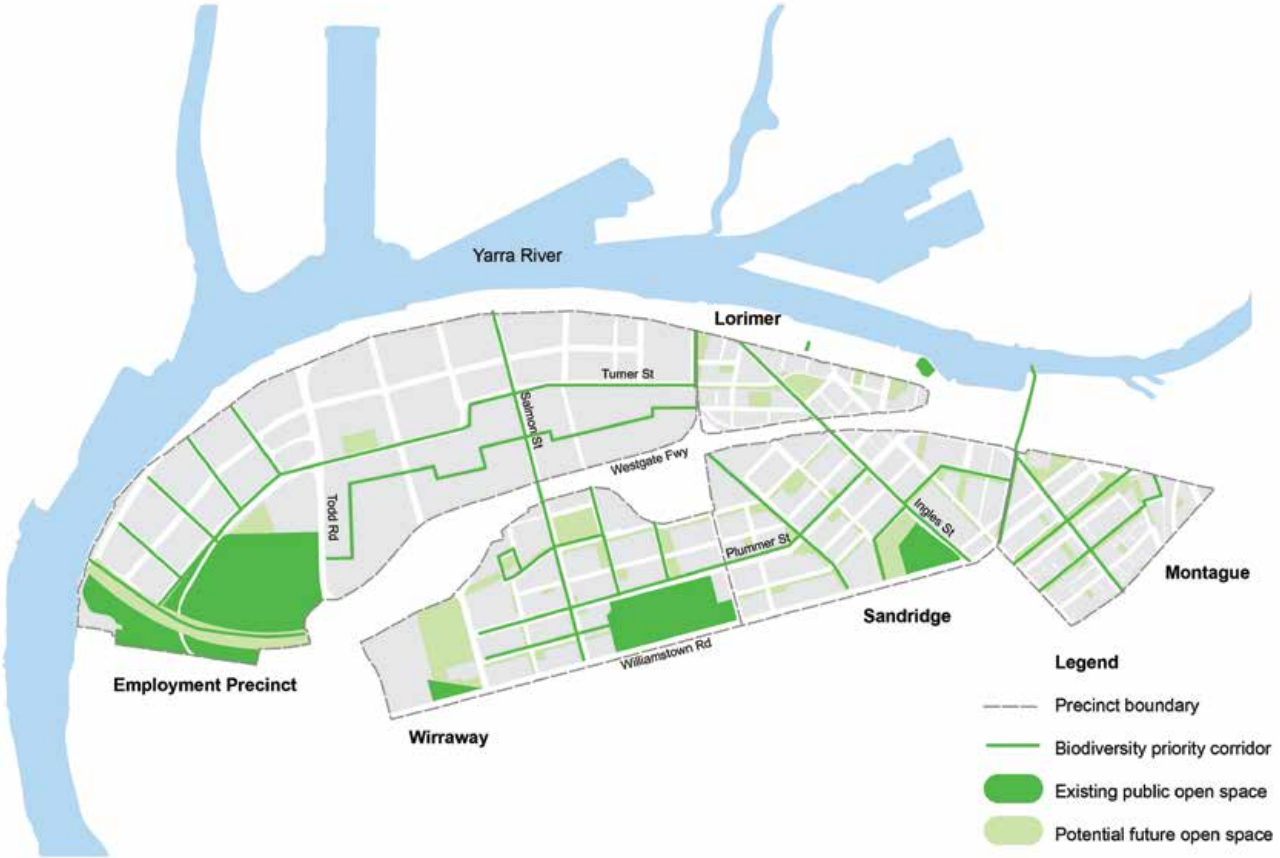


Figure 21. Priority corridors for biodiversity (including the new Green Link proposed in Section 4)

Water sensitive corridors

Through the Water Sensitive City Strategy GHD, the CRC-WSC, and the Fishermans Bend Taskforce have identified the areas of Fishermans Bend which are to have above ground flood storage. These areas which are to have above ground flood storages are referred to here as **"water sensitive corridors"**. In water sensitive corridors (refer Figure 22) it will be necessary to co-locate flood storage (refer to Water Sensitive City Strategy, 2019), with other corridor priorities. For example, if a corridor is both a priority for heat and water, then it will be necessary to design the street to have water storages and large canopy trees. This will create some technical challenges, but also benefits (potentially additional passive irrigation, cooling from evaporation, amphibian habitat etc).

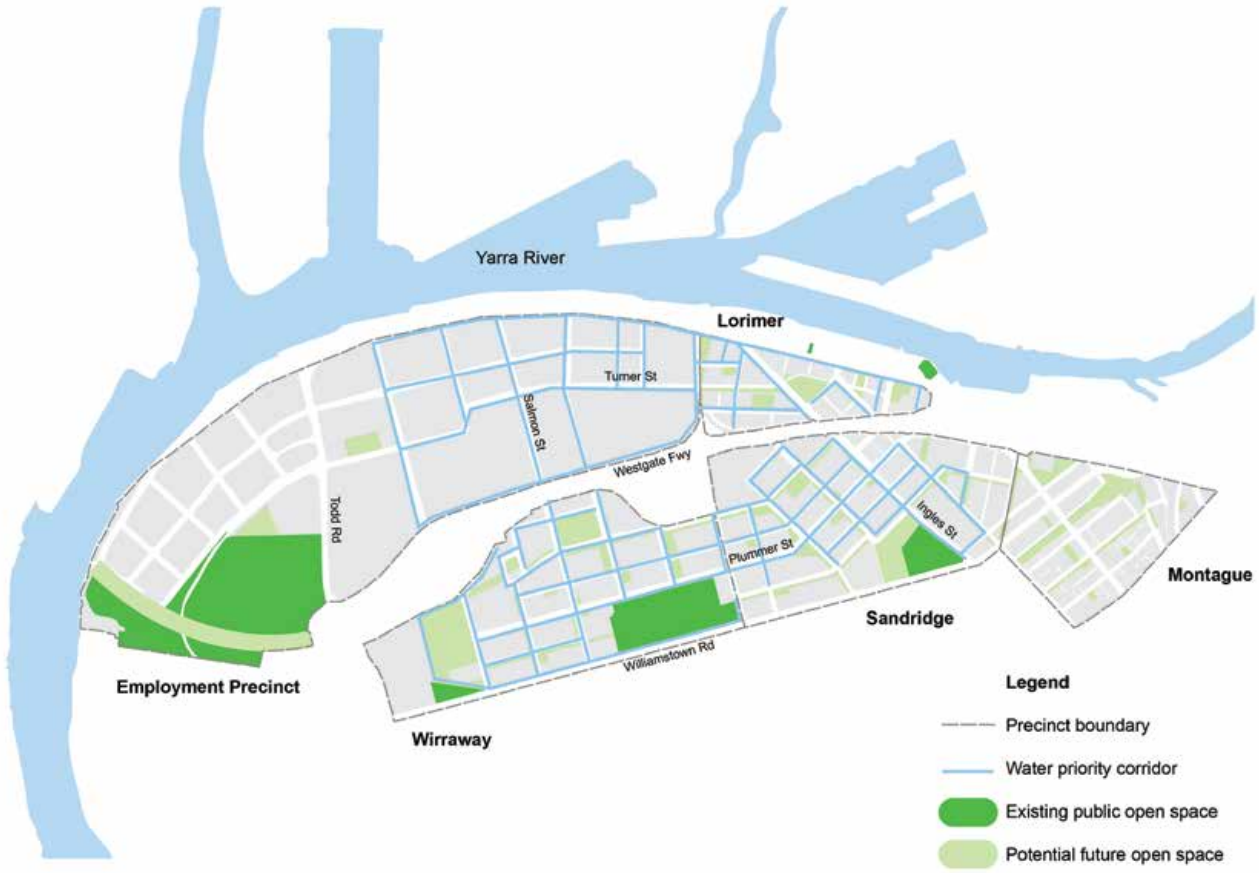


Figure 22. Priority corridors for water

Indicative design guidance for priority corridors

All corridors have the capacity to provide urban ecology outcomes through suggested street level interventions. The project team have selected a point along existing or planned street corridors across Fishermans Bend with varying characteristics to interrogate what they may look like and explore the design nuances related to each theme. These illustrative example locations along streets are selected as the following “scenarios”:

Scenario A - Biodiversity Priority Corridor

Scenario B - Wind Priority Corridor

Scenario C - Wind Priority Corridor

Scenario D - Heat Priority Corridor

Scenario E - Complementary Priority Corridor

The following indicative cross-sections demonstrate how the scenarios for each street could be developed. Each scenario responds to the adjacent land use and future landscape character of the precinct to demonstrate greening and cooling interventions, public amenity and habitat creation. The project team have explored how the streets with different urban ecology priorities can all achieve extensive urban forest outcomes, incorporate above ground flood storage, and general street amenity to meet our urban ecology vision without compromising people’s safety.

Figure 23. Indicative biodiversity street

Scenario A – A biodiversity priority corridor in Wirraway

The road profile is nominally 22 m wide with separate bicycle lanes and footpaths and is adjacent to a linear park. This scenario explores how BSUD principles can be applied through habitat creation in nature strips, vertical gardens, podium landscapes and adjoining public spaces. Key attributes that make the corridor suitable for biodiverse interventions include lower traffic volumes and linkages to a broader linear park system for greater bio-connectivity

Key interventions for include:

- Aligning biodiverse corridors with compatible land uses such as active transport, nature play, passive recreation and low volume transport routes such as neighbourhood streets. Biodiversity corridors should not be prioritised in places with vehicular transport, including public transport, areas with high volume public use, such as sports grounds, or areas with high levels of noise and light at night.
- Contiguous green naturestrips & medians planted with structurally diverse (under, mid, and canopy) vegetation designed for bio-connectivity, including large canopy trees, and adequate, healthy soil volumes
- Diverse native vegetation that provides multiple resources for animal species, including shelter (e.g. dense, protective shrubs), food (e.g. flowers/fruits) and nesting sites (e.g. tree cavities). Species selected in consultation with Westgate Biodiversity: Bili Nursery & Landcare
- Passive irrigation of naturestrips & medians, as well as active irrigation with recycled water (opportunity for above ground flood storages although this area has not been identified as requiring these)
- Seating and interpretive signage to provide education on vegetation
- Install eco-street lighting which have long wavelength LED lights. Provide lighting only along pedestrian and cycle routes, to minimise excessive disruption to areas of habitat. This could incorporate scheduled periods of darkness in appropriate places. This could be via motion sensors (in appropriate locations) to reduce excessive light spill, while still maintaining a safe level of lighting to the streetscape (Longcore, et al., 2018; Davies, et al., 2017)
- An integrated bio-connectivity network linking street corridors and biodiversity areas in public spaces (refer Section 3.4.1 for description of public space biodiversity areas)

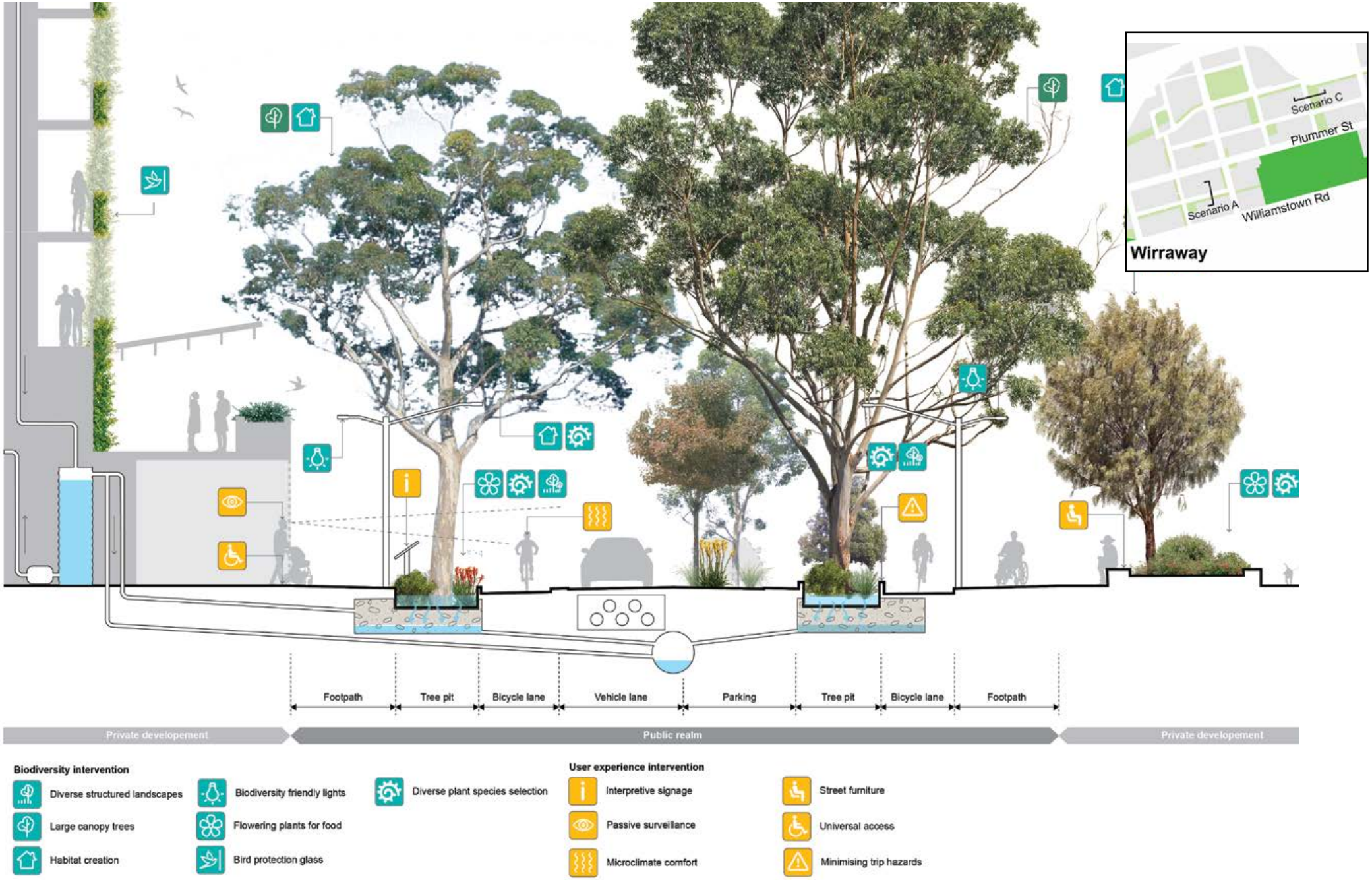


Figure 24. Scenario A: A biodiverse priority corridor in Wirraway

Scenario B – A wind priority corridor in Sandridge

Bridge St corridor has been categorised as a wind priority corridor within the Sandridge Precinct. The road profile is nominally 30 m wide and connects to a new bridge to the north, over the Westgate Freeway. The corridor has competing objectives as a potential connection for biodiversity and active transport, however wind mitigation is the priority to protect people from strong northerly wind gusts at street level and upper building facades. In this location the wind canyon is created when a northerly wind travels south from Lorimer and the Employment Precinct and experiences downwash into the Freeway corridor before entering Sandridge (refer to 3D CFD image inserted into Figure 2).

Key interventions include:

- Requirement for testing new building designs through a centralised CFD wind model during building design in both Lorimer and Sandridge. This should be done using a CFD model for all of Fishermans Bend, as it can be seen that buildings in one precinct can alter wind results in other precincts
- There is a long-term intention to include a bridge north across the freeway from Bridge St. The current CFD model does not include any bridge, and this may have a significant impact on wind conditions in Bridge St. There should be a requirement to test new bridge designs through a centralised CFD wind model during bridge design
- Require podiums and/or structural canopies (on building façades) to protect sidewalks and entrances
- Strategic location of awnings or porous screens to protect outdoor seating for cafes/restaurants (if any)
- Require densely planted, diverse structured vegetation in naturestrips and medians with large canopy trees in upper and mid-story, to create “roughness” to reduce wind speeds (tree stabilisation may be required depending on tree species and soil depth)

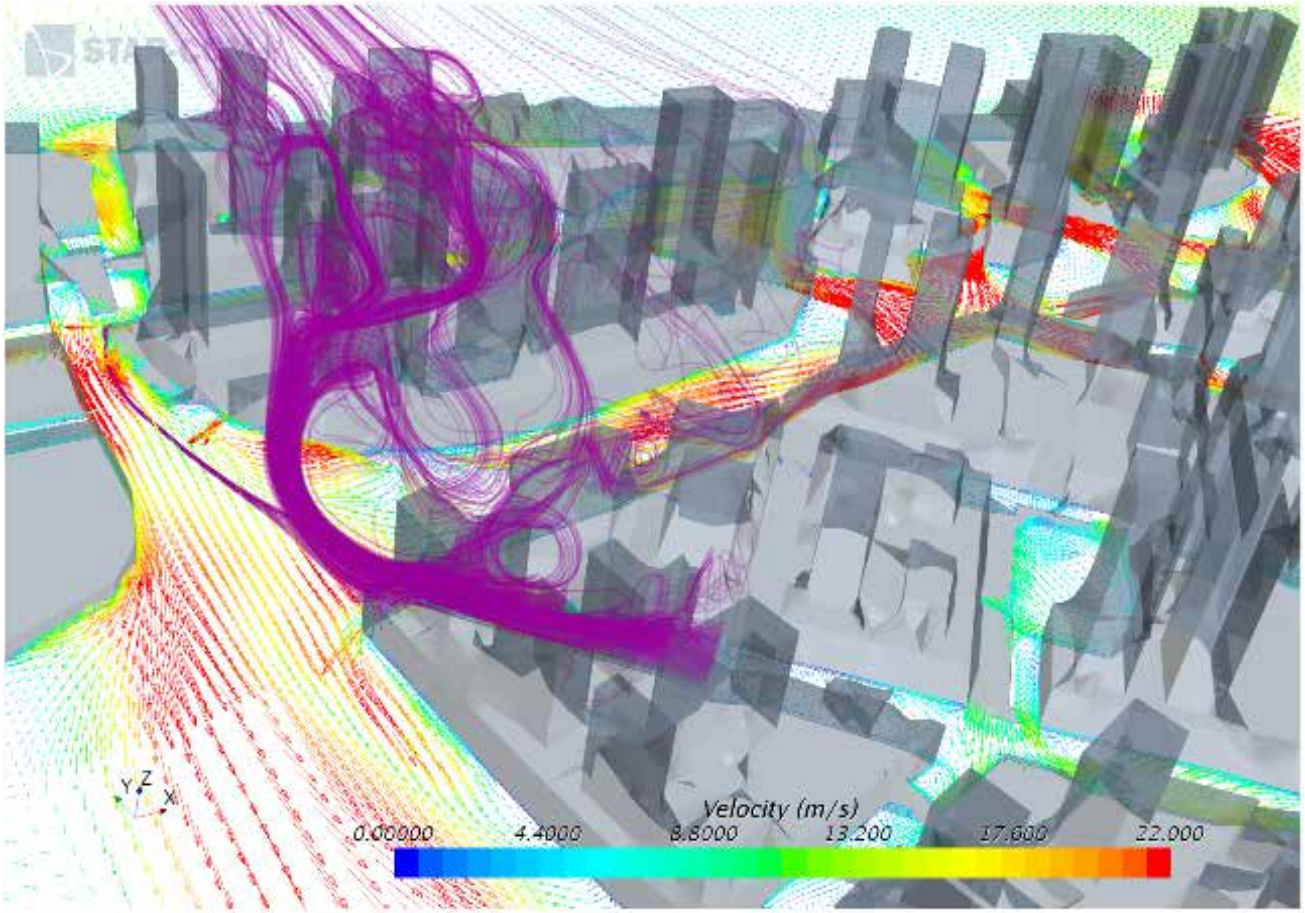


Figure 25. Wind from the north being funneled into Bridge Street from CFD modelling

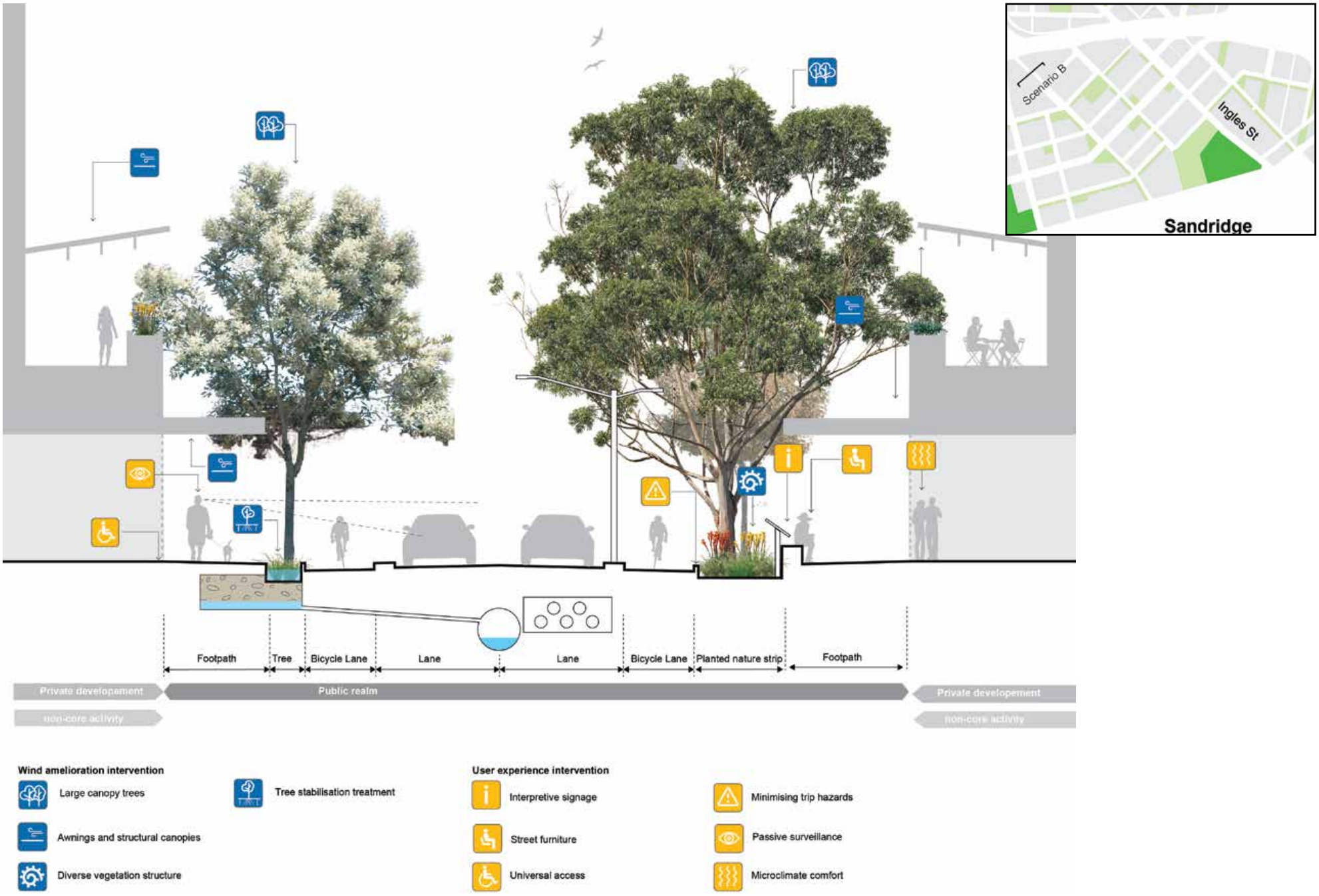


Figure 26. Scenario B: A wind priority corridor in Sandridge

Scenario C – A wind sensitive corridor

A new street corridor perpendicular to JL Murphy Reserve has been categorised as a wind priority corridor within the Wirraway Precinct. The road profile is nominally 22 m wide and connects Woolboard Rd and Plummer St. The corridor is also adjacent to Wirraway East linear park, opening up its vulnerability to strong wind gusts from the north into the JL Murphy Reserve. In this case the wind canyon is created when the westerly wind travels from an area with narrower streets over a wider street, causing the wind to downwash into the street canyon (refer to Figure 64). Other competing objectives include as a connection for biodiversity and active transport, however wind mitigation is the priority to enhance human thermal comfort and the experience at street level.

Despite the cause of the wind canyon differing between Scenario B and C, many of the interventions that can be implemented to mitigate the impact of wind on pedestrians are the same:

- Requirement for testing new building designs through a centralised CFD wind model during building design
- Require podiums and/or structural canopies (on building façades) to protect sidewalks and entrances
- Strategic location of awnings or porous screens to protect outdoor seating for cafes/restaurants (if any)
- Require densely planted, diverse structured vegetation in naturestrips and medians with large canopy trees in upper and mid-story, to create “roughness” to reduce wind speeds (tree stabilisation may be required depending on tree species and soil depth)

One difference between the two scenarios is the inclusion of the linear park, which allows opportunities for a more densely planted segment that acts as a windbreak. Planting of a forest of trees, densely planted and varying in height, would mitigate wind gusts in the linear park to make for a more pleasant space for informal play and passive recreation.

The linear park and road reserve also allow for other services, such as above ground water storage and permanent water features to improve habitat and cooling attributes on a hot day.

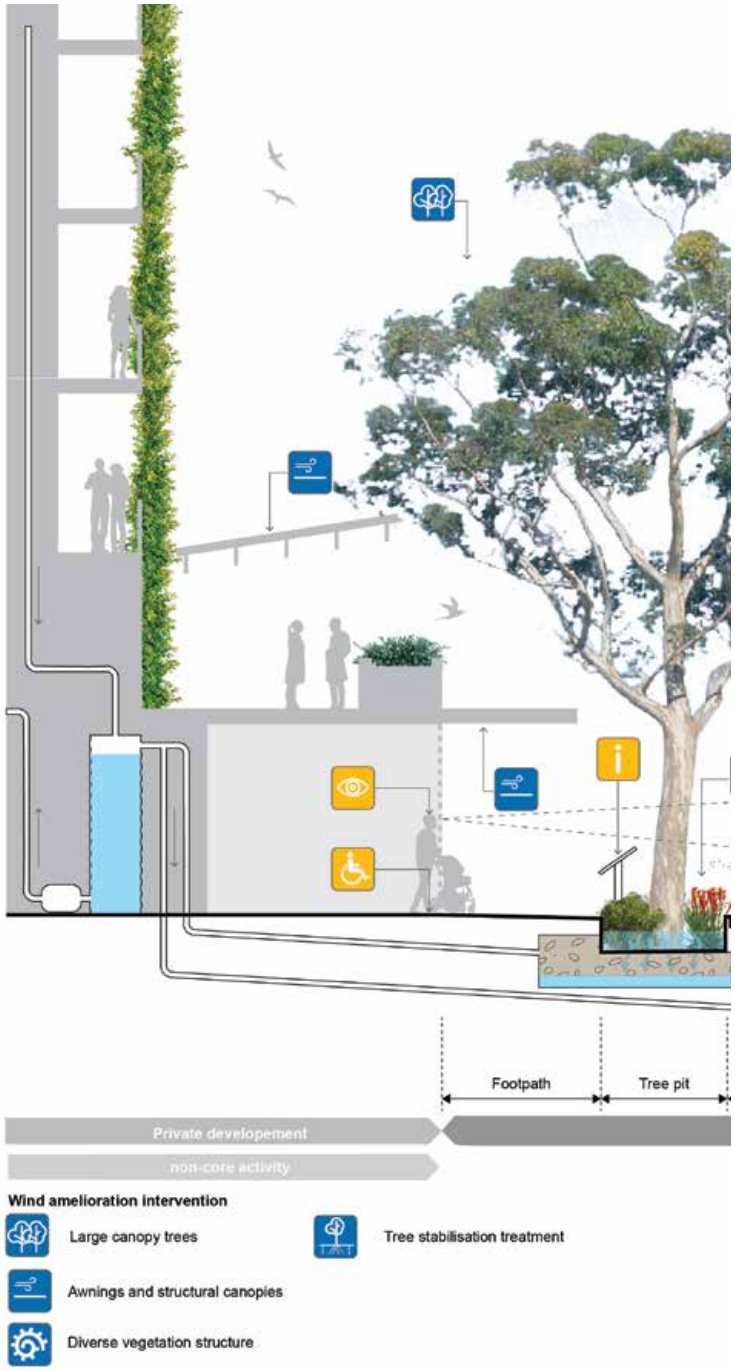
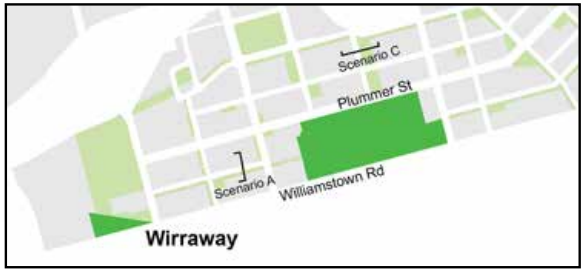
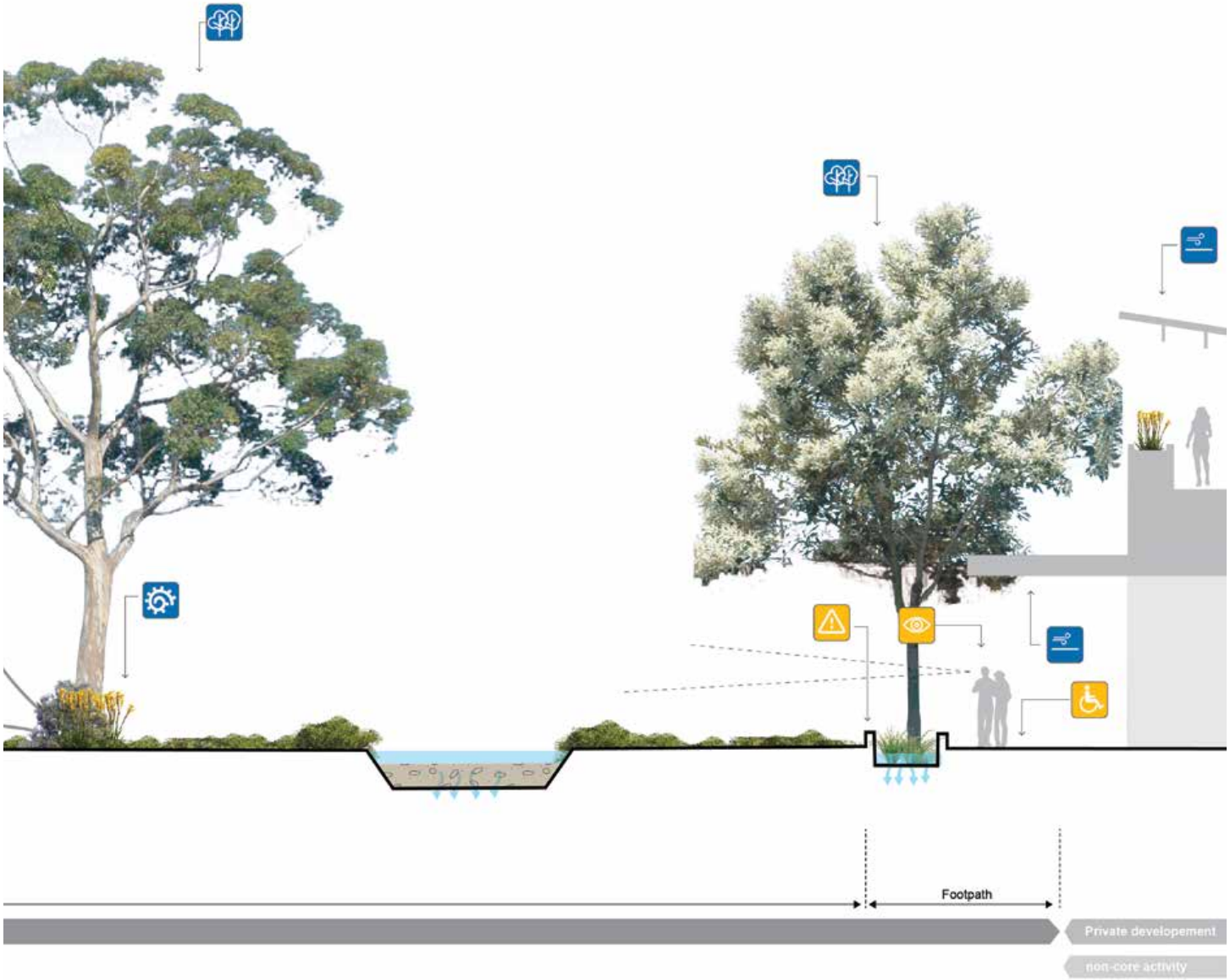


Figure 27. Scenario C: A wind priority corridor in Wirraway

User experience intervention

- Interpretive signage
- Street furniture
- Universal access
- Minimising trip hazards
- Passive surveillance
- Microclimate comfort





Scenario D – A heat priority corridor in Lorimer

Turner St corridor has been categorised as a heat priority corridor, which extends from the Employment Precinct into Lorimer Precinct. The road profile is nominally 36 m wide and is a major multi-modal boulevard servicing the majority of the working community who are transiting between the CBD and the universities, workplaces and residential areas. The wide profile of the street means it is susceptible to heat and so key interventions tend to exist adjacent to the shared use paths and bike paths to improve human thermal comfort.

Key interventions include:

- Large canopy trees densely planted across whole length, with priority over active transport linkages
- Inclusion of awnings and canopies to shade street level footpaths
- Rest spots with shaded seating and drinking fountains and associated bike end-of trip facilities, to provide respite on hotter days for commuters and local residents
- Applying cool pavements and permeable pavements on the road and tram line, where possible to increase evapotranspiration and cool the urban environment

Due to the amount of noise and light pollution along the Turner St biodiversity objectives are compromised, however provision of flowering plants for insects and birds still contributes to delivering BSUD principles and creating opportunities for informal interactions with nature.

Figure 28. Scenario D: A heat priority corridor in Lorimer

Scenario E – A complementary priority corridor in the Employment Precinct

This corridor is located in Employment Precinct and co-locates initiatives to improve wind, heat, biodiversity and urban forest. It acts as a biodiversity connector between the Yarra River and Westgate Park via Wharf Road. The road profile is nominally 22 m wide to allow for heavy vehicle traffic movements and active transport, however it is assumed pedestrian and cycling activity will be limited to day use through intermediate streets in the Employment Precinct. To improve biodiversity outcomes in the Employment Precinct where land use and transport modes are less compatible, interventions should focus on minimising light, noise and air quality pollution impacts on habitat. This scenario explores how BSUD principles can be applied through habitat creation in nature strips and on podiums on industrial/commercial buildings and mitigate the impacts of wind through complementary interventions.

Key interventions for include:

- Contiguous green naturestrips planted with structurally diverse (under, mid, and canopy) vegetation designed for bio-connectivity, including large canopy trees, and adequate, healthy soil volumes
- Diverse native vegetation that provides multiple resources for animal species, including shelter (e.g. dense, protective shrubs), food (e.g. flowers/fruits) and nesting sites (e.g. tree cavities). Species selected in consultation with Westgate Biodiversity: Bili Nursery & Landcare
- Strategic location of awnings or porous screens to protect outdoor seating (if any)
- Require densely planted, diverse structured vegetation with large canopy trees in upper and mid-story, to create “roughness” to reduce wind speeds (tree stabilisation may be required depending on tree species and soil depth)
- Passive irrigation of naturestrips, as well as active irrigation with recycled water (opportunity for above ground flood storages although this area has not been identified as requiring these) for cooling measures
- Seating and interpretive signage to provide education on vegetation
- Large canopy trees to shade to be stabilised
- Strategic location of awnings or porous screens to protect outdoor seating for cafes/restaurants (if any)
- Require densely planted, diverse structured, large canopy trees in upper and mid-story, to create “roughness” to reduce wind speeds (tree stabilisation may be required depending on tree species and soil depth)
- An integrated bio-connectivity network linking street corridors, biodiversity areas in public spaces and waterways

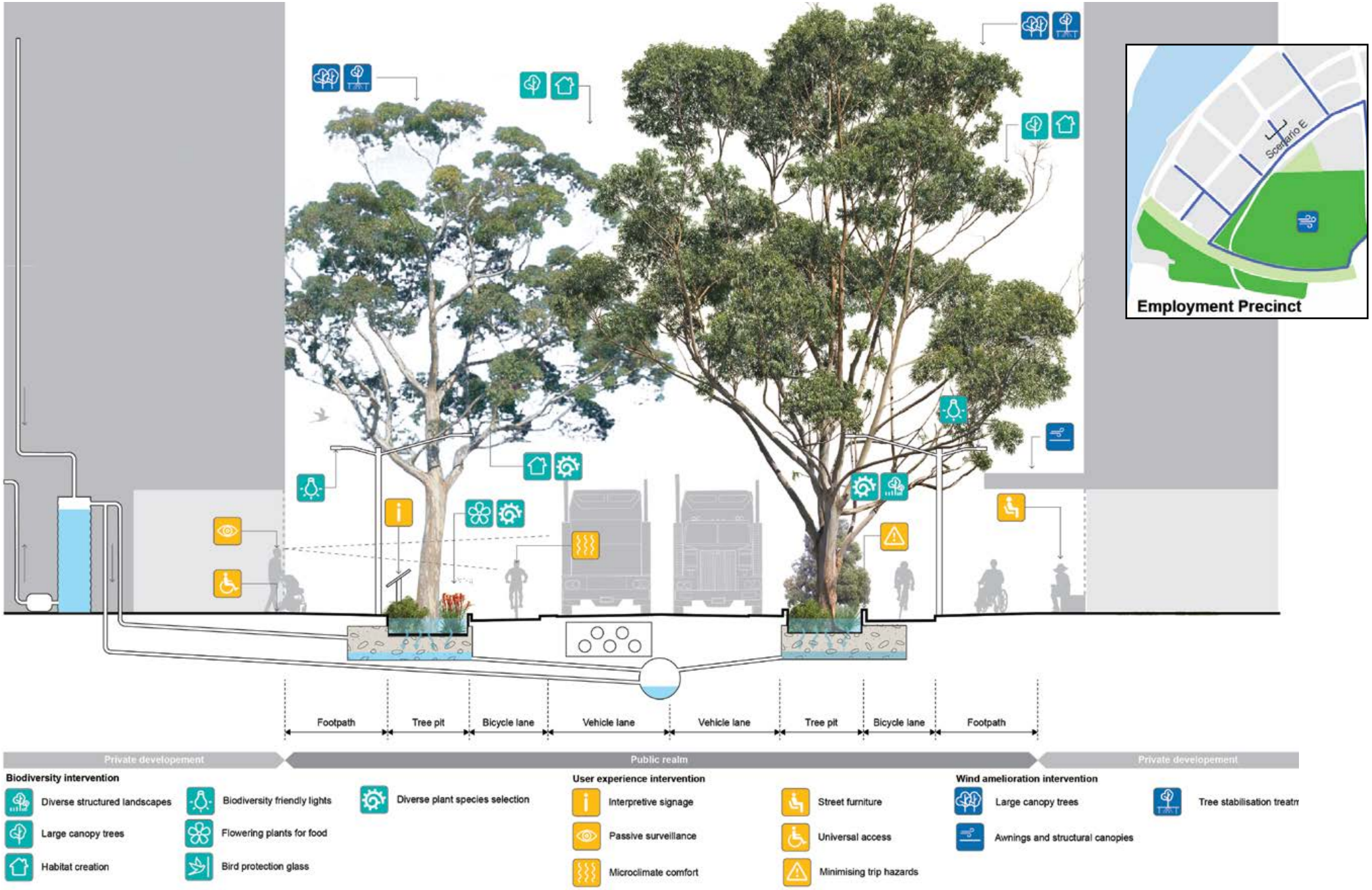


Figure 29. Scenario E: A complementary priority corridor in the Employment Precinct

Additional miscellaneous corridor design guidance

Corridor strategic planning (general)

The broader corridor strategic direction should:

- Prioritise GI over on-street parking when planning and designing streetscapes. This approach should be supported through the development of a car parking strategy
- Canopy tree location should be prioritised during the planning phase, to inform the location and design of services and utilities, and to ensure the trees have time and space to grow and flourish
- Prioritise protecting existing public realm trees where possible to contribute to landscape character and offer immediate shading and cooling
- Require developers and council to collect GIS data of new trees as they are planted (location, species, age, health) and submit as part of the planning process to add to council databases, and potentially also the Fishermans Bend digital twin model. This will allow asset performance to be tracked and scheduling of routine maintenance by Council

Corridor strategic planning within the Employment Precinct

The Employment Precinct will be a unique area in Fishermans Bend as a specialist manufacturing area and university campus. Specific guidance around planning better corridor designs include:

- Provide a continuous network of shared use paths to avoid conflict between freight trucks and other road users
- Create walkable streets with rest stops and shade to offset the impacts of larger blocks
- Reduce the visual impact of on-site storage and general refuse/waste storage areas from street view through improved siting, design, landscaping, fencing and other screening treatments
- Promote the inclusion of a more people-friendly urban realm and corridor experience through landscape treatments, such as planted naturestrips, footpaths and bicycle end of trip facilities
- Follow CPTED principles when planning and designing industrial areas
- Further investigate the minimum area and distance between biodiverse patches or novel habitat for target species. This will provide clearer direction to decision makers on spacing and planning open space

Employment Precinct design challenges

The Study identifies the Employment Precinct as an opportunity to coordinate public space and urban forest corridors networks (inclusive of heat, wind and biodiversity priority corridors) with the new campus design model and the urban ecology findings.

The operational requirements for light industrials zone / specialist manufacturing and educational facilities differ substantially to the other City Zones. The functional and spatial requirements of the precinct including street morphology, hours of operation of the universities viruses manufacturing, building heights and transport integration, already pose conflicts.

Some of the challenges we foresee in this precinct include:

- Requirements for truck movements in industrial streets generally result in large carriageways that take up to 60% of the road reserve, refer Figure 30
- Large block sizes don't support walkability and create poor connectivity and permeability for pedestrians and cyclists
- Intermodal conflicts between freight and delivery trucks, cyclists and pedestrians
- Significant amount of car parking and hard surfaces increase localized heat retention, refer Figure 30
- Poor interface with street corridors and businesses resulting in a lack of landscape character
- Balance competing needs for delivering urban ecology services while maintaining typical precinct logistical functions and productivity

Figure 30. Example of industrial estate devoid of landscape character, greening and cooling

There is an opportunity to re-visit how these street corridors could operate considering their potential integral role in bio-connecting Westgate Park with the rest of Fishermans Bend, encouraging active transport trips along prioritised routes through improved amenity, shading, pedestrian night lighting (if required). If we were to consider that an optimum abundant biodiverse street corridor may look like, the percentage road could be decreased by nearly 50%. This initiative would also attribute to heat mitigation and increase permeable space significantly, refer Figure 31

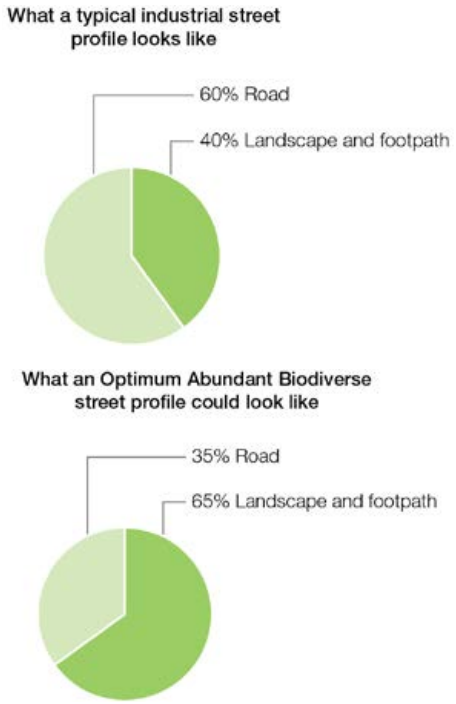


Figure 31. Comparison of land-use in typical street corridors

Diverse structured understorey plantings (biodiversity priority streets)

- Select shrub and ground cover plantings to be no more than 500 mm in height adjacent to active transport edges
- Prioritise wider street garden beds to consolidate maintenance requirements
- Implement automated sensory irrigation to all soft landscaping areas during establishment
- Strengthen ecological biodiversity within the streetscape through optimising plant diversity, and seasonal flowers, colour and form
- The species selection should reflect both an indigenous and exotic plant palette that is drought tolerant and resilient to site specific conditions
- Understory vegetation may be co-located with above ground flood storages in water sensitive corridors, and/or raingardens. If irrigation is not intended in some of these areas of co-location of understory and drainage assets, then in these cases it is important that this understory has the capacity to deal with long dry periods
- In all areas understory plant species must be resilient to short but intense storm surges. Investigate viability of trees being planted in raingardens and the impact of tree root balls on filtration performance
- Allow for irrigation (preferably recycled water) to all corridors to lift the visual appearance of the gardens and support healthy plant growth. Irrigation should only be supplied when passive irrigation is insufficient. This aligns with the Fishermans Bend Water Sensitive Strategy (2020)
- Planting shall support water quality where possible by selecting species that filter and extract minerals
- Co-locate biodiversity areas within all corridors and public places where possible. Each biodiversity area shall look and function differently depending on their location, however they are proposed to remain unfenced to people. In areas such as public spaces next to residential areas, some areas may requiring low fencing to discourage dogs and other domestic animals entering

Figure 32. WSUD corridor interventions

Corridor amenity & experience

- During functional design of corridors consider integration of seating, cultural interpretive signage and indigenous plant identification labels to offer opportunities for continued learning for all
- Seek opportunities to communicate climate resilient urban interventions through signage, physical/ digital markers or on-ground markings to make the community more aware and engaged with their environment (e.g. around above ground flood storages)
- Design the corridors as sensory places to stop and reflect through selection of seasonally diverse flora
- Install eco-street lighting which have long wavelength LED lights, possibly with scheduled periods of darkness in appropriate places. This could be via motion sensors (in appropriate locations) to reduce excessive light spill, while still maintaining a safe level of lighting to the streetscape (Longcore, et al., 2018; Davies, et al., 2017)
- Minimise excessive light installations on building facades adjacent to linear parks and biodiverse priority corridors to reduce unnecessary disruption to local habitat
- Install contemporary weather protection solutions including retractable awnings, arbours and climbing plants at ground level to connect street and façade infrastructure
- Protect and enhance key views to the CBD and the bay along North-south corridors to maintain a sense of place

Pavement materials & finishes

- Hard pavement colours shall be a lighter tone to reflect and mitigate heat retention. Where bluestone is required to be specified to meet CoM design standards consider integrating varying patterns to include lighter coloured paving materials (Low Carbon Living CRC, 2017), refer Figure 33

Figure 33. Applying cool pavements to street corridors in decorative ways that contribute to street character and identity

- Carry out further investigation cooling pavement technologies which can be spread over asphalt to reflect heat

3.4 Public space

Public space must be multi-functional, fit for active and passive activities and is expected to cater for a growing and diverse population, as each precinct evolves. Active recreation should not be developed at the expense of ecological outcomes. The creation of public spaces are vital to a healthy and happy community. This includes provision of diverse and natural environments for exploration, reflection, physical activity, and fostering positive social interactions.

Public space design guidance

Amenity, experience, and heat mitigation

- To the extent possible public spaces should interface seamlessly with vegetation corridors (heat, biodiversity and wind priority corridors)
- Investigate opportunities to locate permanent and ephemeral water bodies within public spaces, specifically linear parks for flood storage amenity, urban cooling, and to provide above ground flood storages to assist with flooding outcomes. Wherever possible water features should include soft amphibian friendly edges, refer to Figure 34, 35 & 36.
- Incorporate nature play elements within public space to engage families with sensory and natural features
- Irrigate grasses with recycled water to modify the microclimate and avoid high temperatures
- Other than in active recreation areas, high tree canopy cover should be adopted as an objective. These should provide both ecological and human refuge areas. This could be achieved by clustering trees, and selecting tree species with large canopies
- To highlight Fishermans Bend as a climate responsive and sustainable neighbourhood showcase water, wind, light and shadow in the landscape through creative, educational and interpretive interventions in public spaces

Figure 34. Perception of cool through good plant selection and maintenance regime

Figure 35. Water features in the public realm, Ostebros Climate Neighbourhood, Copenhagen

Figure 36. WSUD interpretive signage to educate the community

Protection from wind

- Public space identified as a priority for wind shelter (all major public space as noted in Figure 18) should be investigated for the potential to include a wind break. Introduce wind breaks to strategic edges of public space via mounding and dense vegetation to buffer winds, and create comfortable spaces for recreation. This would support passive recreation by mitigating noise and visibility of traffic. Park entries and movement network shall consider CPTED principles and avoid traversing through the breaks
- Utilise mounding and capped soil to contain soil contamination issues without moving soil off site
- Maximise densely planted canopy trees on the northern edges of proposed public space to mitigate the impact of prevailing winds on recreation

Biodiversity

- One segment of each park to be designated as a biodiversity area to provide a diversity of vegetation structure, habitat and resources for fauna. Where possible it is preferable to locate this biodiversity zone near to the beginning of a biodiversity priority street corridor, but more than 3 m away from traffic. Minimum patch size of 15 square metres (approximately 2 car parks)
- Biodiversity areas should have structurally diverse vegetation (multiple layers), be large and contiguous enough to accommodate wildlife. They are compatible with active transport and quiet recreation (not sports). Species selection for planting should be supervised by professional ecologists. Note: these areas are also accessible and encouraged for human passive recreation
- Grassed open areas from an urban ecology lens do not play a big role in cooling and little ecological value. Grass turf should be implemented in active recreation areas, and some proportion of passive recreation areas, but not automatically applied across all public space. Within biodiversity zones diverse vegetation structures including long grasses, shrubs, small and large trees should be prioritised. Where no grass turf is installed the provision of adequate seating is important to facilitate passive recreation
- Provide pedestrian lighting only along key pedestrian and cycle routes, to minimise excessive disruption to areas of habitat
- Ecologically important public spaces should require dogs to be leashed, while other active recreation areas may function allow dogs off leashes
- Plant nurseries (such as Bili Nursery or St Kilda Co-op) and other social enterprises should be encouraged to operate within Fishermans Bend to continue contributing to the ecological restoration of the precinct and share important local botanic knowledge

Figure 37. Managing competing objectives with pets and wildlife

Public space strategic planning within the Employment Precinct

The Employment Precinct currently has no clear guidance around provision or type of public spaces. Provision of well sited and designed public space will ensure positive experiences for visitors, university students, workers and potentially residents (although intended to remain industrial, there may be residences along the tramline, universities and/or potential future metro station). The project team recommends the following:

- Consider the use of an offsets approach under which the Go Kart area adjacent to Westgate Park is sold, to fund the purchase of land for public space within the Employment Precinct which is further away from Westgate Park (e.g.in the Eastern quarter of the Precinct)
- Public space in the Employment Precinct can and should be complemented by private realm at ground level (courtyards, gardens and streetscape interfaces). All options for encouraging developments to provide this additional private open space should be pursued. For example there is an opportunity to allow additional building height in the Employment Precinct in exchange for accessible green space
- Provide a variety of smaller public space (potentially pocket parks) that are suitable for smaller gatherings, with predominantly canopy trees and medium shrubs to improve localised cooling and ecological patches. Consider CPTED principles to maintain passive surveillance
- Provide one larger public space to cater for active recreation programs that is connected to a biodiverse corridor (e.g. the Green Link, refer Section 4, recommendation 1)
- Provide a hierarchy of public spaces including smaller patches that are interconnected via linear parks or active transport off-road routes, especially to Westgate Park via the proposed Green Link, refer Figure 38
- Provide opportunities for smaller vegetated patches minimum size of 15 sqm (preferably larger) within the precinct to extend connectivity to the priority corridors. Max distance between patches is determined by animal movement ability. For example, if the habitat is for Growling grass frogs it should be no further than 200 m apart (and contain water). Habitat patches for fairywrens ideally should be no more than 500 m apart. This also depends on the type of habitat between those patches is conducive to the adjoining patches
- In spaces/corridors where biodiversity is not the primary focus, nature based solutions should still be selected as biodiverse designs can solve multiple objectives

Figure 38. Biodiverse permeability diagram

3.5 Private realm

The private realm has potential to showcase innovative, micro-climate responsive design. Initiatives for better ecological outcomes (heat, wind and biodiversity) within the private realm can provide important contributions towards achieving the vision set out for urban ecology in Fishermans Bend.

Private realm design guidance

General

- Developers should be encouraged to follow a Biodiversity Sensitive Urban Design approach at the beginning of their process
- Developers should be encouraged to consider greening/ biodiversity outcomes prior to building architecture, it was noted that this can be done informally by providing design guidance to developers as early as possible. BSUD can be incorporated as the initial focus for identifying these outcomes
- Buildings in priority wind areas should incorporate the guidance outlined in the Management of Wind flagship recommendation, refer Section 4, recommendation 4
- Consider directing stormwater and/ or rainwater from roofs to priority passive irrigation and/or water bodies, e.g. in Westgate Park
- Promote anti bird strike glass in all tower developments
- Further investigate the value to the Indigenous groups of having a developer contribution incentive (DCI) to serve as a strong compliance mechanism to support the Aboriginal RAPs and groups participating and engaging through the life of the project
- Promote the application of cool roofs (not just green roofs, but also high albedo/reflective roofs) to play a significant role in urban heat mitigation (Gallant, Jacobs, Tapper, & Li, 2018).

Vegetation and private spaces

- Prioritise at grade vegetation (over elevated plantings) to promote human/biodiversity interactions, street level shading and access to public space. It is noted that some parts of Fishermans Bend already have a requirement for buildings to cover 70% or less of the lot (some less dense sections of Wirraway and Sandridge). Consider further application of this to other areas of the precinct
- Carry out a full inventory of canopy trees on private property to determine what trees should be encouraged to be retained
- Further investigate the minimum distance between biodiverse patches or novel habitat for target species. This will provide clearer direction to decision makers on spacing and planning open space
- Provide elevated (including but not limited to forecourt, podium and roof) green infrastructure to achieve shade/ cooling, stormwater retention/treatment, biodiversity habitat, and spaces for humans to gather
- Provide tiered balconies to allow for an articulated façade
- Promote inclusion of green walls, climbers and climbing structures to mitigate heat adjacent to smaller constrained corridors
- Provide both ecological and human refuge areas in podium and forecourt designs by clustering trees or providing large shade canopy trees on podium
- Develop an ecologically diverse species list for rooftop and podium landscapes specific to Fishermans Bend, that promotes flowering species on rooftop gardens for bee and butterfly pollination
- Encourage developers to include urban agriculture within the private realm on podiums and roofscapes

Figure 39. Integrated roof gardens, Burnley Campus, University of Melbourne

Implementation

- Existing vegetation should be identified and protected. Existing vegetation is valuable because it provides: instantaneous urban cooling and biodiversity benefits, and provides critical information about which parts of this highly modified site are currently suitable for hosting vegetation. To date, trees within the public realm are the only vegetation to have been assessed. A comprehensive assessment of the quantity and quality of all existing vegetation across the site is required prior to planning and development. This is particularly true across the Employment Precinct and at the GM site
- A mechanism should be developed (whether it be the CoM Green Factor or otherwise), that requires a minimum amount of private greening in new developments across all of Fishermans Bend, and suitably prioritises the above recommendations. CoM are currently building a business case for Green Factor, and will soon begin process of planning scheme amendment. CoM have attempted to fill a gap in existing tools (Green Star, BESS). Further investigation of Green Factor tool is required to check for incorporation of biodiversity requirements (e.g. flowering plants and other resources for bees, insects and birds). Also to determine whether this tool can adequately prioritise ground-level vegetation, which may require specific controls for the building footprint and street level circulation space. CoM and CoPP will work with DELWP and DJPR to determine appropriate tools to apply to Fishermans Bend

Figure 40. Biodiversity and cooling at the street interface

3.6 Interface between public and private realm

As design objectives require flood management and greening in both the public and private realm, there is a risk that interfaces between the two realms will not be effectively coordinated in relation to walking tracks, and planting beds. Streetscape and private realm should be designed in coordination, establishing seamless green corridors.

Interface guidance

- The built form shall act as an extension of the streetscape and contribute to the urban experience by integrating and extending the landscaped area from the public to the private realm
- Foster everyday nature experiences through maximising opportunities for planted areas
- Blend visual boundaries between public and private realm through continuous styles (built form and vegetation)
- Maintain at-grade building thresholds to provide universal access
- Promote retail and residential lobbies to include information boards inside blocks to showcase the Indigenous culture, habitat & wildlife that can be found in the area and also the role of water in the landscape, reminding people of the local place character
- Green roofs/podiums and walls on the western and southern elevations shall mitigate energy usage in buildings ensuring no over reliance is placed on selected materials
- Contemporary weather protection solutions shall include arbours and climbing plants at ground level to connect street and façade infrastructure
- Employ the use of cool surfaces and greening to all rooftops to reduce urban heat
- Resolve building interface treatments where habitable floor levels are raised to mitigate the impacts of flooding
- A selection of this guidance is visualised in Figure 41

Implementation

- Providing design guidance to developers in advance may be the most effective way to influence development designs prior to submission for council approval
- Consider where overlays would be needed in specific high priority locations
- Opportunity to use incentives (e.g. additional floor heights) to influence development in the Employment Precinct but not elsewhere

Figure 41. Property threshold permeable treatment

Figure 42. Greening off-road bike paths

Figure 43. Interface between public and private realm cross section (Source: GHD)

3.7 Delivering the precincts

To further define how urban ecology can be delivered throughout Fishermans Bend we have evaluated the theme priority corridor mapping at a precinct scale to identify pertinent locations for interventions.

Figure 44. Articulate facades in laneways with climbing plants where space is limited

Figure 45. At-grade water bodies in the linear parks for habitat and cooling

3.8 Delivering Montague

Described as **"A diverse and well-connected mixed use precinct celebrating its significant cultural and built heritage, and network of gritty streets and laneways"**
The Montague network of laneways and local streets shall offer diversity of urban environments that vary in scale. Design considerations across the precinct should include:

- The existing street tree palette is generally made up of smaller trees both exotic and indigenous. New tree plantings should retain the diversity, and increase both large canopy and understorey planting where possible
- Protect the existing trees in corridors and private property, which have a higher ULE rating, contribute significantly to the visual amenity, cooling and existing ecological services
- Recommend further investigation for incorporation of opportunities of urban agriculture (prioritise pollinator species in this area) in both public and private realm and on rooftops to service the high dwelling density ratios

Key initiatives (illustrated in Figure 46) are:

A Montague St should prioritise heat and active transport initiatives

B Laneway environments should consider utilising smaller scaled planting initiatives such as planters or plant climbing structures that complement of heritage built form and semi-industrial feel, (refer Figure 44)

C New linear parks adjacent to the Montague St Light Rail alignment offer a good opportunity for inclusion of diverse structured vegetation patches while maintaining sightlines and CPTED principles

D Biodiversity corridors should be prioritised along Buckhurst with smaller biodiverse areas at a minimum size of 15 square metres

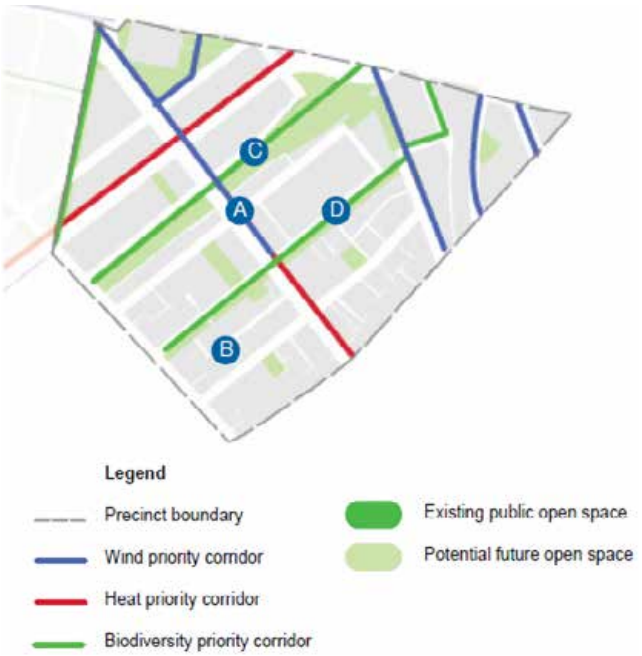


Figure 46. Montague precinct key corridor plan

3.9 Delivering Lorimer

Described as **"A vibrant mixed use precinct close to the Yarra River and connected to Melbourne's CBD, Docklands and emerging renewal areas"** *Lorimer shall experience high levels of pedestrian and other active modes of transport, due to the proximity to the CBD, and high concentration of active and passive recreation located within the precinct. This will require consideration for additional shading interventions to improve the level of comport along these routes and within the public spaces. Design considerations across the precinct should include:*

- North-South orientation corridors facing the Port of Melbourne will require particular urban design considerations to reduce the ingress of northerly winds into these corridors, such as Ingles St and Boundary Rd. This would include the selection of large, dense, evergreen trees that are anchored or stabilised in ground
- The existing street tree palette is generally made up of medium to tall native trees. New tree plantings should retain the diversity, increase overall canopy, and increase understorey planting where possible
- Recommend further investigation of wind impacts on built form and corridors, especially the whole frontage to Westgate Freeway
- Recommend further investigation for opportunities of urban agriculture (prioritise pollinator species in this area) on both public and private open space to service the high dwelling density ratios

Key initiatives are:

- **A** Integrate cool permeable ground treatments along the tram line to reduce heat and improve commuter sense of comfort
- **B** Provide large canopy trees along active transport routes to provide heat mitigation and improve human comfort
- **C** Integrate biodiverse areas within Lorimer Central open space, along with other nature play and interpretive elements to maximise interactions with nature and water
- **D** Provide shaded rest spots with large canopy trees throughout the public space corridor
- **E** Where possible protect the existing trees in corridors such as Ingles St and Boundary Rd, which have a higher ULE rating and contribute significantly to the visual amenity, cooling and existing ecological services
- **F** Integrate WSUD initiatives along the Northern tram corridor and adjacent public spaces and linear parks that supports habitat creation and linkages

Figure 47. Lorimer precinct key corridor plan

Figure 48. Permeable ground treatments along tram lines

Figure 49. Nature play

3.10 Employment Precinct

The Employment Precinct is intended to be largely industrial, but may include residential buildings along tram and/or potential train infrastructure alignments. Key landmarks in this precinct will include two university campuses and Westgate Park. Design considerations across the precinct should include:

- Integrate BSUD into all built form frontages and roofscapes, and road reserves and bridges as an urban design objective to enhance the quality of the precinct and educational resource to complement the precinct program (particularly in the biodiversity priority areas, refer Figure 21)
- Protect and enhance existing trees, vegetation and landscape character in the GM site and other private properties
- Provide a hierarchy of streets for major transport access to separate bio-connectivity, active transport and logistics and reduce noise and light pollution on bio-connections
- Recommend further investigation into opportunities to divert rainwater and/or stormwater into Westgate Park to supplement water bodies
- Identify all streets radiating from Westgate Park primarily as biodiversity priority corridors to extend connect to the Yarra River and future Living Levee, refer Section 5.2
- Look to double the existing tree canopy (in accordance with CoM endorsed strategy) as a critical component of climate change adaptation

Key initiatives are:

A Integrate cool permeable ground treatments along the tram line to reduce heat and improve commuter sense of comfort

B Consider a Green Bridge connection from Westgate Park over Todd Rd to support bio-connectivity into proposed Green Link as well as pedestrian connectivity. Keep bike and pathways to one side of the bridge and provide a turf buffer between garden beds and pathways. Also provide a gridded animal underpass to allow light penetration and safe passage across the roadway. Further details are found in Volume 2: Appendix E

C Provide shaded rest spots with large canopy trees throughout new public spaces

D Protect and enhance the cultural landscapes around the GMH site and provide a complementary landscape character with the inclusion of a biodiverse patch, similar to the smaller courtyards found on site

E Prepare a bio-connectivity framework plan to inform the network of biodiverse “links and patches”, based on the physical attributes described in Section 3.4

Note: the proposed Green Link also occurs within Employment Precinct, refer to Section 4, recommendation 1.

Figure 51. Holden Admin Building Fishermans Bend, c1949

Figure 50. Employment precinct key corridor plan

Figure 52. Biodiverse green bridges, Highline NY

3.11 Delivering Wirraway

Described as ***"A family friendly inner city neighbourhood close to the Bay and Westgate Park"***
Wirraway shall be an ecological hub for families to engage and connect to nature. It will foster an active lifestyle by encouraging walking and cycling along accessible public spaces within close proximity of dwellings. The diversity of public space will include a visible biodiverse network enhanced with cultural interpretive stories of the place and from the First Nations Traditional Owners via wayfinding and pedestrian prioritised crossings. Design considerations across the precinct should include:

- Recommend further investigations into how to mitigate northerly wind gusts on developments facing the Westgate Freeway. This could include some combination of vegetated wind breaks, or in some cases blocking streets with buildings, to reduce wind (refer to Figure 64)
- Where possible protect the existing trees in streets and public space, which contribute significantly to the visual amenity and existing ecological services
- Recommend further investigation for opportunities of urban agriculture (prioritise pollinator species in this area) on both public and private open space to service the high dwelling density ratios (due to family friendly precinct)
- Provide iconic local arts and cultural interpretation such as signage, interactive sculptures or water features that are themed around agriculture ecology (both current multicultural practices and Indigenous traditional practices), local history and place identity
- Where there is a requirement for buildings to cover 70% or less of the lot promote an integrated planning approach between the public and private realm

Key initiatives are:

A Provide buffer planting and landscape intervention to ameliorate wind on the Northern and Western perimeter of Edwin Flack Park and within JL Murphey Reserve

B Prioritise biodiverse corridors between JL Murphy Reserve and Edwin Flack Park

C Increase bio-connectivity by linking proposed linear parks and pocket parks throughout the precinct specifically from Prohasky South open space and along Tarver St to JL Murphy Reserve.

D Introduce wind breaks to strategic edges of JL Murphy and Wirraway North public space via mounding and dense vegetation to buffer winds, and create comfortable spaces for recreation

Figure 54. Shaded public space

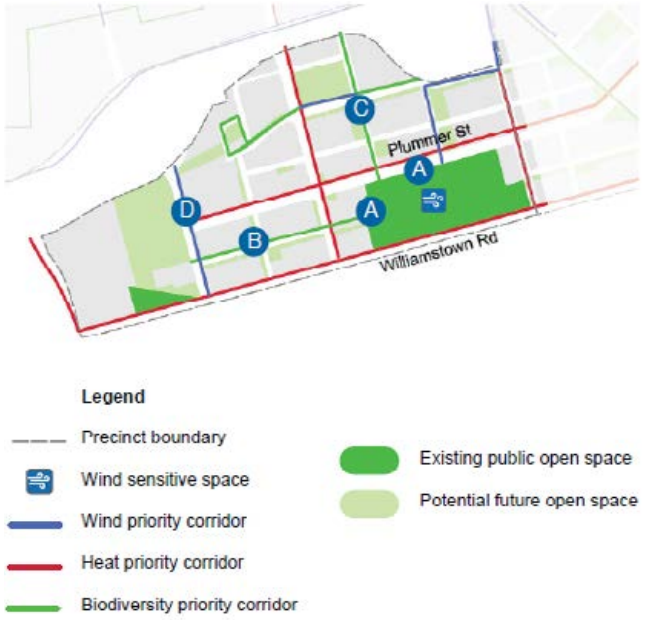


Figure 53. Wirraway precinct key corridor plan

Figure 55. Integration of urban agriculture into the private realm

3.12 Delivering Sandridge

Described as **"One of Melbourne's premium office and commercial centres, balanced with diverse housing and retail"** *Sandridge shall be a vibrant neighbourhood with active street corridors and a strong arts and culture narrative within the street character. Design considerations across the precinct should include:*

- Recommend further investigations into how to mitigate northerly wind gusts on developments facing the Westgate Freeway. This could include some combination of vegetated wind breaks, or in some cases blocking streets with buildings, to reduce wind (refer to Figure 64)
- Where there is a requirement for buildings to cover 70% or less of the lot promote an integrated planning approach between the public and private realm
- Recommend further investigation for opportunities of urban agriculture (prioritise pollinator species in this area) on both public and private open space to service the high dwelling density ratios
- Where possible protect the existing trees in streets and public space, which contribute significantly to the visual amenity and existing ecological services
- Showcase innovative ways of incorporating water in the streetscape to contribute to the character of the place

Key initiatives are:

- **A** Provide buffer planting and landscape interventions for wind amelioration along the northern, southern and western perimeters of North Port Oval
- **B** Prioritise bio-connectivity (including active transport) along Bertie St and Johnson St to link proposed public space
- **C** Conduct case studies on the wind outcomes of potential built forms where development and streetscapes meet the Freeway Corridor

Figure 57. Greening and cooling transport corridors

Figure 56. Sandridge precinct key corridor plan

Figure 58. Water in the street corridor

4. Flagship recommendations

Recommendation 1

Green Link through the Employment Precinct

A Green Link running through the Employment Precinct will act as a green movement corridor for wildlife and people permeating through the otherwise large scale block structure. The link provides a safe biodiverse corridor that is away from major roadways, while also serving a linear open space function.

This link, made up of a continuous linear park and active transport (walking and cycling) corridor, is to include large canopy trees, diverse vegetation, passive recreation, seating, conveyance/storage of stormwater, and restricted vehicle access (for maintenance only). This link is designed to support active transport (through providing a shaded and cool corridor), biodiversity connectivity, amenity, and contribute to the requirement for both new public space, and above ground stormwater management, within the Employment Precinct.

A dedicated Green Link in the Employment Precinct is required to ensure ecological connectivity across the site. This contributes to multiple levels of biodiversity infrastructure and significantly improves ecological connectivity across Fishermans Bend. To strengthen its ecological value, it should be separate from major vehicular transport, including public transport.

Figure 59. Green Link indicative location plan

Additional details

Currently the large scale street grain of the proposed Employment Precinct significantly lacks active transport connectivity protected from heat and wind, space for passive recreation, iconic amenity and biodiversity connectivity east from Westgate Park. A proposed east-west linear open space, active transport and biodiversity corridor (conceptualised as a Green Link) would connect biodiversity at Westgate Park towards the other precincts, particularly along biodiversity priority corridors and public space within Lorimer.

A typical cross section of the proposed Green Link is shown in Figure 61. This shows:

- An overall corridor width of 20 m has been used to model bio-connectivity and test urban design interventions
- A walking/cycling track covered by large canopy trees to protect from heat and wind, aiming for a full growth canopy cover of 60%
- Space for seating and passive recreation
- Inclusion of stormwater storage/conveyance that supports vegetation with passive irrigation (this can be integrated with stormwater outlets from adjacent private land along corridor)
- Planting of diverse vegetation structure including tall grasses, shrubs and small trees. These should be selected specifically to provide multiple resources for animal species at different life stages, including shelter (e.g. dense, protective shrubs), food (e.g. flowers/fruits/seeds/pollen/nectar), nesting sites/shelter (e.g. tree cavities), and water

Figure 60. Green Link indicative photomontage

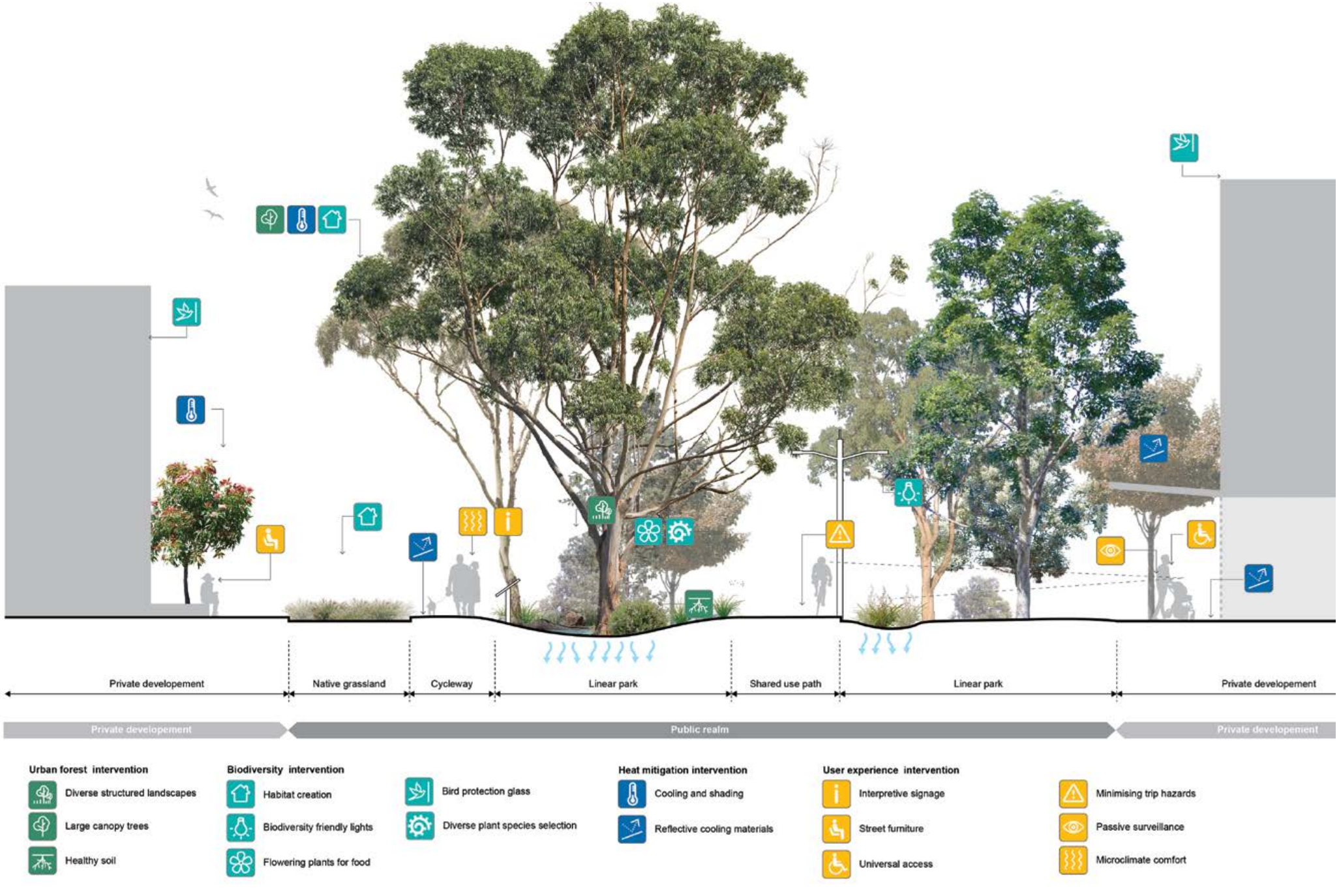


Figure 61. Green Link typical cross section

Benefits

A dedicated Green Link separated from the road network is necessary in addition to active transport along Turner St for the following reasons:

- **A connected, liveable, inclusive and healthy community:**

  There is currently a lack of public space designated within the Employment Precinct, provision of an additional linear public space through the core of the precinct would provide access to a significant component of the workers/residents in the area (Framework Objectives: 1.9.4, 3.7.1, 3.7.2, 3.7.8)

- **A climate resilient community protected from heat and wind:**

  It would be possible to provide greater protection from heat and wind in the Green Link, due to having a larger area available for planting of large canopy trees (Framework Objectives: 4.1.2, 4.3)

- **A water sensitive community:**

  Provision of a Green Link provides significant opportunity to store, and potentially convey, large amounts of stormwater, make this water visible in the landscape and use this water for passive irrigation of the linear park (Framework Objectives: 5.1.1, 5.1.4, 5.1.5).

- **A biodiversity community:**

  Separating public space from traffic provides significant benefits for biodiversity. Creating a biodiversity corridor protected from traffic between Westgate Park and the other precincts has been shown through connectivity modelling to significantly improve ecological outcomes (Framework Objectives: 6, 6.1.2, 6.2.1, 6.2.2, 6.2.5)

Integration

Figure 59 shows an indicative location for the link. The final location, shape and alignment of the link would largely be subject to land availability, however the link should be designed according to its core objectives, which is to encourage active transport, passive recreation and biodiversity connectivity. As such key design factors would include alignment with other open spaces, existing landscape patches, orientation for thermal comfort, orientation for habitat connectivity, provision of passive surveillance, route directness for active transport etc. The Green Link connectivity is also explored in Section 3.4.

Implementation actions and planning considerations

- This recommendation should be included in the Employment Precinct PIP, other CoM strategic planning, as well as design guidance as a long term consideration
- High level cost-estimation of this recommendation would be valuable prior to further consideration
- It is likely that the Green Link would need to be public property, either purchased from or gifted by developers (potential for entire sections to be built by others, but maintained by Council)
- GM site and other private developments along route could provide opportunity for supporting urban design at interfaces with complementary interface treatments, such as retail offerings with outdoor dining
- It will be necessary to work closely with land owners to identify the optimum route for the Green Link
- Inclusion of residential properties along Green Link would also be a positive urban design outcome, however BSUD principles would need to be applied to protect the integrity of the corridor, while minimising excessive light and noise pollution.

Recommendation 2
Diverse vegetation structure

A holistic approach to vegetation structure with the provision of adequate native understorey vegetation will be a key foundation for cultivating biodiversity in Fishermans Bend. It is advised that all public space in the precinct have designated minimum "biodiversity areas". Some streets should be designated as biodiversity priority streets (see Figure 17), which include a diverse understory of plants varying in height in connected nature strips. All linear parks should include native understory vegetation. In the private realm, native flowering plants should be included in gardens beds in all new gardens, including street frontages, podiums, rooftop gardens and other elevated green infrastructure. In all cases native vegetation should be selected that provides both habitat and resources.

Note: Planting of diverse vegetation structure does not preclude planting of large canopy trees. It is possible to plant large canopy trees and also shrubs, grasses and smaller trees in between larger canopy trees.

Additional details

A typical biodiversity area within a park is specified as follows:

- One segment of public space to be designated as a biodiversity area to provide a diversity of vegetation structure, habitat and resources for fauna. Where possible it is preferable to locate this biodiversity area near to the beginning of a biodiversity priority street corridor, but more than 3 m away from traffic. Minimum patch size of 15 square metres (approximately 2 car parks). This also informs the size of 'patch' where the biodiversity area exists on its own
- Biodiversity areas should have structurally diverse vegetation (multiple layers), be large and contiguous enough to accommodate wildlife. They are compatible with active transport and quiet recreation (not sports). Species selection for planting should be supervised by professional ecologists. Note: these areas are also accessible and encouraged for human passive recreation

Guidance for private realm is as follows:

- Private realm should include urban agriculture, canopy trees for shade, and flowering species to support bees and butterflies, in all gardens both ground level and elevated (podiums and rooftop gardens) and other guidance as indicated in Section 3.5

Vegetation guidance consistent across public space, streets and private realm is as follows:

- Native vegetation that provides multiple resources for animal species, including shelter (e.g. dense, protective shrubs), food (e.g. flowers/fruits) and nesting sites (e.g. tree cavities)
- Australian native understorey species should be considered to maximise the likelihood of planting success
- Plant nurseries (such as Bili Nursery or St Kilda Co-op) and other social enterprises should be encouraged to operate within Fishermans Bend to continue contributing to the ecological restoration of the precinct and share important local botanic knowledge
- Multiple contiguous green medians planted with structurally diverse (under, mid, and canopy) vegetation designed to create bio-connectivity

Benefits

- **A connected, liveable, inclusive and healthy community:**

  Through increasing the amenity of public spaces and selected streets the inclusion of diverse vegetation structure would support passive recreation and active transport **(Framework Objectives: 1.9.4, 3.7.2, 3.7.8, 3.8.2)**

- **A climate resilient community protected from heat and wind:**

  Providing multiple layers of canopy can be effective at protecting from both heat and wind. Biodiversity areas can be incorporated into windbreaks on park edges **(Framework Objectives: 4.1.2, 4.3)**

- **A water sensitive community:**

  Provision of biodiversity areas and streets can both be co-located with storage, and/or conveyance of stormwater, make this water visible in the landscape and use this water for passive irrigation. It is common for infrastructure such as a drainage swale to include various shrubs, which can double as biodiversity understory, creating multiple benefits from one space **(Framework Objectives: 5.1.1, 5.1.4, 5.1.5).**

- **A biodiversity community:**

  Creating segments of public space and some streets which incorporate diverse native vegetation structures would make Fishermans Bend a new benchmark for infill urban growth, expanding the existing habitat and resources above what is currently existing **(Framework Objectives: 6, 6.1.2, 6.2.1, 6.2.2, 6.2.5)**

Integration

- Biodiversity areas: Concept should be applied within one or more areas within each public space, of a size larger than 15 square metres, nearby to biodiversity streets where possible but more than 3 metres from traffic
- Biodiversity priority corridors: See Figure 21 for recommended locations for where biodiversity street concept should be required
- Private realm: Private realm concepts above should be included within all forecourts, courtyards, gardens, podiums and rooftop gardens

Implementation actions and planning considerations

- Could be included in Precinct Implementation Plans, other CoM/CoPP strategic planning, design guidance, as well as park masterplans/design briefs and streetscape detailed design
- There is strong synergy between the plan to provide above ground stormwater storages and this proposal to include understory in streets and public space, as these can be co-located (functional design drawings/materials of stormwater storages needed to progress discussion further)
- Westgate Biodiversity group have knowledge on local species that thrive and support biodiversity in this part of Melbourne, and so should be included as key partners in species selection
- Requirement for multiple disciplines, such as biodiversity experts, to be included in park and streetscape detailed design
- Targets/principles should be developed for understory vegetation in public space and included in masterplans and design briefs
- Pedestrian safety issues, such as passive surveillance and line of sight, should be taken into account
- During future planning consultation with botanical specialists and landscape gardeners it will be necessary to produce a palette of recommended understorey plants for Fishermans Bend, focusing on establishment and maintenance efficiency
- Additional investigation is required to understand the capital and maintenance costs, and appropriate maintenance regimes, in order to achieve these recommendations. It may be necessary for councils, staff and contractors to make efforts towards increasing capacity for design, construction and maintenance of understory
- To require the private realm vegetation guidance, the planning considerations will be consistent with those articulated under private realm implementation in Section 3.5. Most importantly, further investigation of Green Factor and other tools is required to check for their ability to specify and require of biodiversity requirements (e.g. flowering plants and other resources for bees, insects and birds). Soft influence through direct engagement with developers will also be an important avenue for implementation.

Figure 62. Inclusion of low intrusive barriers to discourage dogs and sport through biodiverse areas

Recommendation 3
Water in the landscape

Water will be visible in the landscape by directing water to the urban forest first, before directing water to the drainage pipes. 'A water sensitive community' is a key sustainability goal from The Fishermans Bend Framework and includes the objective to establish an integrated water system. It is recommended that stormwater be redirected to rain gardens, above ground storages, and tree pits (as well as bioswales and artificial wetlands if any) first, before directing water to pipes. These ephemeral features should be complemented by the inclusion of a combination of permanent small water bodies and/or wetlands in public spaces, particularly adjacent to biodiversity areas. Linear parks and the Green Link should include a combination of ephemeral and permanent water bodies. Where possible water features should include amphibian friendly edges.

The Fishermans Bend Water Sensitive Strategy has developed a plan to use above ground storages to reduce the requirement from underground drainage pipe upgrades, and also make water visible within the landscape. The drainage strategy does not:

- Specify where stormwater will go first (above ground storages first or below ground pipes with overflow points)
- Require any permanent water features
- Indicate the functional or visual design of these storages
- Provide detail around vegetation and implications for stormwater treatment objectives

As part of this Study the project team proposes the following:

- Direct stormwater to rain gardens, above ground storages, and tree pits (as well as bioswales and artificial wetlands if any) first, before directing water to pipes
- Provide permanent small water bodies and wetlands in public spaces. These should particularly be located adjacent to, or within biodiversity areas
- Linear parks and the Green Link should include a combination of ephemeral and permanent water bodies
- Where possible all water features (permanent and ephemeral) should include amphibian friendly edges
- All above ground flood storages should be designed to include vegetation consistent with typical wetland and rain garden species selection so that they are able to provide stormwater treatment as well as be resilient to both flooding and dry weather. Where streets with above ground storages coincide with streets that are priorities for heat, active transport and biodiversity, it is preferable to also provide irrigation with recycled water

Benefits

'A water sensitive community' is a key sustainability goal from The Fishermans Bend Framework and includes the objective to establish an integrated water system.

- **A connected, liveable, inclusive and healthy community:**

  Provision of permanent water bodies within some public spaces would improve amenity and diversity of spaces available to the community **(Framework Objective: 1.9.4)**
- **A climate resilient community protected from heat and wind:**

  Providing permanent water bodies reduces heat through evaporation. Also directing stormwater towards above ground storages and other water features prior to pipe networks provides additional water to the landscape for greening and cooling **(Framework Objective: 4)**
- **A water sensitive community:**

  Directing stormwater towards above ground storages and other water features prior to pipe networks would make this water visible in the landscape, increase passive irrigation and stormwater treatment **(Framework Objectives: 5.1.1, 5.1.4, 5.1.5).**
- **A biodiversity community:**

  Providing permanent and ephemeral water bodies with amphibian friendly edges would support a wide variety of plants and animals through providing habitat and resources for birds, mammals, amphibians and macroinvertebrates **(Framework Objectives: 6, 6.1.2, 6.2.1, 6.2.2, 6.2.4, 6.2.5)**

Integration

- All of the areas shown as green in Figure 63 are intended to have above ground flood storages. Within these areas above ground flood storages will be included in streets and public spaces. Therefore in these areas, where heat, active transport, wind and biodiversity priorities exist it will be necessary in many cases to co-locate them within above ground flood storages
- Permanent water bodies should be prioritised within new and upgraded public spaces other than Westgate Park and linear parks, particularly those that are adjacent to biodiversity priority corridors, see Figure 21
- Permanent water bodies already exist within Westgate Park, but this does not preclude investigation of other sites to add additional water bodies. Many Westgate Park water bodies have significant biodiversity present, which can be leveraged to improve biodiversity within new water bodies

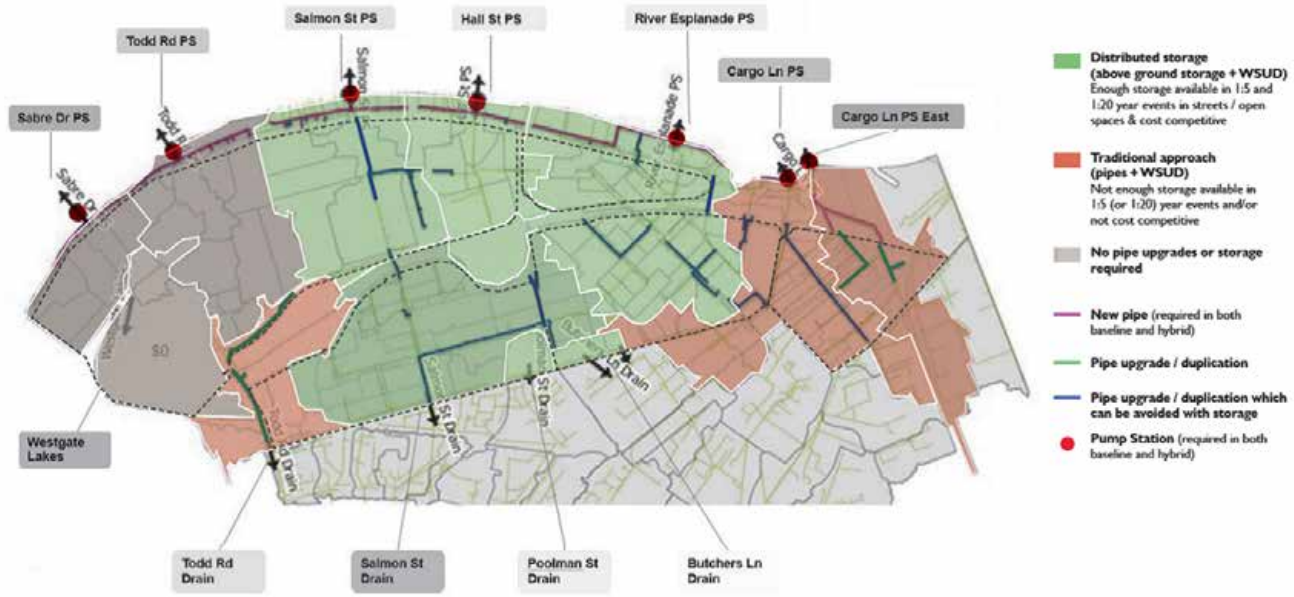


Figure 63. Sub-catchments were above ground flood storages are intended

Implementation actions and planning considerations

- New permanent water bodies could be included in Precinct Implementation Plans, other CoM/CoPP strategic planning, design guidance, as well as park masterplans/design briefs and streetscape detailed design
- Community groups have for a number of years been advocating for additional flows to be diverted to the Westgate Lakes. A special collaborative project with developers, and a dedicated pipeline may be needed to make this a reality
- Requirement for multiple disciplines to be included in park and street detailed design, including Landscape Architects, Botanists, Ecologists and hydraulic/ hydrological engineers
- Determination to send water to landscape first before pipes, or co-location of water storages with other heat/ biodiversity objectives does not necessarily add additional cost
- Determination to add permanent water bodies and wetlands to open spaces does add additional cost, and also should not prevent adequate space for recreation

Recommendation 4
Management of wind effects

Wind represents a key environmental factor that can undermine human comfort and thereby the overall success of an urban renewal development project. Wind outcomes can change over time as an area develops. The mitigation and management of wind effects is therefore dependant on site specific measures and will be critical in realising Fishermans Bend as a successful and liveable precinct.

All new buildings should have building-scale wind analysis conducted to refine building design. This should be done using a centralised Fishermans Bend-scale model (potentially the one developed for this study) that is updated as new designs are proposed, providing mutual benefit for developers (through reduced study cost), and government (through testing large scale impacts).

Various high level recommendations can be made to mitigate undesirable wind conditions within streets and public spaces. For all buildings this includes: encouraging the placement of balconies on southern faces, shielding of balconies with secondary operable facades, avoiding ground-floor openings (e.g. arcades without doors that extend the length of the building) in tall buildings. In streets identified as wind canyons these include: requirements for podiums, and structural canopies to protect sidewalks and entrances. For outdoor seating/eating areas consider use of porous/impervious screens/awnings to blocks winds. Other general wind guidance includes that for tall buildings with rectangular footprints, it is undesirable to have the wide face towards the North (prevailing wind), and it is undesirable to place short buildings directly upwind of tall buildings.

Additional details

The project team have conducted Computational Fluid Dynamics (CFD) analysis to identify which areas of Fishermans Bend will experience wind discomfort from the most prominent wind directions. Meteorology for Fishermans Bend, CFD methods and results from this assessment are described in detail in Volume 2: Appendix B.

The results of this preliminary wind study indicate that there are several areas within Fishermans Bend which are likely to experience high wind velocity (>10 m/s) with high frequency of occurrence (more than 5% of the time). These areas include a moderate number of streets, as well as most public spaces which could significantly undermine their use and therefore their role in supporting public life and a liveable community.

The primary cause of wind canyon creation was not “street level ingress” where wind enters a street directly (Figure 64), but rather the “downwash effect” (when wind is sucked down gradually towards ground level after passing over a building, or wind hits a tall building and is diverted directly towards ground level).

While the scope of this study does not include the assessment of all possible built form outcomes and their effects on wind in the built environment, various high level recommendations can be made to mitigate undesirable wind conditions within the private and public realm. These recommendations and their effectiveness are entirely dependent of the microclimate and urban morphology of the specific site. Local wind patterns of each site in question will determine which urban design interventions will be appropriate to mitigate from undesirable wind conditions in the public realm.

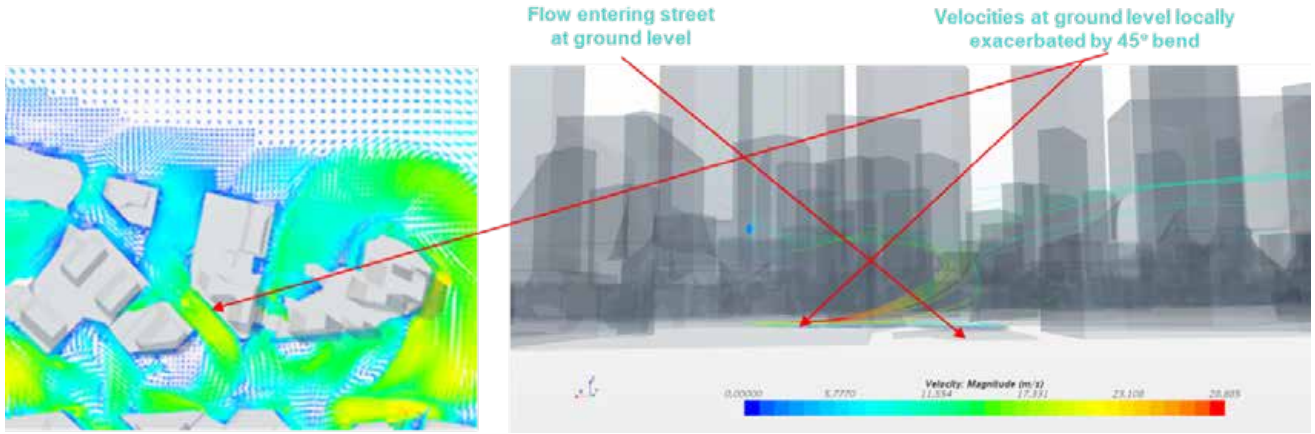


Figure 64. Example of wind canyon street level ingress

The recommendations emerging from this theme were as follows (these are include here as well as in Volume 2: Appendix B due to the fact that all findings from the technical assessment have been adopted within the final FBUES recommendations):

- Requirement for testing new building designs through a centralised model
  - This scale of analysis (given the available resources for this project) provide high-level guidance, but all new buildings should have building-scale analysis conducted to refine building design. It is inefficient for each developer to generate its own wind model from scratch. If building scale analysis is done using the centralised Fishermans Bend-scale model created for this analysis, it would be possible to update this model as new designs are proposed, and test the impact on Fishermans Bend as a whole, providing mutual benefit for developers (through reduced study cost), and government (through testing large scale impacts)
- Recommendations for all buildings:
  - In general balconies on southern faces will be less exposed to wind than other faces (as Northerly is the prevailing wind). Balconies on other faces will require additional shielding. More modelling is required to do case studies on different building shapes/heights, in different parts of Fishermans Bend (testing the impact of the proximity of other buildings), to refine this guidance further. Shielding with secondary operable facades (sometimes referred to as Winter Gardens) should be considered for all balconies (needs to be considered on a building by building basis)
  - Generally avoid ground-floor openings (e.g. “arcades” without doors that extend the length of the building) in tall buildings, as these can create wind canyons. There may be some specific buildings were this is not a problem (due to proximity of other buildings), but this needs to be specifically tested through the CFD model. (For diagram on impact of arcade refer Fig 2(a) in: www.cwejournal.org/vol7no2/wind-field-modifications-in-habitable-urban-areas)
- Other general guidance for buildings:
  - For tall buildings with rectangular footprints, it is undesirable to have the wide face towards the north (prevailing wind) (Refer Fig 2(b) in: www.cwejournal.org/vol7no2/wind-field-modifications-in-habitable-urban-areas)
  - It is generally undesirable to place short buildings directly upwind of tall buildings (which causes wind acceleration), this can be observed in Figure 66. Note: this is particularly noticeable when wind travels from building with small heights (e.g. 8 stories) to buildings greater heights with greater heights (e.g. 24 stories), which is the case in Figure 66 and is the scenario this study has considered design interventions in Figure 25. This is also demonstrated in Fig 2(b) in: www.cwejournal.org/vol7no2/wind-field-modifications-in-habitable-urban-areas). *Note: in areas such as Lorimer Precinct where there are taller towers spread across the area general rules such as this will not always hold true, and more analysis is required to determine the impact of any particular building*

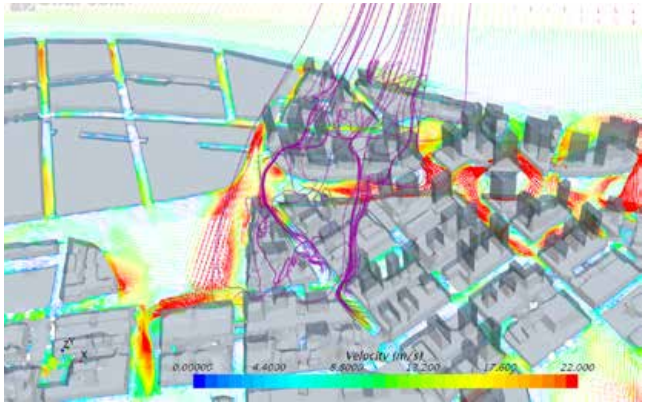


Figure 65. Complexity of wind interface from Lorimer into Sandridge across Freeway corridor

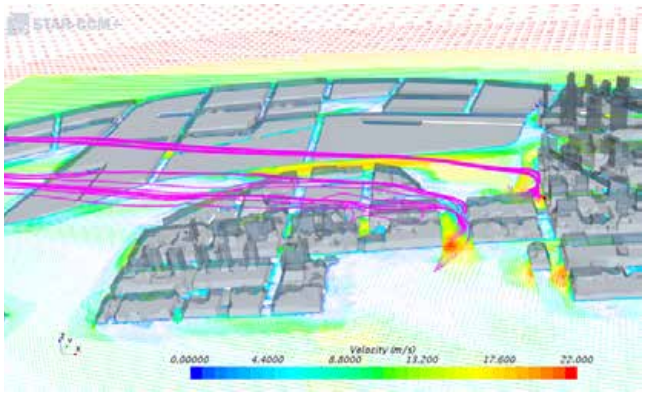


Figure 66. Example of wind canyons created by downwash caused by wider street canyon (lower wind stream) or a short building upwind of a taller building (upper wind stream)

  - Differing building heights and offsetting large towers (horizontally) may improve wind outcomes in some locations. However more modelling is required to test this, as this is substantially context specific

- In streets identified as wind canyons - streets and open space (refer to Figure 18):
  - Require podiums and/or structural canopies (on building façades) to protect sidewalks and entrances (refer Figure 26)
  - Require densely planted large canopy trees and mid-story vegetation to create “roughness” to reduce wind speeds (tree stabilisation may be required depending on tree species and soil depth)
  - Require windbreaks on edges of public spaces, particularly Northern edges of large spaces (e.g. Westgate Park and JL Murphey Reserve) (refer to protection from wind guidance in Section 3.4)
- Communal spaces exposed to wind (cafes, restaurants, courtyards, gardens etc.) should consider use of porous or impervious screens and awnings to blocks winds. Porous screens can work better than non-porous walls for wind protection, because they can largely avoid generating significant wind acceleration and turbulence. For example see awnings over podiums in Figure 27.
- Propositions without sufficient justification
  - One issue considered in the assessment in Volume 2: Appendix B was whether there was evidence to suggest that realigning streets in the Employment Precinct might create benefits for wind amelioration. Our results show there is insufficient justification to realign streets in the Employment Precinct, as modelling did not reveal a significant improvement
  - Propositions that are worthy of further investigations
  - Case studies on tall buildings in different parts of Fishermans Bend (with different surrounding buildings) to refine balcony placement guidance
  - Case studies on specific wind canyons to test the effectiveness of varying tower location and shape, and varying wind heights, in regards wind canyon amelioration (relevant to all areas with taller buildings, e.g. over five stories)
  - There is currently insufficient analysis to test the impact of placement of buildings (or other features to block wind) at the northern ends of streets to block wind entrance into street (this is particularly relevant for areas directly backing onto freeway corridor but without bridges)
  - Related to the above, further analysis is warranted to look for and resolve occurrences of the “Venturi Effect” which occurs when a wider canyon narrows into a narrower canyon (and causes wind to accelerate). In some specific locations it may be possible to ameliorate this effect by widening canyons in key locations. Further analysis is required to identify these locations. Venturi effect is occurring in Figure 6

Benefits

- **A connected, liveable, inclusive and healthy community:**

  Requiring wind-breaks in parks can protect public space from wind increasing amenity and use, while inclusion of podiums, structural canopies and large canopy trees can improve the active transport outcomes and general comfort of pedestrians **(Framework Objectives: 1.12.3, 1.13.3, 1.13.7)**

- **A climate resilient community protected from heat and wind:**

  Requiring wind-breaks in parks and dense canopies in streets contributes to reducing the adverse impacts of wind, and contributes to overall canopy cover **(Framework Objectives: 4.1.2, 4.3)**

- **A biodiversity community:**

  Requiring wind-breaks in parks and dense canopies in streets contributes to reducing the adverse impacts of wind on flora and fauna, and contributes to overall resources cover **(Framework Objectives: 6, 6.1.2, 6.2.1, 6.2.2, 6.2.5)**

Implementation actions and planning considerations

- It is preferable for future wind assessments to be conducted through a centralised CFD model
  - It is proposed these new standards will apply to all buildings of five or more storeys within Fishermans Bend
  - A centralised CFD model could either be held by DELWP, or retained by GHD, depending on commercial agreements. There is a precedent for this as authorities such as Melbourne Water and DELWP are responsible for administering other modelling data that influences built form outcomes
  - Requirement to test buildings through the centralised model could be included within the Planning scheme or Design and Development Overlay for all of Fishermans Bend
  - It is likely that developers would support this concept due to cost savings in comparison to typical building wind assessments. However a long consultation process may be required to test developer sentiment on this issue and provide information and guidance
  - Access to centralised data presents a great opportunity for developers, councils and other authorities
  - The Victorian Government has recently developed a Digital Twin which seeks to resolves some of the complexity around tracking infrastructure and asset delivery for the Fisherman's Bend precinct. A centralised CFD model would be consistent with this intent
- It may be valuable to conduct case studies on select tall buildings and high wind areas (outside of scope of this study)
- Podiums are already required within majority of Fishermans Bend for other reasons, wind study provides additional justification for this requirement
- Structural street level canopies do not need to be required in the planning scheme, but the planning scheme should ensure that pedestrians are protected, and structural canopies are expected to be one of the major mechanism for protecting pedestrians
- Masterplans and detailed design of public space should take into account wind results (e.g. wind breaks species that are tolerant of wind)

Recommendation 5
Management of heat

Summary

Similar to wind, heat also represents a key environmental factor that can undermine comfort and thereby the overall success of an urban renewal development project. The project team have conducted heat modelling on a set of case studies to identify areas which are likely to have high Human Thermal Comfort (HTC) temperatures, as well as test multiple tree canopy scenarios to determine their impact. The results showed that 45% of the modelled areas can be moved down from the “very strong” (feels like low 40s Celsius) to “strong” (feels like mid 30s Celsius) heat stress category, as canopy width and height is increased. It is recommended to prioritise maximising tree canopy over all other urban ecology recommendations in the corridors where a heat priority street coincides with an active transport street.

Additional details

Methods and results of the heat modelling assessment conducted by the project team can be found in Volume 2: Appendix B. See Figure 67 for example heat modelling image.

This heat modelling has informed the identification of corridors which are expected to have a high temperature “heat priority corridors”, which are illustrated in Figure 19. General guidance in regards to design interventions for heat priority corridors is shown in Figure 28. The key design interventions for heat priority corridors are:

- Large canopy trees, and replacing hard pavement with vegetation or a permeable surface
- Irrigation and water in the streetscape public realm
- Heat reflecting pavements

Other interventions such as irrigated GI (walls/roofs/podiums), particularly on southern and eastern edges of wide roads, would also provide cooling benefits. A full list of measures that can be undertaken to reduce urban heat is included in Volume 2: Appendix B.

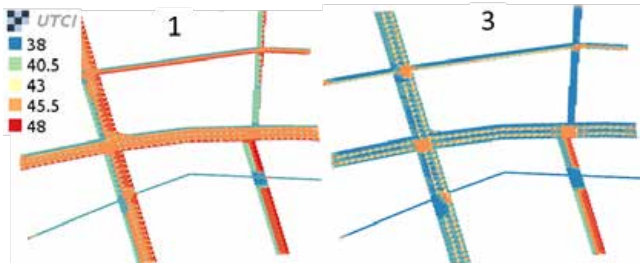


Figure 67. Illustrative example of heat modelling methodology (comparing low tree canopy scenario [1] with high tree canopy scenario [3])

Ideally all heat priority corridors will be protected with the above greening interventions, however there are some heat priority corridors which are more important than others. The most important corridors for maximising heat mitigation interventions are when a heat priority corridor Figure 19, coincides with an active transport street Figure 20. While the interventions recommended are the same, the difference with these specific corridors is that a greater investment is warranted in regards to planning, design, implementation and maintenance. If there is only enough resources to provide large canopies on some streets, it is crucial that these streets be selected over other streets.

Integration

A map showing where heat and active transport priorities overlap is shown in Figure 68.

Benefits

- **A connected, liveable, inclusive and healthy community:**

  Through increasing canopy and reducing heat implementing this recommendation would support passive recreation and active transport **(Framework Objectives: 1.9.4, 3.7.2, 3.7.8, 3.8.2)**

- **A climate resilient community protected from heat and wind:**

  Increasing canopy cover along active transport routes would protect from both heat and wind **(Framework Objectives: 4.1.2, 4.3)**

- **A biodiversity community:**

  Increasing canopy cover also provides habitat and can be co-located with biodiversity areas within streets and public space **(Framework Objectives: 6, 6.1.2, 6.2.1, 6.2.2, 6.2.5)**

Implementation actions and planning considerations

- Existing trees should be identified and retained where possible
- Implementation of large canopy trees is within the Business As Usual operation of City of Melbourne and City of Port Phillip
- Implementation of recycled water irrigation to street vegetation is already included within Fishermans Bend planning
- Detailed assessment of the barriers and opportunities in regards to the incorporation of large trees into above ground flood storages will need to be done as part of streetscape functional design
- The current recommendation to focus large tree canopies on streets that are both hot and intended for active transport is significantly consistent with Fig 14 (Green Links) from the Fishermans Bend Framework, with the exception of:
  - Lorimer St is recommended for heat mitigation works but is generally outside the boundary of the Fishermans Bend Framework. City of Melbourne may investigate options for this street separately
  - An additional corridor within the Montague precinct for additional active transport connectivity

Figure 68. Priority corridors for heat intervention

5. Recommended next steps

Implementing the design guidance and flagship recommendations within The FBUES will contribute to the liveability of Fishermans Bend, and improve comfort, sense of place and pride for the projected 80,000 residents and 80,000 workers. The research carried out has identified key principles, themes, functions that inform how urban ecology can be applied, experienced and integrated into the urban environment to meet the sustainability goals established in the Fishermans Bend Framework. To further enhance this body of work the following next steps have been identified.

Note: these recommendations for further assessment substantively relate to biodiversity because the interventions required to support the other themes assessed (heat and wind) are better established and understood. Incorporating biodiversity considerations into large scale infill developments is an industry leading endeavour, and requires further investigation.

5.1 Biodiversity in the design of catalyst projects

If the first major projects in Fishermans Bend do not adopt biodiversity focussed design objectives, this is a wasted opportunity for momentum towards goals. Biodiversity Sensitive Urban Design principles should be embedded in catalyst projects (a) tram line (and associated streetscape), (b) sewer mining plant, and (c) Melbourne University and RMIT engineering campuses. The tram line is along Turner Street, sewer mine location is yet to be confirmed, university campuses are also along Turner Street. Some implementation considerations are as follows:

- Tram line business case is under development by Department of Transport, initial discussions are warranted to determine whether biodiversity/greening aspirations can be included within the current business case
- South East Water are progressing with the design and location of the sewer mining plant. Initial discussions are warranted to determine to what extent biodiversity/ greening aspirations can be embedded into the design
- There is also a window of opportunity to engage with University of Melbourne and RMIT on the design of their engineering campuses, and inform of the overall design objectives for Fishermans Bend
- In all cases there is a requirement for multiple disciplines to be included in detailed design, including biodiversity experts

5.2 Living Levee

There is currently a plan in place for a levee to be constructed around Fishermans Bend, but no plan in place for how this would look or how it could support multiple social and environmental benefits. If a Living Levee was developed it would support climate adaptation, ecological diversity, active transport, provision of new public space, tourism, and sense of place/pride. Some implementation considerations are as follows:

- Install a Living Levee (inclusion of mangroves, oysters or other natural elements) and riverside walk along river mouth
- Living Levee could extend the entire length of levee, e.g. Figure 69, or a smaller portion
- Could be included in the EP Precinct Implementation Plan, other CoM strategic planning, and is a long term consideration (levee expected for construction in ~2050)
- This recommendation is consistent with Ramboll and GHD flood studies for Fishermans Bend. The concept has been explored by Ramboll. Potential functional requirements (height, adaptation over time etc.) are discussed in the GHD report
- Much of the riverbank is currently leased to the Port, significant negotiation will be required at time of levee construction (regardless of Living Levee). Inclusion of Living Levee increases complexity of negotiations further, such as in relation to public access
- A levee of any kind will be expensive, and inclusion of living elements would add further cost
- Further analysis is required to determine optimum functional design of levee

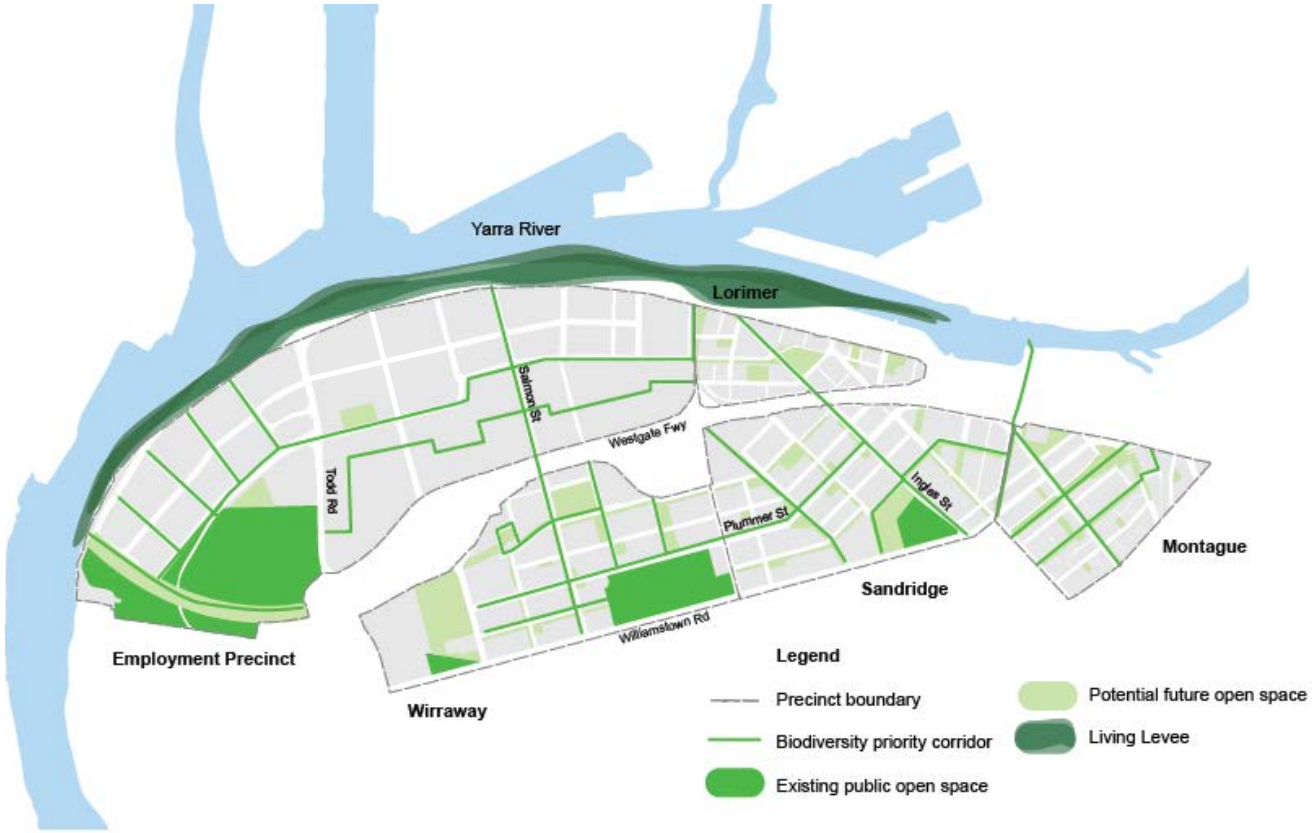


Figure 69. Map of living levee location and connection to Westgate Park

5.3 Cat containment

Biodiversity is threatened by cats. Solutions could include cat containment laws and council round-up of feral cats in all of Fishermans Bend, particularly in high priority area around Westgate Park. This would support biodiversity and community connection with nature. Cat control could be included in Local laws.

5.4 Canopy and understory targets

According to GHD analysis, the current canopy target of 50% in the public realm may not be achievable (see Volume 2 Appendix B). This target does not consider grass, understory or shrubbery in the public realm, or any greening in the private realm. Public realm tree canopy target should be revised through functional design of all streetscapes and public space, with priority given to placement of large canopies on streets designated as both heat priorities and active transport. During functional design, targets could also be set for understory/shrubbery and grass.

Note: large tree canopies for urban cooling should be prioritised over other targets (e.g. understory) due to the significant impact on human health and wellbeing.

In order to achieve intended human health outcomes it is important that public and private tree canopies targets be considered in combination, although private realm outcomes will also need to be influenced through design guidance/ controls. Benefits would include urban cooling/active transport, human experience, and biodiversity.

The project team recommends the following implementation considerations could be included in the Precinct Implementation Plans, other CoM/CoPP strategic planning, as well as design guidance

5.5 Biodiversity targets and monitoring

Stakeholders are in agreement that ambitious biodiversity objectives should be set, but these objectives are not currently associated with measurable targets and monitoring. Biodiversity targets should be set and measured against. These targets should be for on-site biodiversity rather than offsets. Outcomes should be monitored for implications in other infill sites.

As much structurally diverse vegetation as possible should be included, however it is the linkages and connections that create viable landscapes for wildlife. Providing quantitative targets for a site this large requires ongoing consultation with ecological professionals during planning and design stage. It also depends on the existing habitat available (which has still not been mapped) and how the provision of other services is being approached systematically. We strongly recommend further consultation as the development progresses.

The project team recommends the following implementation considerations:

- Could be included in the Precinct Implementation Plans, other CoM/CoPP strategic planning, as well as GHD design guidance

5.6 Protections for existing trees and other habitats

Vegetation has been mapped across public spaces in most of Fishermans Bend. However trees and other habitat has not been mapped on private property. The Employment Precinct in particular may have trees and other habitat that has not yet been identified, and for which there is no plan to protect. Mapping of existing trees/habitat and planning controls to protect these, are crucial as Fishermans Bend is redeveloped. This could include significant trees as well as understory, across all of Fishermans Bend, particular streets and private land within the Employment Precinct. Developing these protections is crucial for both urban heat mitigation as well as biodiversity.

- The project team recommends the following implementation considerations:
- An assessment of habitat in the streets and private property of the Employment Precinct is recommended
- New areas of habitat identified, along with areas of habitat identified previously, should be protected under the planning scheme
- Collaboration with the Westgate Park Biodiversity, and biodiversity academics, would result in improved outcomes

5.7 Green bridges and other links

There are currently no ground-dwelling fauna connectivity (as opposed to birds/insects) planned across Westgate Freeway and across Todd Rd. This could be supported by the inclusion of green elements on pedestrian bridges (to allow fauna to cross freeway), potentially complemented by an amphibian underpass under Todd Rd (only valuable if an public space or green spine is located directly adjacent to Westgate Park).

The project team recommends the following implementation considerations:

- Could be included in Precinct Implementation Plans, other CoM/CoPP strategic planning, as well as design guidance
- Engineering, maintenance and associated cost requirements need to be investigated further before a judgement can be made around the feasibility of these projects
- Research into appropriate functional designs may be required before the likelihood of fauna transport can be realistically assessed (e.g. length, elevation, pedestrian frequency in relation to green bridges, and distance between water bodies in relation to underpasses)

5.8 Indicative tree species planting palette

The selection of planting species and an overall planting palette for a particular site is linked to various objectives, design considerations, site constraints and characteristics particular to a location/environment. We recommend that all aspects of the urban environment are considered to inform the landscape character to deliver the optimal urban ecological outcomes. We present some initial guidance in regards to plant species in this section, which would need to be refined through functional design. Many of the species suggested here are not locally indigenous. Ideally a minimum of 50% locally indigenous species should be included, appropriate for the site context and fidelity to historical vegetation communities. The planting palettes should be developed in consultation with a qualified botanist or ecol-ogist.

Proposed process for selecting species

Step 1: Assess corridor priorities (refer Figure 17)

Step 2: Assess landscape character (i.e. place-specific nuisances)

Step 3: Localised site conditions (i.e. street orientation, adjacent built form, groundwater table, available in-ground space)

Note: Just because an area/street does not have biodiversity as a "priority" does not mean that BSUD cannot be considered. For example, when choosing vegetation for wind-mitigation plant species selection should still provide flowers/fruits to act as food resources for insects and birds. Also if a non-native tree species is chosen to mitigate heat, BSUD can still be implemented by the addition of mistletoes and artificial hollows to create new opportunities for habitat.

Initial species guidance

The tree species palette that has been used to provide suggestions for species selection in the scenarios below have been derived from both the CoM's Fishermans Bend Urban Forest Precinct Plan and CoPP's Greening Port Phillip Street Tree Planting Program 2017-2022.

It is acknowledged that these species lists are provided for guidance only and do not preclude the use of other trees that are consistent with the character of Fishermans Bend.

While the aim is to maintain the existing character, species from many different genera should also be planted to increase diversity and reduce vulnerability of the Fishermans Bend urban forest population. Species that have been identified to have performed poorly at the site have been avoided.

- **Scenario A (refer Figure 24):**

  Planting and tree palette to be diverse in species and structure to facilitate biodiversity objectives, primarily consisting of native/indigenous species. The existing tree species to the western end of the street is predominately an avenue of *Eucalyptus sideroxylon* of varied size and age on both sides of the street. There are no trees or landscaped areas at the eastern end of the street. With an existing monoculture of over-story species the aim would be to develop a greater diversity of over-story and mid-story with infill planting using an alternate species to the *Eucalyptus sideroxylon*. Consideration should be given to providing species that flowers/fruits to act as food resources for insects and birds. Example species include:

  – Large infill trees: *Casuarina cunninghamiana* (She-oak), *Eucalyptus leucoxylon subsp. Connata* (Yellow Gum), *Grevillea robusta* (Silky Oak)

  – Mid-story trees: *Eucalyptus torquata* (Coral Gum), *Banksia integrifolia* (Coast Banksia), *Hibiscus tiliaceous* (Coast Cottonwood), *Cupaniopsis anacardioides* (Tuckeroo)

- **Scenario B (refer Figure 26):**

  Tree palette to be diverse in structure with preference for large robust leave to facilitate wind mitigation. Larger and denser canopy trees should be located along the eastern side of the street to shade from intense afternoon sun. The existing street trees comprise a mixed palette including *Pyrus. melia, fraxinus sp*. that are small to medium in size, which are sporadically placed with large gaps. The aim would be to develop an upper-story with evergreen species that have a large leaf profile and are resilient to wind to provide to provide wind protection, addressing the main priority. Example species include:

  – Large infill trees: *Lophostemon confertu*s (Queensland Brush Box), *Vitex lucens* (Puriri)

  – *Tristaniopsis laurina* (Water Gum)

  – Mid-story trees: *Cupaniopsis anacardiodes* (Tuckeroo - best suited to the western side of the street due to their smaller size), *Bankia integrifolia var. integrifolia* (Coast Banksia), *Brachychiton populneus* (Kurrajong)

- **Scenario C (refer Figure 27):**

  Tree palette to be diverse in structure with preference for large robust leaf to facilitate wind mitigation whilst also providing attributes to provide biodiversity and water objectives. Species should be evergreen to mitigate wind all year round and be tolerant to windy conditions. Preference for native species or species that provide habitat for fauna with the ability to tolerate inundation in an above ground water storage environ. Example species include:

  – Large infill trees: *Lophostemon confertus* (Queensland Brush Box), *Tristaniopsis laurina* (Water Gum), *Angophora costata* (Smooth-barked apple)

  – Mid-story trees: *Bankia integrifolia var. integrifolia* (Coast Banksia), *Brachychiton populneus* (Kurrajong), *Harpullia pendula* (Tulipwood), *Cupaniopsis anacardioides* (Tuckeroo)

- **Scenario D (refer Figure 28):**

  Tree palette to include a range of species with preference for large canopy trees to provide maximum amount of shade and mitigate heat. Large and dense canopy trees should be located along both sides of the street to maximize shading from midday sun, however an emphasis should be placed on those placed on the southern side of the street, protecting from northern sun exposure through the day. Selected species may also address other priorities such as biodiversity, with the selection of fruiting and flowering trees with potential habitat values, and tolerance of water logging due to the site's proximity to the river. Part of the proposed street is currently industrial land with no existing trees, and at the proposed street's junction with the existing western end of Turner Street, there are a number of large existing *Platanus x acerifolia* specimens. Example species include:

  – Large infill trees: *Quercus suber* (Cork oak) – slow growing, but a good feature tree, *Acer platanoides* (Norway Maple), *Tristaniopsis laurina* (Water gum)

  – Mid-story trees: *Calodendron capense* (Cape chestnut) – ideally suited to the northern side of the street due to its smaller size, *Harpephyllum caffrum* (South African Wild Plum), *Waterhousea floribunda* (Weeping Lilly Pilly), *Melaleuca linariifolia* (Snow in Summer) – ideally suited to the northern side of the street due to its smaller size

- **Scenario E (refer Figure 29):**

  Planting and tree palette to be diverse in species and structure to facilitate biodiversity objectives, primarily consisting of native/indigenous species. The existing tree species is predominately an avenue of mature *Corymbia citriodora* (>10 m) on both sides of the street with *Ficus* species planted at either end of the street. With an established over-story the aim would be to develop a mid-story with infill planting of over-story to include an alternate species to the *Corymbia*. Consideration should be given to providing species that flowers/fruits to act as food resources for insects and birds. The location being close to the river is suspected to have a high water table and possible salinity. Example species include:

  – Large infill trees: *Casuarina cunninghamiana* (She-oak), *Eucalyptus leucoxylon subsp. Connata* (Yellow Gum), *Grevillea robusta* (Silky Oak)

  – Mid-story trees: *Eucalyptus torquata* (Coral Gum), *Banksia integrifolia* (Coast Banksia), *Hibiscus tiliaceous* (Coast Cottonwood), *Cupaniopsis anacardioides* (Tuckeroo)

5.9 Implementation monitoring framework

The project team recommends the development of a monitoring framework to oversee the implementation urban ecology outcomes in Fishermans Bend. One way this could be achieved is through noting which of the Fishermans Bend Framework objectives are relevant (refer Table 1), and then assessing approximately every 2 months the likelihood that each objective will be partially achieved (1-10 scale), and the likelihood that each will be substantively achieved (1-10 scale). Whenever a score of below a certain threshold is noted, a resolution meeting could be called for the relevant Fishermans Bend working group to discuss what can be done. If it is determined that an objective can no longer reasonably be achieved, it should be removed from future assessments.

The benefit of using the Fishermans Bend Framework objectives to monitor implementation is that it avoids the need for two separate, slightly different and heavily overlapping lists of intended outcomes.

5.10 CPTED

To maintain passive surveillance and ensure the corridors operate as safe, accessible and inclusive spaces the nominated design interventions are indicative only and would not be continuous along the entire street. CPTED principles would need to be considered in the detailed design process to ensure a balance between other urban design objectives (e.g. heat mitigation and biodiversity) and public safety.

6. Conclusion

The analysis conducted, and recommendations developed as part of this Study provide an evidence base and future directions for the more detailed Precinct Implementation Planning actions within Fishermans Bend. Overall it has been demonstrated that it is technically possible to deliver a precinct in Fishermans Bend that sets a new benchmark for sustainability and liveability, with iconic, walkable neighbourhoods where residents are protected from adverse effects of wind, and both water and biodiversity are visible within the landscape.

Great enthusiasm, dedication and creativity has been applied by all involved to make the project and enjoyable and meaningful process. Whilst there have been some challenges in prioritising competing interests it is understood that urban ecology rightly has a place in the early planning of liveable, vibrant and connected neighbourhoods. By bringing urban ecology to the forefront of urban design we can envisage greener, cooler corridors and buildings that apply traditional cultural and contemporary ecological knowledge, and as a result change the function of our cities for future generations.

The key limitation of this work is that is has not included cost estimation, functional or detailed design. Undertaking an assessment of engineering and costs, would be a crucial next step towards assessment of the recommendations outlined within this Study. Actual outcomes will need to be tailored in regards to available funding and resources.

As there will not be an infinite budget to spend on urban ecology interventions, the project team have created a simplified and integrated priority map (refer Figure 70), showing one key priority for each area. This map may be helpful for future planning exercises by providing a rapid understanding of what initiatives should be prioritised where. In areas where there were overlapping priorities, the project team has considered the local context and determined which theme should be considered as the top priority.

Figure 70. Top priority corridor interventions

7. Terms and abbreviations

List of terms and abbreviations used within the Urban Ecology Strategy include:

Ancillary open space (restricted public land)	Land in public ownership and/or under Council management that has public-use potential, but potentially limited access. Examples include streetscapes (refer below), government schools, cemeteries, transport reservations, and public golf course, and encumbered public space (refer below). While these areas may provide some recreational benefit, they have limited/restricted access and may not always be available for public use (i.e. a retarding basin holding water). These areas are complementary to the public space network; however, do not count towards Council's required developer public space contributions.
Active Public space	Land set aside for the specific purpose of formal outdoor sports by the community
Active recreation	Activities that are re engaged in for the purpose of relaxation, health and wellbeing or enjoyment with the primary activity requiring physical exertion, and the primary focus on human activity
Active transport	Priorities pedestrian and cycle routes and networks
Biodiversity	The variability among living organisms from all sources, including terrestrial, aquatic, marine and other ecosystems and the ecological complexes of which they are part), at all levels of organisation, including genetic diversity, species diversity and ecosystem diversity. Source: Australia's Biodiversity Conservation Strategy 2010-2030 (Holcombe, S., Rimmer, M. and Janke, T., 2009)
Biodiversity areas	Are spatially defined areas with should have structurally diverse vegetation (multiple layers), be large and contiguous enough to accommodate wildlife.
BSUD	Biodiversity Sensitive Urban Design
CFD Model	Computational fluid dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structures to analyse and solve problems that involve fluid flows. In this instance it was used to assess the wind flow
Co	City of Melbourne
CoPP	City of Port Phillip
Corridors	For the purpose of this report the word 'corridor' refers to the street and active transport network.
CPTED	Crime Prevention Through Environmental Design is a crime prevention strategy that focuses on reducing the incidence and fear of crime in planning and design of cities and neighbourhoods.
ESD	Environmental Sustainable Design
IWM	Integrated Water Management
GHD Project Team	Refers to GHD, RMIT & CRC For Water Sensitive Cities
GI	Green Infrastructure is a cost effective, resilient approach to managing wet weather impacts that provides many community benefits
Linear Parks or Linear Public Space Network	Corridors of public space, mainly along waterways and adjacent to road reserves that link together form a network
LPPF	Local Planning Policy Framework
Native vegetation	Plants that are indigenous to Victoria including trees, shrubs, herbs, and grasses.
Novel ecosystems	Man-made/ artificially created ecosystems, For example, the inclusion of artificial cavities in buildings, rockeries & wood piles/mulch in gardens and parks. Seeding native mistletoe in upper canopy of street trees to increase diversity of form
Passive Public space	Public space that is set aside for public space, gardens, linear corridors, conservation bushlands, nature reserves, public squares and community gardens that are made available for passive recreation, play and unstructured physical activity including walking, cycling, hiking, revitalisation, contemplation and enjoying nature
P&E Act	Planning and Environment Act
PIP	Precinct Implementation Plan

Private realm	Land that is privately owned and provides recreation, leisure, greening and cooling benefits, which may be publically accessible but have limited/restricted membership/fee-paying access. Examples include: non-government education facilities, private sports fields, golf courses, race courses, and private shopping areas. These areas can contribute to the public realm (e.g. biodiversity, amenities, landscape character)
Public Space	Land in public ownership and/or under public management that is freely accessible and provides recreation, nature conservation and leisure benefits. This includes public parks, gardens, reserves, waterways, linear corridors for walking and cycling, publicly owned forecourts and squares, and any publicly owned sporting venues. Typically reserved in the planning scheme as Public Park and Recreation Zone (PPRZ).

Street corridors (road reserves)	Primarily transport routes for vehicles, cyclists and pedestrians, recognised to have amenity, biodiversity, urban cooling and passive open space benefits. Considered complementary to the public space network, providing green links and movement corridors to improve access and walkability. Landscaped areas within road reserves (e.g. nature strips and medians) are maintained by Council and/ or adjoining land owners. These areas contribute to open space values, but they are not considered public open space, nor counted towards Council's required developer open space contributions.
Structured recreation	The activity is organised by a club, association, school or community group and participation is by becoming a member of the club or on a fee paying basis.
The Study	The Fishermans Bend Urban Ecology Study
Territorial reinforcement	Territorial reinforcement is the idea of modifying the environment to emphasis 'ownership' by particular social groups to support social control intended to encourage law-abiding behaviour.
ULE	Use Life Expectancy of trees
Unstructured recreation	The activity is not organised by a club or other group, where participation initiated by individuals.
Universal design	The designing of environments for people of all ages and abilities.

WSUD	Water sensitive urban design. A sustainable water management approach that aims to provide water quality treatment, flood management and green landscapes. Key principles include minimising water resistant areas; recharging natural groundwater aquifers (where appropriate) by increasing the amount of rain absorbed into the ground; encouraging onsite reuse of rain and incorporation of rain gardens; encouraging onsite treatment to improve water quality and remove pollution, and using temporary rainfall storage (retarding basins/ wetlands) to reduce the load on drains.

8. References

ASPECT Studios and Tree Logic. (2011). *Urban Forest Diversity Gudelines - 2011 Tree species selection guidelines for the City of Melbourne.*

Burden, D. (2006). *22 Benefits of Urban Street Trees.*

City of Melbourne. (2012). Urban Forest Strategy - *Making a great city greener 2012 - 2032.* Retrieved from City of Melbourne : www.melbourne.vic.gov.au/Sustainability/UrbanForest/Pages/ About

Davies, T., Bennie, J., Cruse, D., Blumgart, D., Inger, R., & Gaston, K. (2017). Multiple night-time light-emitting diode lighting strategies impact grassland invertebrate assemblages. *Glob Change Biol., 23*, 2641-2648.

DELWP. (2019). *The Urban Heat Amelioration Guidelines*.

Department of Environment, Land, Water and Planning. (2019). *Better Apartments in Neighbourhoods Discussion Paper 2019.* Melbourne: The State of Victoria Department of Environment, Land, Water amd Planning.

Ecological Society of America. (2020). *What is ecology?* Retrieved from esa: https://www.esa.org/about/what-does-ecology-have-to-do-with-me/

Ecological Society of Australia. (2012). *Urban Ecology.* Retrieved from Ecological Society of Australia: https://www.ecolsoc.org.au/groups/urban-ecology

Extent Heritage Advisors. (2017). *Aboriginal Cultural Values Interpretation Strategy.* Coburg, Victoria: Extent Heritage Pty Ltd.

Gallant, A. J., Jacobs, J. S., Tapper, N. J., & Li, D. (2018). Use of Cool Roofs and Vegetation to Mitigate Urban Heat and Improve. *American Meteorological Society,* 1747.

GHD. (2018). *Water sensitive city drainage strategy, flood storage recommendations and streetscape design* . Melbourne: GHD Pty Ltd.

Holcombe, S., Rimmer, M. and Janke, T. (2009). Australia's Biodiversity Conservation Strategy 2010-2020 Submission to the National Biodiversity Strategy Review Taskforce. *ANU College of Law Research Paper No.10-24.*

Longcore, T., Rodríguez, A., Witherington, B., Penniman, J., Herf, L., & Herf, M. (2018). Rapid assessment of lamp spectrum to quantify ecological effects of light at night. *J Exp Zool., 329,* 511-521.

Low Carbon Living CRC. (2017). *Guide to Urban Cooling Strategies.*

Monash University. (2016). *Caring for Country: An urban perspective.* Monash Sustainable Development Institute.

Planisphere. (2017). *Fishermans Bend Public Space Strategy.* Melbourne : Planisphere.

The Nature Conservancy and Resilient Melbourne. (2019). *Living Melbourne - Our metropolitan urban forest.* Melbourne : The Nature Conservancy and Resilient Melbourne.

Victorian State Government. (2018). *Fishermans Bend Framework*. Victorian State Government.

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GHD Pty Ltd

T: 61 3 8687 8000 E: melmail@ghd.com

Level 18 180 Lonsdale Street, Melbourne VIC 3000

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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