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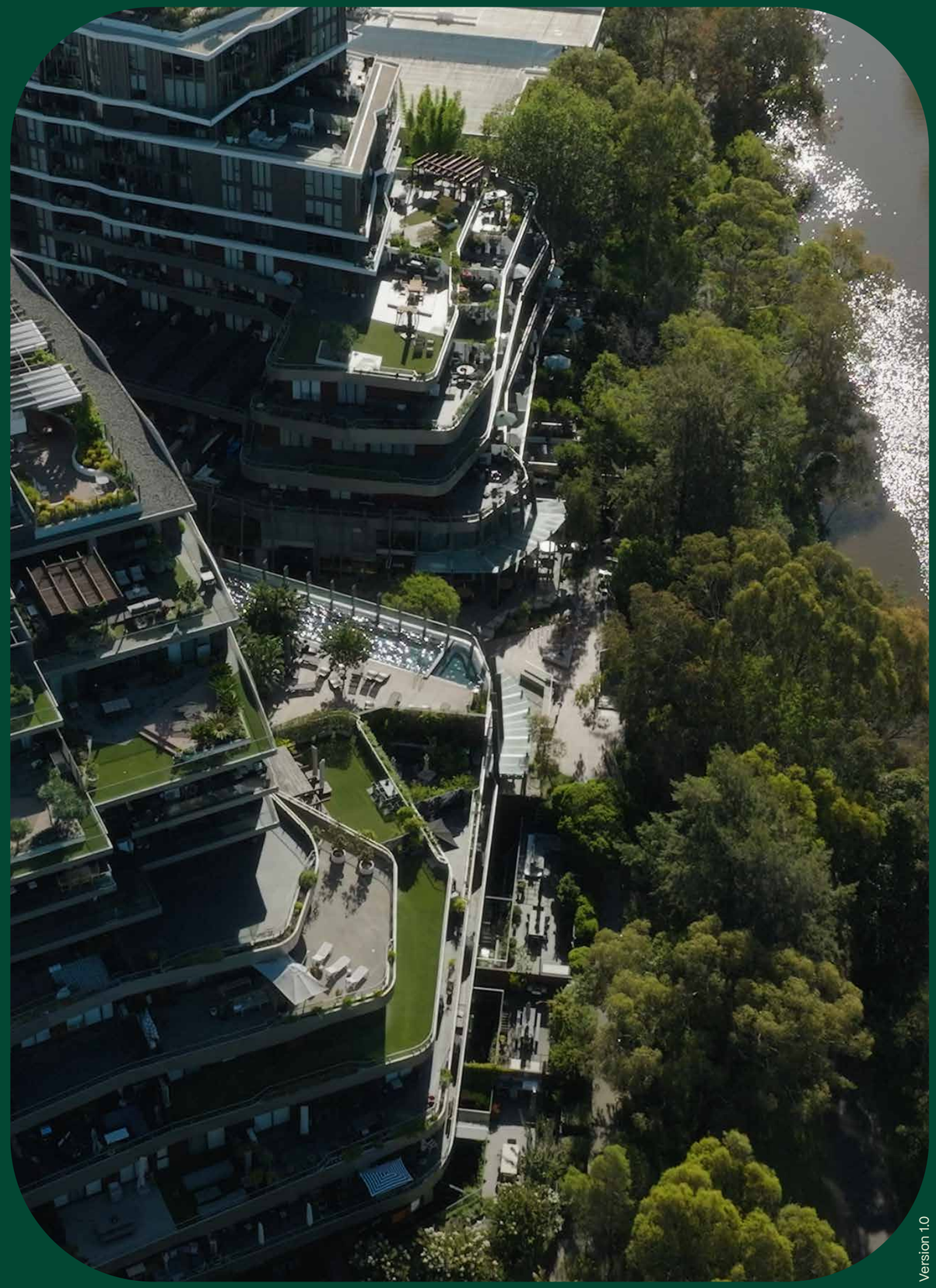
Design Guidelines

for Medium & High Density Residential Developments

Nature-based development excellence for better urban environments.



Nature Based Cities®

Version 1.0

Since time immemorial First Nations people have managed, cultivated and cared for the landscape and waterways where Australia was established and continues to grow. First Nations people hold profound knowledge, understanding, obligation and custodianship of these natural assets, and this is often expressed as Connection to Country.

As the oldest living and continually practiced culture on earth, we acknowledge the ongoing connection between Indigenous people and the Country of Australia, including our shared natural green spaces. We acknowledge the traditional custodians, and pay our respects to their Elders – past, present and emerging.

Acknowledgments

These guidelines were commissioned by Nature Based Cities, prepared by Tract and peer reviewed by Ark Resources and Nature Advisory.

Contents

01

Introduction

1.1 What are Nature Based Cities?

There are many emerging approaches to creating sustainable outcomes in the urban environment. But what works? Which are philosophical ideals, and which have meaningful outcomes?

The terms ‘biophilia’, ‘biodiversity positive design’, ‘re-wilding’, ‘nature-positive developments’ and ‘biodiversity sensitive urban design’ (BSUD) are but a few of the emerging terms employed worldwide to describe urban design movements to reduce ecological impacts and embrace nature in design.

‘Nature-based’ design synthesises sustainable, environmental, ecological, aesthetic and cultural values to set a direction for improving design outcomes.

Within multi-residential developments, the ‘Nature Based Cities’ design approach recognises the co-benefits for both humans and urban ecology when nature is successfully integrated into the urban fabric.

Nature based cities take every opportunity to increase green space over grey and design these green spaces to deliver multiple benefits for nature and people.

The University of Melbourne describes the importance of this ‘Nature-based city’ approach below:

‘Creating nature-based cities, in which green spaces are essential elements integrated in the urban fabric of our cityscapes, is critical for sustainable and liveable urban futures.’

Figure 1. Concept Sketch for 70 Southbank Boulevard.

1.2 What are the benefits to you as a developer?

The business case for investing in quality, well considered, green infrastructure is compelling. Consumers have been shown to pay up to 15% premium for green infrastructure in their dwellings, with multifunctional green space delivering the most benefits.[1]

Increase property value

A 10% percent increase in tree canopy cover across a suburb has been shown to increase property values in an area by 7.7 percent [2]

Improve marketability

Cooler – Urban greenery can drop temperatures by 4–8°C which will be critical for liveability as summers get hotter with more extreme heat days [3]

Healthier – Greenery can remove pollutants, provide mental health benefits and encourage active transport that can reduce traffic congestion. Biodiverse plantings can improve respiratory health and improve gut micro biota [4]

More comfortable – Trees can reduce wind impacts by up to 10% [5]

Perceptions of safety – Increased canopy cover has been linked to increased perceptions of safety [5]

Differentiate the development

Create a unique sense of place by using local species

Reduce operational costs

Reduce air conditioner use with savings estimated at between 12–15% per annum when trees and urban greenery are in place [5]

1. Zalejska-Jonsson et al, 2020, 2. AECOM, 2017, Urbis Research, 2017, 3. Cooperative Research Centre for Water Sensitive Cities, 2020, 4. Liddicoat et al, 2018, 5. Moore, 2019

1.3 What are the community benefits?

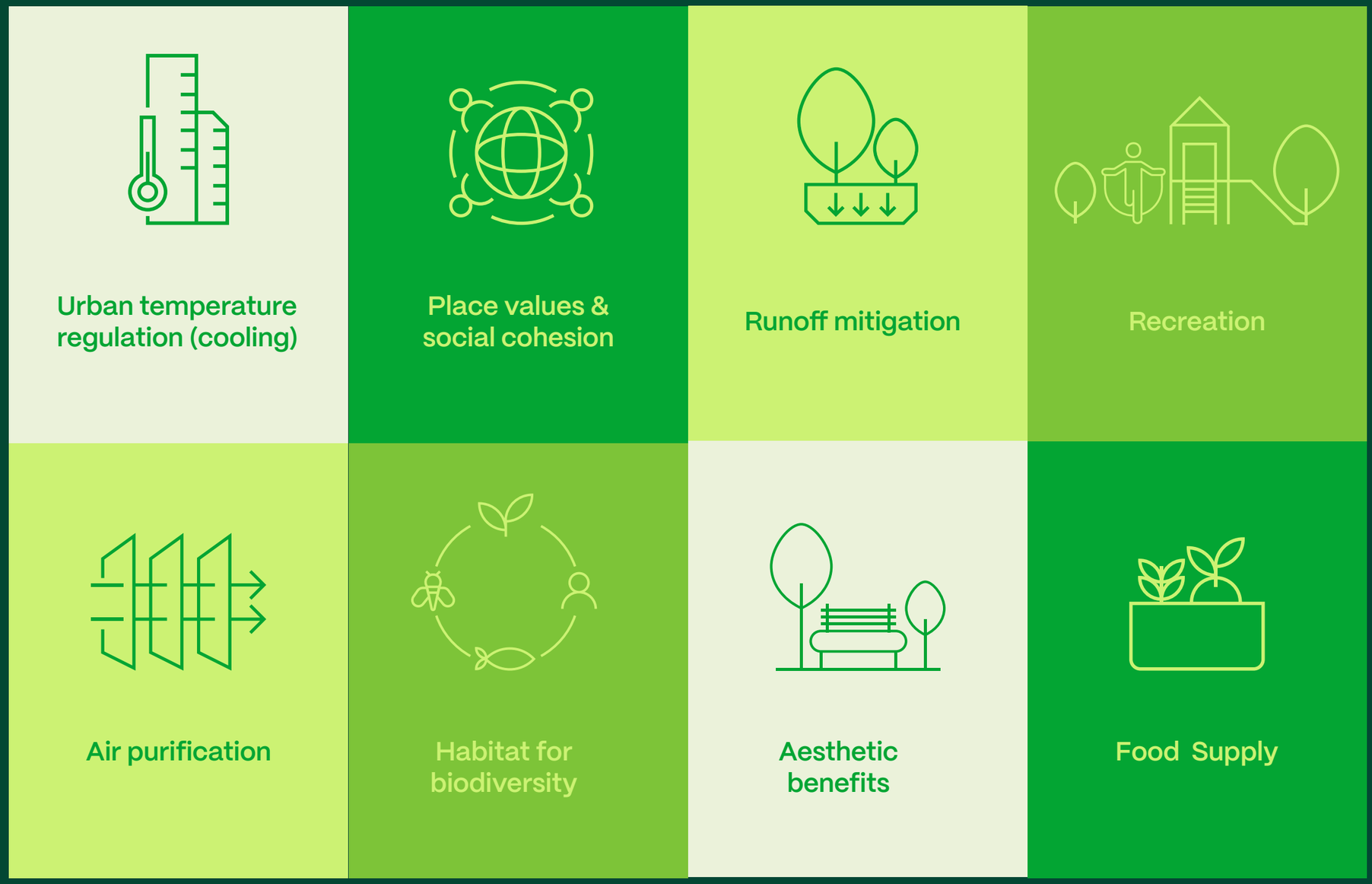
The Nature Based Cities framework and direction seeks to create thriving environments for the health and wellbeing of all its inhabitants. In the article 'Integrating Green Infrastructure into Urban Planning: Developing Melbourne's Green Factor Tool', the University of Melbourne has developed a framework for prioritising functional outcomes in urban green spaces.

These primary functions and associated benefits are:

- Urban temperature regulation (cooling)
- Habitat for biodiversity
- Runoff mitigation
- Recreation
- Air purification
- Place values & social cohesion
- Aesthetic benefits
- Food supply

There are, of course, other considerations and benefits for our urban environment, which include:

- Ecological enhancement
- Physical and mental health benefits
- Increased property value
- Carbon sequestration



1.4 Purpose of the guidelines

High-level sustainability and environmental aims are not often at the forefront of property developer's minds during the feasibility and early planning stages of a development.

Nature and living landscape outcomes are often applied much later in the design process and integrated as a way of 'dressing up' marketing images or satisfying technical development approval requirements.

These Guidelines seek to build upon leading academic research, strategic policy and industry recommendations to provide a series of practical design principles that Property Developers, Owners and their design teams can implement at project commencement and integrate into the urban form.

These guidelines are for medium and high density residential developments and can be applied to apartment buildings or townhouses on a single lot. Larger precinct-scale developments should use the Nature Based Cities Design Guidelines for New Communities.

At its core, the guidelines offer a range of methods, benchmarks and targets to enhance amenity and livability, increase biodiversity and improve climate resilience.

The guidelines present early design considerations alongside green infrastructure typologies and case studies.

An associated scorecard has been designed and should be used at the commencement of a project to set targets for the development and to brief your project consultant team. This scorecard can then be used for gaining your Nature Based Cities accreditation.

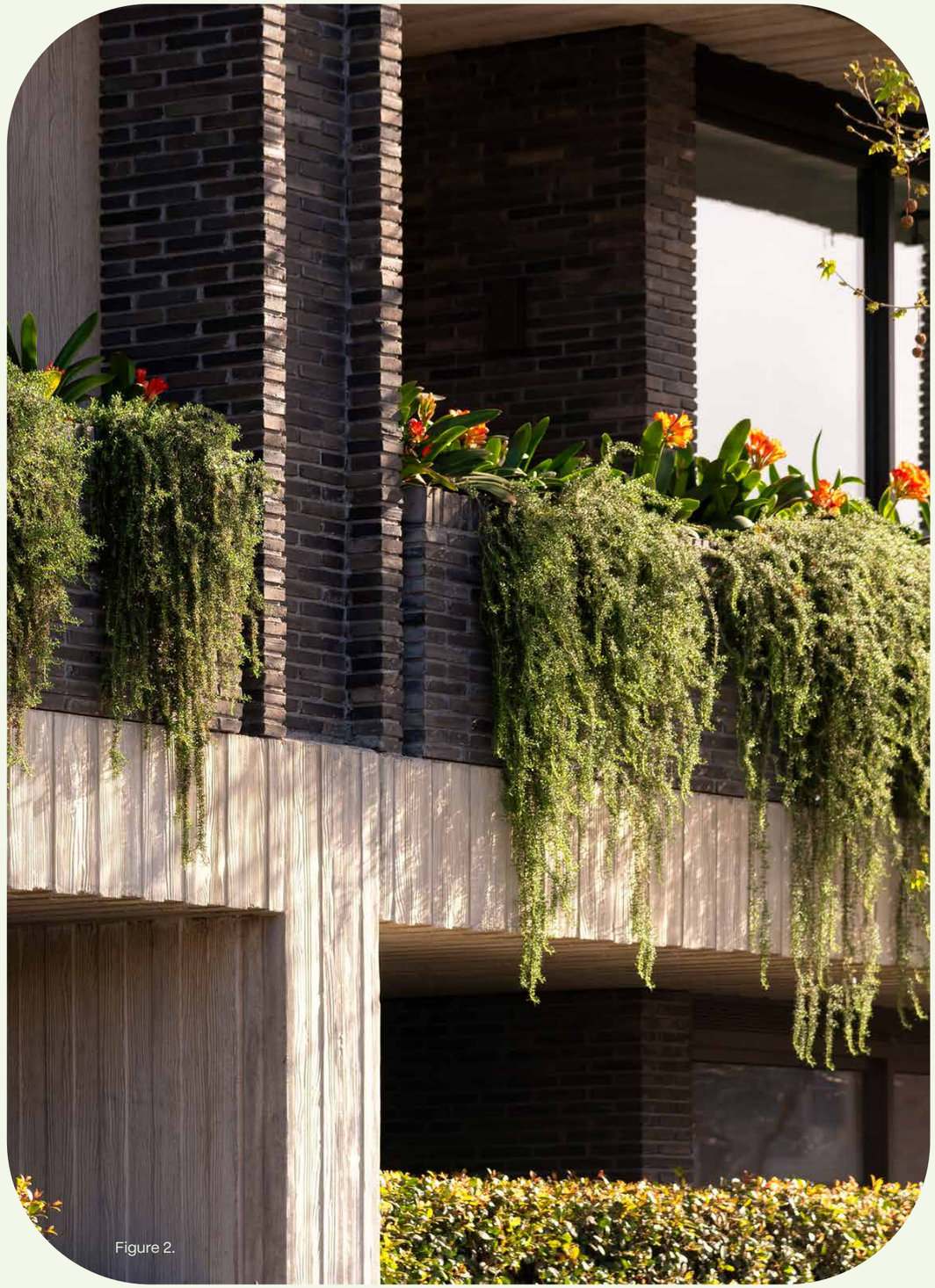


Figure 2.

Figure 2. Green infrastructure integrated into the street setting can create an aesthetically pleasing, functional and vegetated interface. Elwood House, Victoria.

02

Planning & Design Considerations

2.1 Early engagement

At project inception, consider the early engagement of key specialist consultants and stakeholders who can set a strong direction, narrative, and green/blue targets for the project holistically.

Do

- **Consult with arborists**
- **Engage landscape architects**
- **Collaborate with an ecologist**
- **Collaborate with Traditional Custodians to understand their traditional ecological knowledge of the site and surroundings. This should be enabled by a First Nations Engagement Strategy.**

Why

- Arboricultural consultation determines which trees have high and moderate values and those with structural integrity (safe, useful life expectancy). An Arborist will determine appropriate tree protection zones, which may affect the setback and site planning, including neighbouring properties. Early engagement with the Arborist will also assist with providing suitable construction techniques to integrate the landscape with the built form.
- A Landscape Architect can identify landscape opportunities, setback requirements, open space programming, place / character themes to differentiate your development and establish a framework for the landscape contribution. Your Landscape Architect will also implement an appropriate planting regime to enhance the native vegetation and habitat to support biodiversity.
- Your Ecologist will consider broader canopy connections, corridor links, ecological assessment strategies, green building certifications, biodiversity targets and offset strategies and work with your Landscape Architect to improve the biodiversity outcomes of the site.
- Collaboration with First Nations, indigenous people encourages integration of key site values, expands spatial awareness of land form and integrates language, uses and management issues for the site.

The following page is a design process ‘flow chart’ to assist with navigating the nature-based city design process:

Figure 3. Connect existing green corridors through the site.

Design and engagement process

Appoint Head Consultant

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Undertake Feature Survey

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Undertake Design Feasibility phase with input from whole team, including:

- Site Analysis
- Identification of existing biodiversity values and enhancement opportunities.
- Topographic Profiles
- Soil Analysis
- Urban Design Analysis
- Blue/Green Design Opportunities

↓

Commence Site Planning & Schematic Design phases and implement 'Nature Based' targets/benchmarks

Appoint Key Secondary Consultants:

- Town Planner
- Landscape Architect
- Arborist
- Ecologist
- Engineers
- First Nations Advisors

Leadership Workshop

Agree on Nature Based City landscape targets as appropriate to the site & market.

Seek preliminary input from specialists, external consultants & stakeholders, such as Cultural Heritage advice.

2.2 Local characteristics, climatic conditions, soil type & topography

Figure 4. Typical early phase design principles

Fundamental to designing with nature in our cities is an understanding of the prevailing site characteristics.

This is, however, complicated by factors such as our changing urban context, climate change and ambient air temperatures. Some areas, for example, may readily support tree establishment – such as those with good rainfall and drainage.

However, other areas may require greater measures and design initiatives such as those areas with clay soils, subject to flooding or where within potential rising sea levels.

Typical early phase design principles as per figure 4.

A. Integrate the topography and land form into the design.

B. Integrate key vistas of vegetation and landscapes.

C. Provide adequate in-ground and above ground canopy setback to highly valued trees.

Do

- Undertake a rigorous site analysis, including key vistas
- Enhance & protect key landscape features
- Work with & integrate the topographic, soil and hydrological site conditions
- Work with specialists to understand the local climatic (heat, flooding, wind) impacts, including the development of a range of site responsive mitigation techniques and locations
- Undertake a soil test for plant growth & performance characteristics early in the process

2.3 Precinct planning & urban context

At an urban or municipal scale, planning for nature at this level will assist with developing the overall landscape character, recreational and social outcomes of the site as well as enhancing biodiversity connections. The consideration of a broad design framework can improve biodiversity corridors, enhance scenic vistas and embed the built form into the environment.

Do

- **Protect existing significant vegetation**
- **Connect to surrounding green and blue corridors**
- **Enhance local ecosystems using diverse, endemic species**
- **Integrate multiple green 'layers' and green infrastructure throughout**
- **Front onto open spaces**
- **Co-locate compatible uses to support wildlife**

Consider

- **The retention of large, canopy trees.**
  Large canopy trees can promote an individual landscape character, enhance shade and site cooling, retain carbon in the soil; and provide significant, often irreplaceable habitat for an array of indigenous fauna species.

- **Strengthening green corridors and biolinks**
  Locate new open spaces to connect with existing corridors, waterways, parks, habitats or other functional ecosystems.

- **In-ground planting.**
  Continuation of tree canopy and understorey planting through the street network and within the public domain can provide wildlife corridors and improve biodiversity, people's visual and physical connection to nature and amenity of the built form.

  Diversifying the plant schedule with a variety of species and lifeforms (trees, shrubs and groundcovers) will increase the suitability of the habitat for a range of fauna species, thereby enhancing biodiversity values on site.

- **Enhancing water infiltration.**
  Site planning with integrated water management systems (such as capturing site runoff, rainwater storage, street water flow diversion and passive irrigation techniques) improves the soil condition and improves water quality downstream.
  This will require consideration of spatial planning at various levels including basement, ground and upper levels.

- **Safe wildlife movement across barriers.**
  Consider providing links to the broader context, which may include contiguous street tree canopy, green roofs, habitat bridges, tunnels etc.

- **Co-locate compatible uses.**
  Provide compatible social uses with sensitive landscape features. For instance, many birds and mammals need natural light, low artificial light and low noise levels. It may be more appropriate to co- locate a community library next to an existing large tree, rather than a restaurant.

2.4 Town planning requirements and considerations

Your design team will be well versed in the regulatory design criteria.

To be successful, development applications need to satisfy certain contextual, planning, built form and spatial requirements.

Nationally, there are numerous objectives and assessment tools in Australia, seeking to enhance design outcomes, but which regularly change depending on the use, location and context. Some of these considerations include:

A Strategic planning

B Statutory planning

C Assessment tools

These nature-based design guidelines have been designed to complement and enhance existing policy directions, objectives and tools. The following recommended principles and targets draw upon leading industry directions and best practice to elevate your development's marketability and long-term occupant comfort and amenity, beyond compliance matters.

A

Strategic Planning

- Urban Design initiatives and frameworks
- Sustainable building policies
- Urban Forest strategies
- Biodiversity in Cities strategies
- WSUD strategies

B

Statutory Planning

- Planning scheme objectives and benchmarks
- Permeability %
- Open space %
- Deep soil %
- Communal open space areas and locations
- Integration of encumbrances (drainage, easements etc.)
- Canopy cover

C

Assessment Tools

- Green Star Rating
- Green factor tool
- Climate Positive Design – Pathfinder app

2.5 Existing vegetation

The retention of mature, contributory vegetation is a key component of any new design. In many instances, trees and existing vegetation can have high amenity, ecological, historical or cultural value, beyond safe, useful life expectancy (arboricultural value).

It is important to engage an Arborist at the commencement of the project to assess existing trees and provide useful information such tree protection zones (TPZs) to inform the design.

Your Landscape Architect can assess the merits of the character of existing vegetation, whether it is suitable within an urban environment and affords good long-term amenity for the future occupants.

An Ecologist can assist in understanding the habitat value of existing vegetation. They should be engaged to undertake a preliminary site assessment to understand the existing biodiversity values within and surrounding the site, and provide meaningful advice to achieve biodiversity enhancement outcomes.

Do

- **Engage an Arborist to assess existing trees prior to the commencement of design**
- **Engage an Ecologist to advise on habitat value of existing vegetation**
- **When evaluating trees to be retained, consider habitat value as well as useful life expectancy (ULE)**
- **Locate existing trees in publicly accessible spaces**
- **Provide adequate setbacks at and below ground level and at canopy level**
- **Minimize encroachment into the Tree Protection Zone (TPZ)**
- **Not impact the water percolation in existing TPZ's nor excavate into Structural Root Zones (SRZ)**

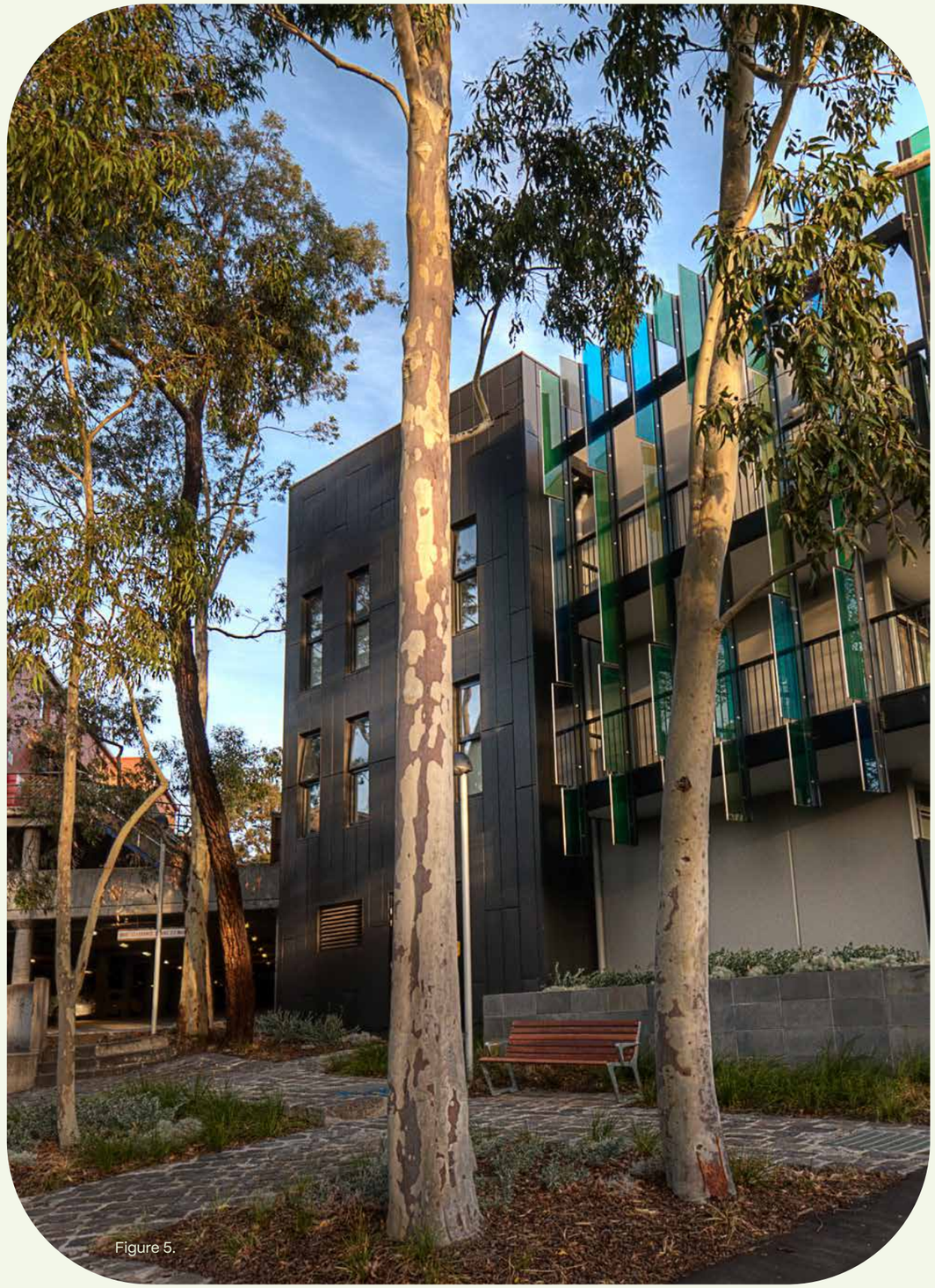

Figure 5. Existing trees can assist with grounding the building scale and strengthen carbon capture, habitat and character. St Johns Place, North Melbourne, Victoria.

2.6 Site planning targets

At the commencement of design, set urban design and landscape targets that respond to the site context. These targets seek to improve vegetative outcomes and can be used to measure environmental performance. However, sites will vary depending upon factors such as size, topography, hydrology, cultural heritage value, function and user groups.

The following section offers a range of targets and 'rules of thumb' that can be applied during the feasibility and site planning phases of your project:

A. Tree targets

B. Open space targets

C. Tree coverage target

D. Tree replacement ratios

E. Biodiversity target

A

Tree targets

Implement the 3:30:300 target [1] for a minimum provision of urban trees in urban communities:

- Views to 3 trees from every home
- 30 percent tree canopy cover in every neighbourhood
- 300 metres from the nearest public park or green space

1. Kanijnendijk et al. (2022)

B

Open space targets

Your spatial requirements will often be mandated by planning scheme principles & objectives (refer section 2.4).

In an urban environment and to provide sufficient connection with nature, it is recommended that:

- A minimum 7.5% of ground floor space be dedicated for passive and active public open space uses

C

Tree coverage target

Tree canopy cover is a measure of the physical coverage of the tree canopy over the land. It represents how much of any given area is shaded by trees and is a better indicator of urban resilience rather than quantity of trees. Your landscape architect can assist with the calculation of this measure.

- For a highly encumbered site aim for a minimum: 15% tree coverage (ratio over the total site area)
- For a less encumbered or larger site aim for at least: 30% tree coverage (ratio over the total site area)

D

Tree replacement ratios

As tree growth offers high carbon sequestration and not all trees will establish on site (due to various conditions), it is recommended that:

- For every tree removed, replace the tree at a ratio of 3:1

E

Biodiversity target

Through both the early and detailed design phases, consider integrating biodiversity targets.

These include the indigenous and diversity planting targets set out in the Nature Based Cities scorecard, and further enhancement considerations outlined in Section 2.10 Ecological Principles in Landscaping.

Your ecologist can recommend appropriate biodiversity targets based on the preliminary site assessment.

2.7 Conceptual design and development

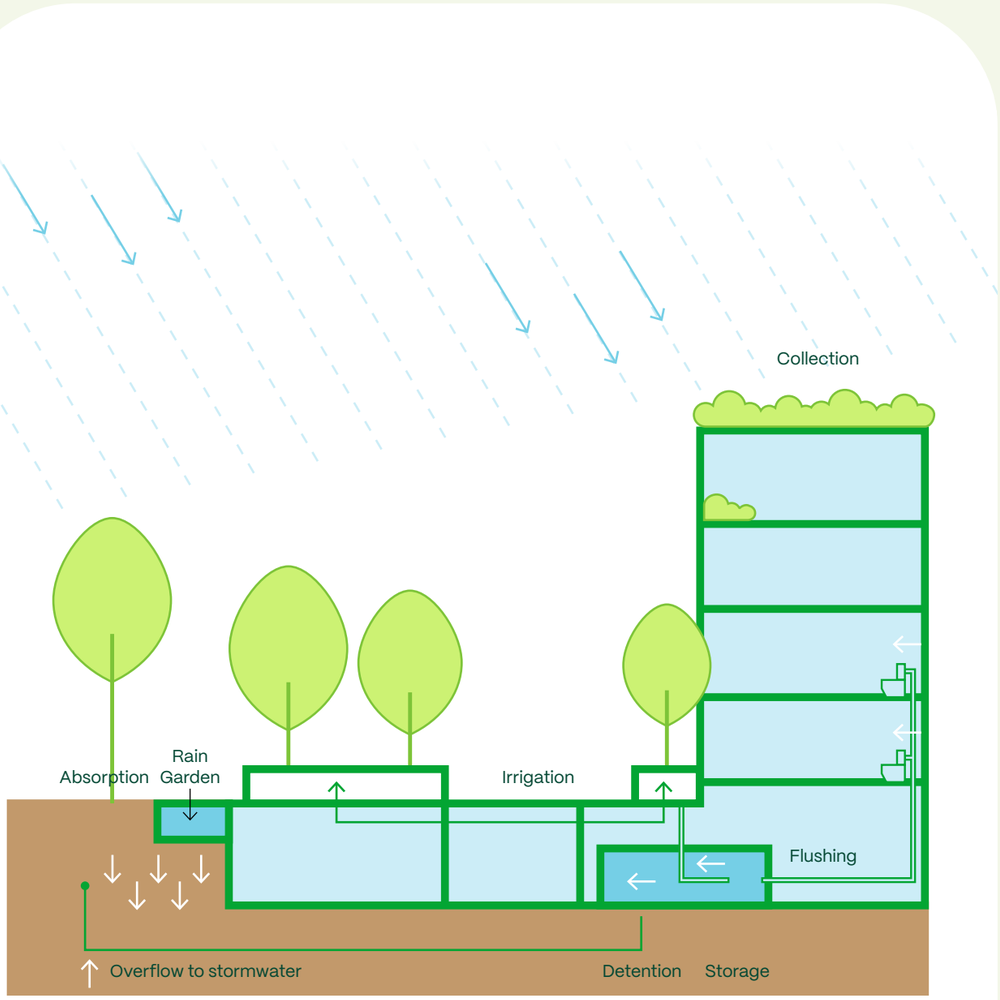

Figure 6. Provide sufficient building setbacks for root development & in-ground water infiltration.

Upon addressing the site fundamentals and broad planning approach, the design will be refined and informed by greater detail and technical input by the consultant team. Your landscape architect will seek to create an appropriate landscape setting with differing functional spaces.

Do

- **Minimise the building footprint**
- **Set back building footprints for both new and existing trees**
- **Create key view lines and framing opportunities for enhanced visual connections**
- **Provide space for large spreading canopy trees**
- **Provide for in-ground planting opportunities with good solar orientation**
- **Include layered, understorey planting, vegetation strips and buffers to all buildings edges**
- **Provide opportunities for vegetation in the private realm**

Throughout the design process, consider:

Deep soil planting

Provide deep-soil planting as appropriate to the site. This can be integrated by providing adequate building footprint setbacks to enable root and canopy development or through basement setdowns to permit adequate soil volume.

Orientation

Many species (including people) need sunlight. Ensure north-facing open spaces for both planting and communal living are included in the external design environment.

Reduce lawn areas

Focus upon planting areas rather than lawn as this requires more maintenance and thus incurs higher operational costs.

Lawns result in environmental damage to both beneficial insects and soil; whilst establishing environments that encourage pest birds.

Urban temperature regulation (cooling)

Provide building setbacks to permit spreading canopy trees. Allow for planting areas directly adjacent to hard landscape areas (such as driveways) to permit canopy trees to overhang, shade and cool dense materials with high thermal properties (such as concrete).

Habitat for biodiversity

Retain habitat trees to encourage shelter and food for fauna; and to encourage pollinators. Similarly, improve biodiversity and restore nature (the local ecological system and environmental vegetation communities, EVCs), rather than obtain offsets.

Runoff mitigation

Provide for a dedicated 'blue' area for water permeability and percolation (as distinct from recreational areas), which takes into account the natural topography or low point of the site. Enhancing the character of the 'blue' site initiatives can assist with education, caring for the environment, conserve water use, minimize applied irrigation and maintenance costs.

Recreation

Provide a variety of spaces to access and accommodate a diverse range of recreational activities, including passive/active, for people in different age groups and spaces that can be utilized at different times of the day or night and across the seasons. These spaces should have differing levels of hierarchy/ public interfaces, with thresholds and transitional spaces to be welcoming and comfortable.

Air purification

Inclusion of various forms of green infrastructure throughout the site will embody different vegetated responses and leaf characteristics. This has the potential to improve air quality through the diversity of plant species through transpiration.

Place values & social cohesion

Strong connections beyond the site, early engagement of the Landscape Architect and a range of differently sized and orientated spaces can permit a strong landscape character to be established. This has the potential to create a unique environment, which the community can relate and feel close to.

Aesthetic benefits

A range of differently sized and orientated spaces will permit the establishment of a variety of species with differing forms, colours, leaf characteristics, solar penetration, shading etc.

Food Supply

Consider a dedicated area for food production and/ or pollinators (such as beehives), which incorporate good solar orientation, maintenance areas and materials/equipment storage.

Strategic and Multifunctional Green Infrastructure Design

Features should be designed to optimise ecosystem service benefits taking account of the sites deficiencies, and opportunities. Features should aim to be multifunctional and provide multiple benefits. For example, buffer planting along a road can reduce air pollutants reaching the site, while also reducing noise, providing a green corridor for wildlife, and recreation corridor for people.

Avoid

- **Blank vertical walls abutting hard horizontal surfaces as this reduces the 'grounding' of the building in a green surround and encourages both pest birds, visual debris and waste.**
- **Perforated façades with large holes that encourage nesting or perching of pest birds.**
- **Imported materials that have high carbon footprints and extensive supply chains.**

2.8 Greening beyond the site

When starting the design and planning for your new project, consider how public space adjacent to your site could be transformed into a 'living' street, where underutilised road reserve and 'low value' space is reclaimed as green space.

The interface between private and public space can be recalibrated to create usable space with deep soil for pocket parks, as well as extensive canopy and verge greening. These spaces will support movement for both wildlife and people. This will require a partnership with Council.

Benefits

- **Nature connectivity gains**
- **Impervious surfaces increase (20–60%+)**
- **Shade potential increases (20–40%)**
- **Incremental usable common green space and liveability gains for people and biodiversity**

Example strategies

- Work with Council to consider the creative use of private setbacks and public road reserve to create additional usable space, close or narrow roads and pavements, reduce traffic speeds, alter traffic flows to support greater movement for pedestrians and cyclists.
- Design larger core habitat areas with small habitat 'stepping stones' and corridors between them.
- Mixed tree species on a street to allow placement of the maximum tree size, rather than being limited to a small tree size under power lines.
- Maximise trees and green cover in non-standard configurations to allow vegetation where deep soil exists or can be created, such as outstands, blisters, double rows or medians.
- Reduction in hard surfaces for incremental greening, such as pavement cut outs or removal of portions of kerbside pavement allocated for on street parking and a reduction in driveways to protect deep soil for trees.
- Verge planting to existing nature strips.
- Provide multi-layered planting from ground level up to canopy to cater for different species.
- Permeable paving and rain gardens.

Figure 7. A pocket park in medium to high density areas created by reclaiming part of the road reserve.

2.9 Biodiversity inclusive developments

Each type of green infrastructure should be designed to build biodiversity, as well as meet human needs. Why?

1. To stay ahead of legislative requirements: The criticality of biodiversity is being recognised at a national and international level. The UK Government has introduced a biodiversity net gain requirement for small and large developments and the Australian government is pursuing a nature repair agenda. Greater expectations for biodiversity improvement for Australian developments are likely.
2. To protect threatened species: 30% of Australia's EPBC-listed threatened species occur in cities (approximately 370 species).

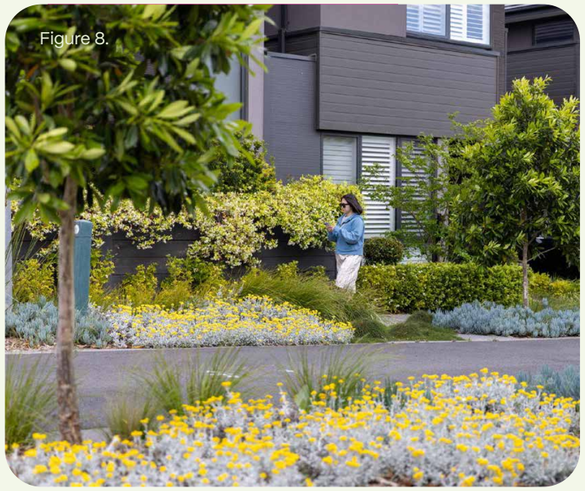

Figure 8. Shrub and groundcover planting to the nature strips at Alphington, Victoria.

To build healthy biodiversity in your developments:

- Consider adopting a Biodiversity Sensitive Urban Design process as part of your development process using resources such as Biodiversity Sensitive Urban Design Guides (see the Appendix).
- Engage an ecologist at project inception to help the team understand the risks and opportunities for wildlife on the site, and identify flora and fauna species the site can be designed to support.

The ecologist will partner with the landscape architect to maximise the landscape design for biodiversity and other ecosystem services, such as reduce wind and heat. An ecologist can help the team carry out an ESD assessment against Green Star and/or other benchmarking and undertake pre and post occupancy evaluations for biodiversity. The ecologist can also:

- Integrate biodiversity measurement into post occupancy measurements.
- Ensure the brief to a landscape architect outlines the importance of building indigenous biodiversity into the design.
- Work with the landscape architect to:

1. Retain quality, remnant existing trees and vegetation. Existing vegetation with high biodiversity value should be protected. A minimum 50% of high value biodiversity must be retained to achieve Green Star compliance.
2. Prioritise indigenous species, provide structural and species diversity in plantings and provide strong understorey.
3. Increase space for nature by taking every opportunity for creating additional planting.
4. Remove invasive plant species.
5. Connect planting to other vegetation outside the site.
6. Reduce risks for nature such as light pollution and window strike for birds.
7. Provide habitat features, such as hollows and rocks. These can be designed as artistic and sculptural elements.
8. Provide water sources such as a pond that wildlife can access.

2.10 Ecological principles in landscaping

When designing landscaped areas, the aim should be to enhance the site for biodiversity. This can be achieved by providing complexity in structure, a variety of habitat niches, a species palette that is diverse and flowers throughout the year, and a wilder naturalistic planting design. Considering these factors will help to optimise the value of the site for wildlife.

Achieving complexity of planting structure, and variation of soil conditions and substrates, can be more important for biodiversity than the choice of plant species alone. This should be a priority in any landscaping seeking to provide for nature.

It is important to follow the Mitigation Hierarchy when designing a site, with guidance from an ecologist:

1) avoid, 2) minimise, 3) restore, or 4) offset biodiversity loss.

Improving a site ecologically can be achieved by:

- Providing a variety of characteristics in planting, including different types of habitat such as woodland, scrub, grassland areas, as appropriate to the local area;
- Deliver structural complexity and resilience by:
    - selecting plants with a variety of shapes and sizes, including plants with a range of flower forms;
    - introducing a diverse selection of species capable of producing flowers, fruits and seeds, as well as providing shelter and food sources throughout the year;
    - planting in clumps and designing in layers, mimicking natural habitats and establish a dynamic plant community.
- Incorporate features that support the needs of local wildlife with input from an ecologist, such as priority habitats, bird/bat boxes, specific food plants for birds, mammals and invertebrates.
- Aim to create a self-sustaining, regenerative, and adaptive ecosystem, rather than an assortment of plants chosen only for their aesthetic appeal. Species or varieties that can self-seed and shift with the conditions and seasons should be used. This can include both indigenous species and appropriate non-invasive exotic species.
- Allowing vegetation to naturally succeed often leads to the establishment of a self-sustaining, well-functioning ecosystem. These species may be different to those that historically occurred naturally on the site but are well adapted to the present conditions. This can be achieved through relaxed or minimal management, which also reduces maintenance costs.
- Natural processes should also be promoted into landscaping schemes as this will improve biodiversity, resilience, and ecosystem function. This includes processes such as decay, competition, and disturbance. Fallen and standing deadwood including large dead branches/stems should be included to provide a variety of niches. Direct seeding can help to promote natural competition, resulting in more resilient planting.
- Providing of a range of substrates, and varying topography across the site will help to enhance structure, create different microclimates, and increase the number of different niches available on the site. The provision of loose soil mounds, decomposing vegetation heaps, and rock and deadwood piles on site will provide shelter for a range of invertebrates and other fauna, and function as hibernation sites.
- In urban areas, many natural tree hollows have been lost, creating a limiting factor for many dependent species. Provision of artificial nesting and roosting habitat structures can mimic these features, and therefore provide significant benefits to urban wildlife.
- Deadwood sourced from trees felled on site can be used to create habitat features. This could include custom made hollowed logs, attached to retained trees. Standing up sections of trunk or branches, drilled with holes creates a bespoke ”bee post” to attract native bees. The buried parts of the trunk retain moisture, providing habitat for soil fauna.
- Design outside lighting to be sensitive to nocturnal fauna including bats. Preserve or create dark areas and corridors across the site, particularly in areas of valuable habitat.
- Water points for wildlife are essential features and should be included on site where possible, e.g. bird baths, rock pools, ponds. Any new water feature should be created with naturalistic sinuous and sunken margins, with shallow edges where possible.

Figure 9.

Figure 9. Standing deadwood can create bespoke bee posts, John Little, Grass Roof Company

2.11 Post occupancy performance

Post occupancy performance and assessment of nature-based design projects is relatively uncommon and a developing area.

An evaluation after construction and upon vegetation establishment has potential benefits for:

- Informing the broader industry
- Improving the design, implementation and management of similar projects or strategies
- Assisting with on-going facilities and operational management
- Maintaining or securing long term tenants or enhancing purchases and sales
- Optimising efficiencies in utility and water consumption to minimise costs (in terms of irrigation, grey water, tank performance etc.)

There are two main approaches that could be taken to assess the project performance – namely technical assessment and community value.

Measurements, monitoring and counts for items such as air temperature, species support and biodiversity monitoring etc., can form part of a 'Biodiversity management plan'. This is typically undertaken by a qualified Ecologist and should be implemented during the design and documentation phases to influence the design outcomes.

Importantly, the evaluation should also include any remedial actions or improvements as part of the long-term strategy for the site – as microclimates, weather patterns and landscapes change over time.

Long term monitoring and maintenance is essential to achieving the goals set out in the Biodiversity Management Plan, which should form part of the contractual agreement for the future management of the site. This will ensure that habitats created are locally relevant, ecologically functional and contribute all the benefits targeted over the long term.

If habitats are not appropriately managed, particularly those that are more complex or difficult to create, then proposals may not achieve the intended targets for biodiversity and ecosystem services. Management will have to be adapted to deal with any unintended consequences such as vermin or pest species occupying areas intended to enhance biodiversity. Maintenance should employ sustainable horticulture practices to minimise off-site ecological impacts.

Occupant surveys can also form part of the evaluation and be based upon the health and well-being benefits established in section 1.2.

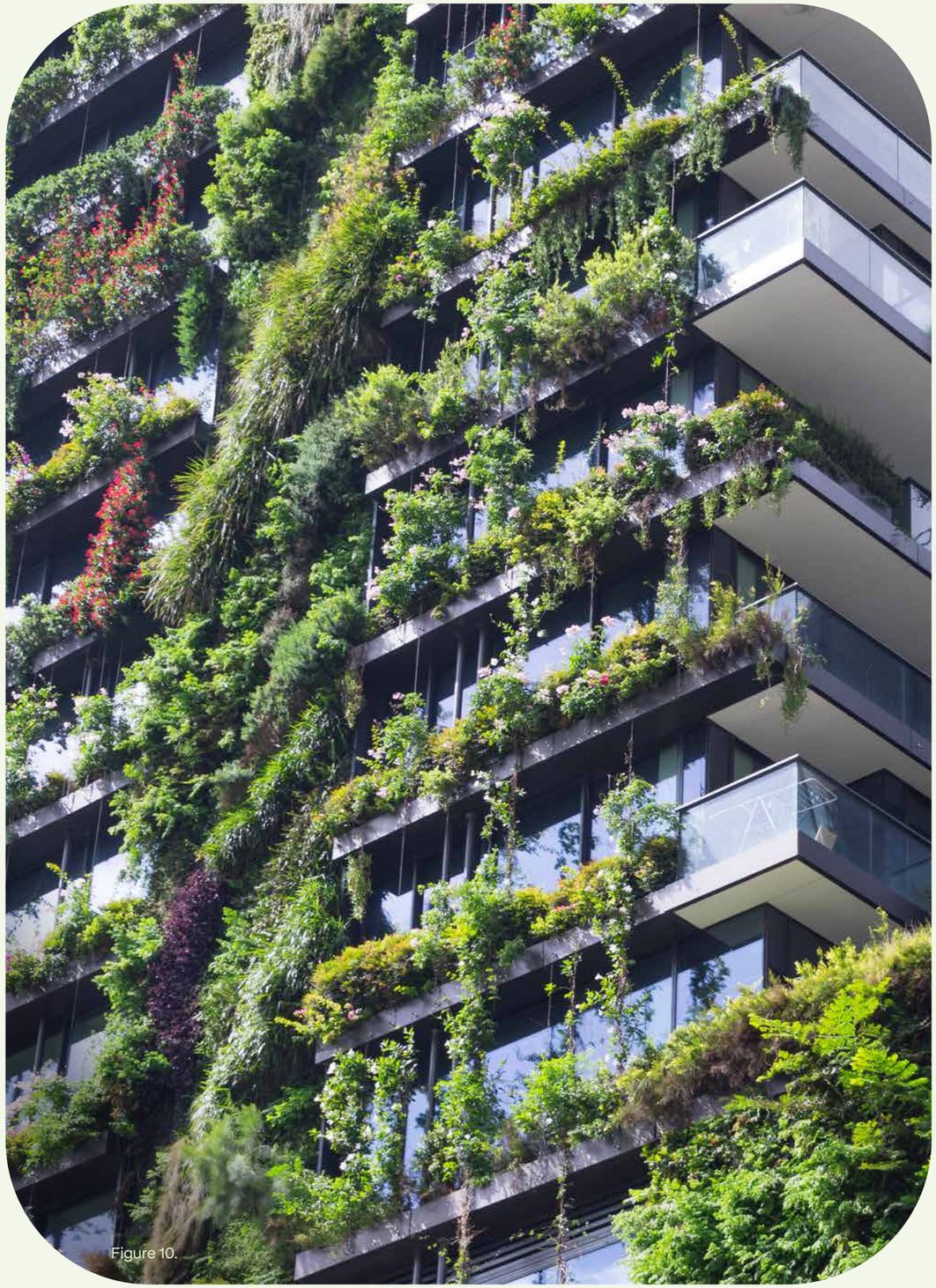

Figure 10.

Figure 10. Monitoring the implementation of built projects can offer valuable lessons. One Central Park, Sydney, New South Wales.

2.12 Government funding and grants

Various climate change, energy reduction, ‘cool city’ urban forest funds or environmental grants may be available at a local or state government level.

Consider the avenue of funding, incentives programs and resources which may be available to you for implementation.

Also consider partnering with local authorities to provide greening to nature strips and public land adjacent to your site.

Figure 11.

Figure 11. Westmead Hospital, Westmead, Sydney, New South Wales. Image by Brett Boardman.

03

Types of Green Infrastructure

3.1 Integrated water management

This section outlines the various types of vegetation infrastructure that can be incorporated into new building design. Advantages of each type of vegetation system are included, together with a broad scale understanding of cost solutions.

The cost benefit should also consider potential energy savings, reduced maintenance costs & water storage infrastructure (which is beyond the scope of these guidelines).

Figure 12.

At the outset, incorporating integrated water management ('blue' systems) and water sensitive urban design initiatives (WSUD) is a key objective across all planning, landscape and building design outcomes and at all scales of development.

Storing, harvesting, and treating stormwater and enhancing percolation into the ground plane are key targets for most of the current sustainable building tools and check-lists. This works jointly with vegetation objectives and outcomes. The types of WSUD initiatives integrated into urban buildings typically include passive irrigation, rain gardens, tree soakage pits, rainwater capture, storage and harvesting.

Whilst grading of paving to passively irrigate in-ground garden beds is typical in the documentation, rain gardens (or bio-retention systems) have the biggest spatial and visual character impacts on the site planning. Rain gardens are designed to capture the stormwater run-off, which is filtered through selected garden bed media and 'reedy' style plants to remove nutrients and toxins from the water, prior to exiting the site.

Rain gardens should be designed in consultation with landscape architects and engineers to ensure the hydraulic and visual functioning is appropriate. They should be in a publicly accessible location, typically along prevailing drainage lines or at low points of the site and with an available depth of 800mm.

As they require ongoing maintenance and removal of the filter material, rain gardens will need to be reasonably accessible via a maintenance vehicle.

Where there is a high level of circulation required or opportunities to extend into the streetscape, the design should consider and plan for passive irrigation pits to enhance tree canopy and establishment. This integrates paving, road surfaces and kerbs to direct the water run-off into a soakage pit to irrigate specimen trees.

Waterbodies and water sources should also be considered for their ecological importance.

- Water bodies of various forms can provide huge value to biodiversity and should be incorporated where possible
- Features should be interconnected, for example, blue/green roofs could percolate rainwater to green walls and to ground level
- Water features should be multi-functional and provide co-benefits such as diverting and slowing storm water, storing it, and delivering it to planting, as well as being designed to provide habitat and aesthetic/amenity value

Figure 12. Integrated rain gardens can offer attractive environments and build habitat. Acacia Place, Abbotsford, Victoria.

Case Study: The Drying Green

Location: Gadigal Country, Zetland NSW

Developer: City of Sydney

Landscape Architect: McGregor Coxall

Completed: 2022

Nature based features:

A series of cascading wetlands harvest and treat stormwater from trunk drain before returning to stormwater system and ultimately Botany Bay.
Local aquatic plants provide habitat for local fauna.

Key takeaways:

- Integrated water management can reflect the site's history and hydrology with references to past waterways.
- Integrated water management can be a visually appealing feature and sculptural form when designed well.
- Interpretive signage can assist in educating the public about the benefits of nature-based design.

Links:

https://mcgregorcoxall.com/project-detail/311
https://landscapeaustralia.com/articles/the-drying- green/

Figure 13. The Drying Green

3.2 Existing in-ground conditions

As noted in the above section, remnant and existing trees can contribute significantly to the landscape amenity of an area and provide instant visual appeal and ‘marketability’ in new developments. They can cool new buildings as well as sequester carbon in undisturbed soil and aid filtration of water runoff.

Further, retention of existing trees in-ground can improve soil conditions and biological plant processes. The ground plane is primary habitat for a range of beneficial insects and pollinators- leading to improvements across the entire ecosystem.

Retention of existing trees is always preferable to planting new trees which can take a long time to establish and provide the benefits that existing trees are already providing. Some trees are ‘irreplaceable’ from a fauna habitat perspective as hollows can take 100-200 years to develop.

Implementation cost: Minimal

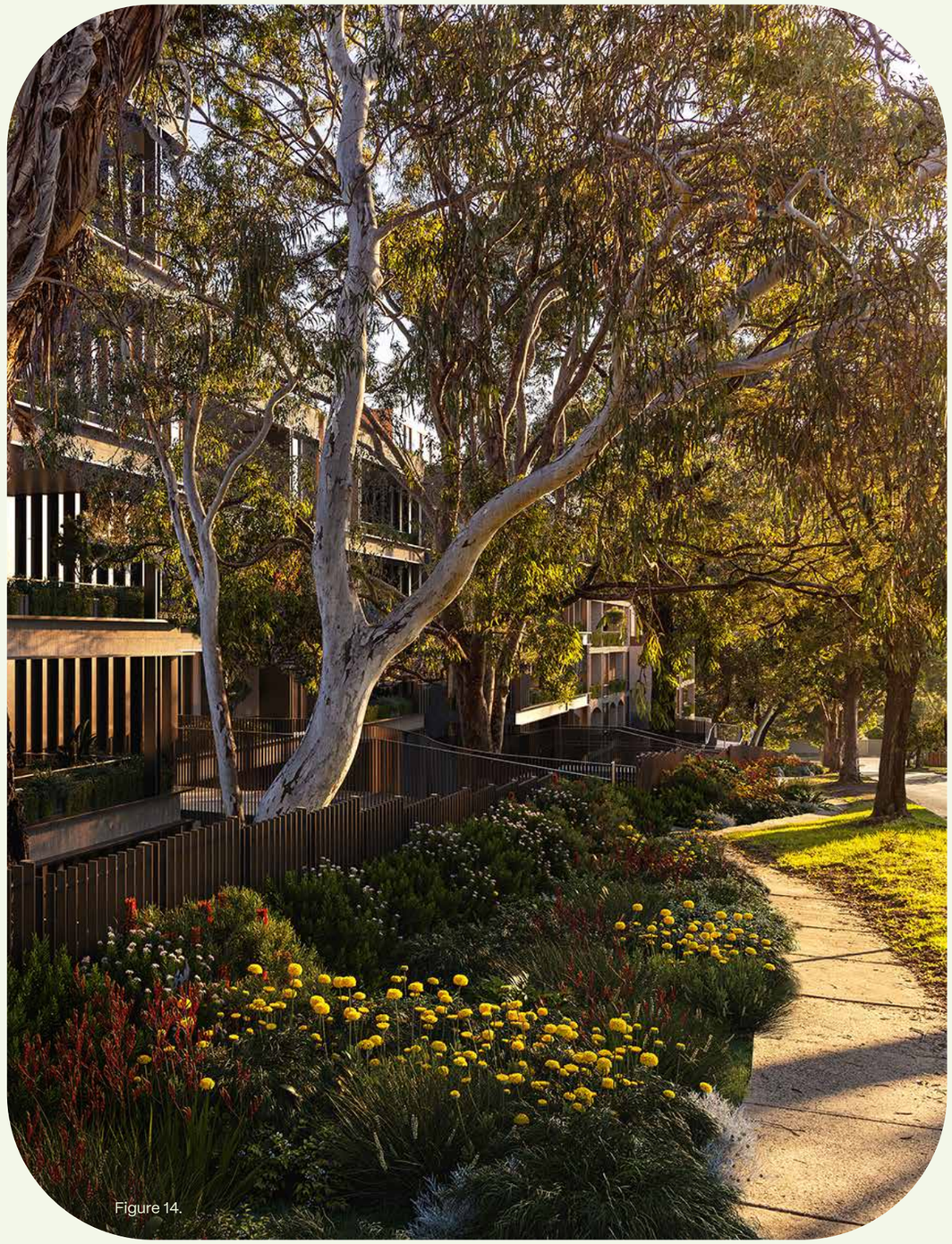

Figure 14. Retention of exiting trees can contribute to the visual appeal and marketability of a development, Scotch Hill Gardens, Hawthorn, Victoria.

3.3 New in-ground planting

The planting of new trees in the existing, natural ground soil permits tree roots to develop and grow to an optimum size (provided there is adequate irrigation, drainage and maintenance).

Tree planting in other infrastructure forms can result in smaller mature sizes and can compromise the canopy growth and the shading afforded by the tree. In-ground planting is the most effective and sustainable way to incorporate new planting into a new development.

In-ground landscapes usually require less irrigation, less material transportation and avoids the need for planter walls, strengthening of structure and waterproofing. Further, incorporating a drought tolerant native species regime not only has biodiversity benefits, but also can reduce operational costs.

In-ground planting is best placed at street interfaces where it can assist with the visual integration of the development into the neighbourhood context, provide an attractive and welcoming address, assist with privacy, and can be appreciated by the wider community.

In-ground planting needs to be considered at the earliest stages of a project as it will require setbacks of building and basement. This thoughtful integration of planting at ground level can assist with planning approvals and minimise time frames.

In the long term, in-ground planting minimises the environmental impact (less herbicides, fertilisers etc.) and ongoing horticultural maintenance and associated costs. When selecting a plant palette for the project, the landscape architect should consider how the landscape can be designed to mimic different habitat typologies. Different species, plants and animals rely on different types of habitats e.g.

- Grasslands are good for invertebrates, reptiles, birds etc
- Dense shrubby planting is important to provide birds shelter
- Trees should be selected carefully to deliver maximum benefits to address local priorities such as urban heat, air quality and value to local wildlife.

Implementation cost: Low

Figure 15. Diverse in-ground planting offers high biodiversity benefits for beneficial pollinators. Monash Uni Flowering Meadow, Victoria.

Case Study: Melbourne Pollinator Corridor 'Bee Highway'

Location: Bunurong Country, South Melbourne, VIC

Developer: City of Port Phillip and community group The Heart Gardening Project

Completed: 2022 with future work planned

Nature based features:

The goal of this project is to provide a habitat corridor for pollinating insects through the incorporation of pollen-rich/flowering plants. Most of the gardens are planted and maintained by the local community.

Key takeaways:

- Consider using the nature strip outside your site boundary for in-ground planting (in consultation with local authority).
- A diversity of flowering species provides much needed habitat for species in decline.
- In-gound planting can greatly enhance the neighbourhood setting and marketability.
- Gardens provide opportunities for the community to come together.
- Attracting native bees to gardens can assist with fruiting in productive gardens.

Links:

https://theheartgardeningproject.org.au/melbourne-pollinator-corridor

Figure 16. Melbourne Pollinator Corridor

3.4 On–structure gardens

On–structure gardens (also known as 'intensive' green roofs) refers to landscapes established over basements, podiums or roofs, and are usually designed as functional, gathering spaces. This type of planting system has the benefit of reducing stormwater runoff, improving the spatial / visual amenity and the potential for productive food areas.

These systems can offer a high quality of canopy tree planting. However, they also require a high degree of consultant coordination that carefully considers waterproofing, drainage, irrigation, loading, heat co- efficiency, wind and maintenance requirements of the area. Additional, sizable infrastructure, such as soil moisture sensors, tree anchoring, rainwater storage tanks, pump and metering rooms will be required to support on–structure planting.

For long term sustainability of these landscapes, they require appropriate soil volumes for the proposed planting. Most on–structure landscapes consist of raised planters to provide the appropriate soil depths for planting.

However, it's worth considering other alternatives such as basement set downs to provide a more attractive and accessible landscape, particularly at ground level. Sometimes an on–structure garden can be located adjacent to a swimming pool and share the same set–down.

Many local planning policies specify minimum soil depths and volumes for various vegetation types. It may be appropriate to seek the advice of an arborist or horticulturist to confirm soil volume requirements for specific tree species.

A general rule of thumb for calculating soil volumes is Mature Canopy Area of Tree x 0.6m^3. It's important to note that the required soil volumes for the establishment of trees are significant and should be considered at the earliest stages of a project as it can impact building design and structure.

Another option for providing canopy cover is to vegetate threshold spaces, such as pergolas with climbing species. This option requires less soil depth, less structural loading and can provide targeted shade to high use paved areas such as entries, seating or social spaces.

Shrub planting in raised planters can be an effective alternative to privacy fencing, acting as an attractive barrier between private and communal or public spaces. This vegetation profile is often absent in urban developments due to potential sunlight and safety concerns, but is a very important feature to enhance biodiversity outcomes.

Careful placement of shrubs and screening should be integrated into the development from the outset during the schematic design phase.

Similarly, suitability sized raised planters along street frontages permit the installation of cascading plants to offer a marketable 'green frontage'.

Technical requirements:

Tree planting will require soil depths of 1.0–1.5m depending on the mature tree size.

Lower height vegetation, such as lawns, shrubs and groundcovers can be established with shallow soil depths, typically 300mm for lawns and groundcovers and 500mm (seat height) for larger shrubs. Automatic irrigation is essential for these landscapes as they are often designed as free draining and lack access to natural groundwater.

Implementation cost: Moderate

Consider incorporating on–structure planting to:

- Entry thresholds & circulation routes
- Built form edges & street interfaces
- Podium & roof top levels
- Social gathering spaces

Figure 17. Poolside recesses provide a good opportunity for integrated tree pits. Lucent, Newstead, Queensland.

Figure 18. Layered green roofs can assist with screening & enhancing the borrowed landscape. Westmead Hospital (Copyright Brett Broadman).

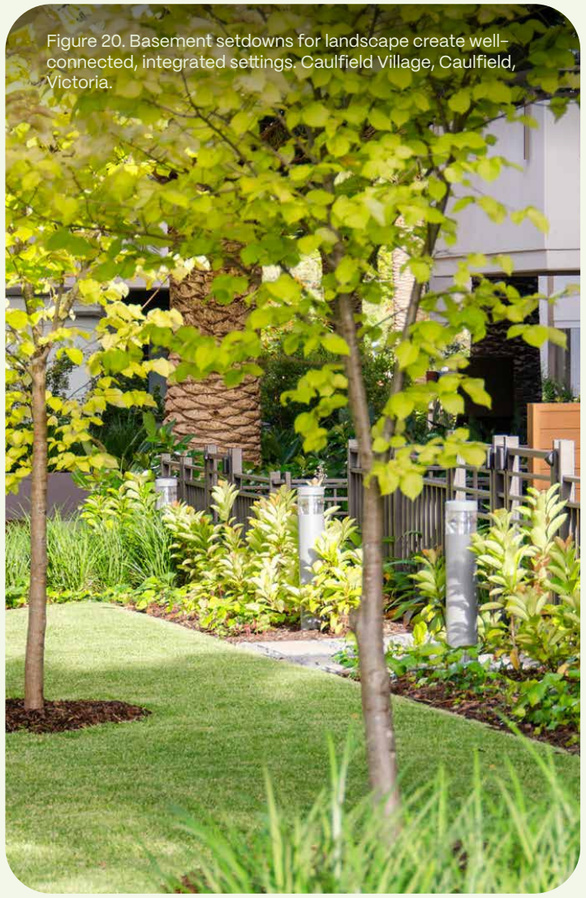

Figure 20. Basement setdowns for landscape create well-connected, integrated settings. Caulfield Village, Caulfield, Victoria.

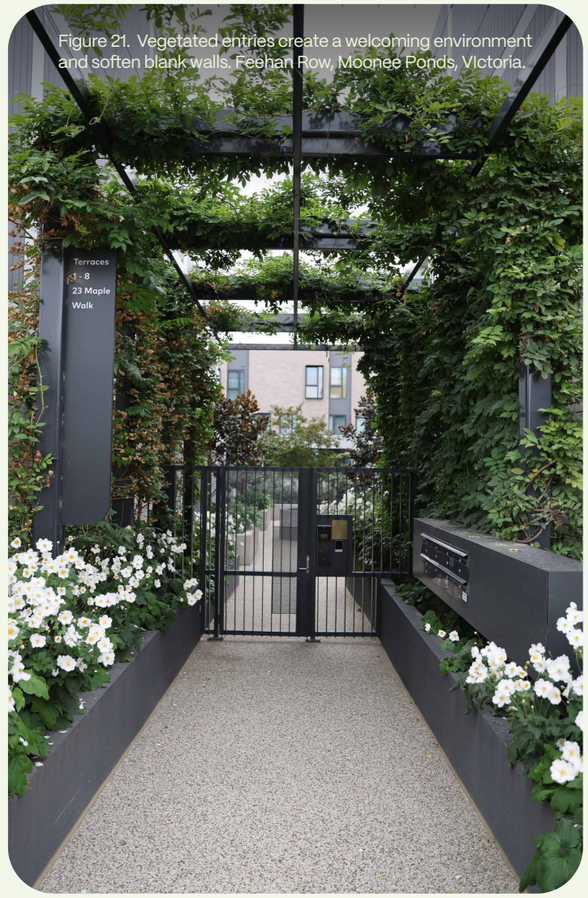

Figure 21. Vegetated entries create a welcoming environment and soften blank walls. Feehan Row, Moonee Ponds, Victoria.

Figure 19. On-structure gardens create shady, cool environments for occupant gathering spaces. Thomas St residential garden at Moonee Valley Park, Victoria.

Figure 22. Diagrammatic section illustrating integrated recesses for landscape soil and swimming pool to provide a vegetated setting.

Case Study: Caulfield Heath

Location: Bunurong Country, Caulfield North, VIC

Developer: Beck

Landscape architect: Tract

Completed: 2015

Nature based features:

The ground level of this apartment village has publicly accessible gardens constructed over the basement. The basement was set down approximately 1 metre below the ground level to allow a depth and volume of soil capable of supporting large canopy trees, gardens and lawns.

Key takeaways:

- Consider setting down the basement to create a park-like setting for your development.
- Canopy trees require large soil volumes, not just depth. Setting down the structure below allows for the creation of an extensive planting zone enabling full root development and reducing the need for planter walls.
- Investment in landscape at ground level will provide the most benefits, allowing for easy access for all residents, and improving the marketability of the development.

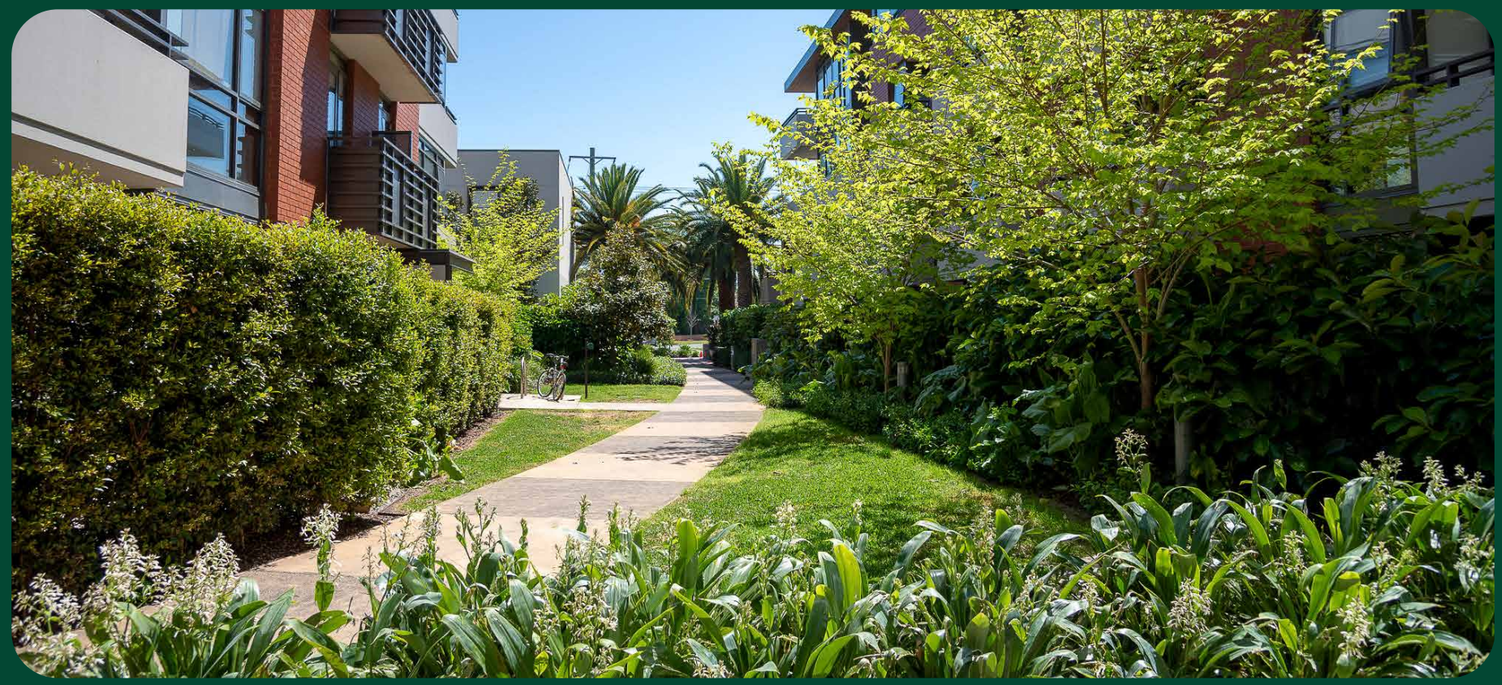

Figure 23. The ground level gardens at Caulfield Heath are constructed over a basement car park, Victoria.

3.5 Green roofs

‘Extensive’ green roofs are broad, vegetated surfaces established on roofs with a shallow soil profile and often inaccessible to the public.

Green roofs provide insulation, rainwater filtration and habitat creation, as well as an attractive surface when viewed from above. Importantly, green roofs can provide ecological stepping stones – particularly for arboreal fauna and bees.

At a highly elevated position, thorough consideration for plant selection is required due to high temperatures and moisture loss. This often presents as an attractive ‘dry-land’ landscape character with indigenous grasses and succulent species.

Green roofs can be established with a lightweight soil profile of 150-300mm depth – often using turf or low growing succulent planting. As shallow profile green roofs are highly specialised, it is recommended that a green roof specialist be engaged for advice regarding design, plant selection, installation and maintenance.

This type of system also requires a high degree of consideration for ongoing operational management, infrastructure and potentially fall-arrest systems (WHS).

When designing a green roof to maximise biodiversity, consider the following:

- Avoid purely sedum/succulent roofs where possible as they are generally lower in biodiversity
- Include a high diversity of species using locally relevant species
- Include varying substrate depths to create varying conditions such as bare sandy patches for invertebrates to warm up and sandy mounds for burrowers
- Additional habitat features such as deadwood, rainwater pools, rock piles etc to provide variety complexity and additional habitat niches for invertebrates and other fauna

Implementation cost: Low to Moderate

Consider incorporating green roofs to:

- Bus stop roofs
- Streets awnings
- Solar panel & mechanical plant areas (co-located)
- Podium level rooftops


Figure 24.

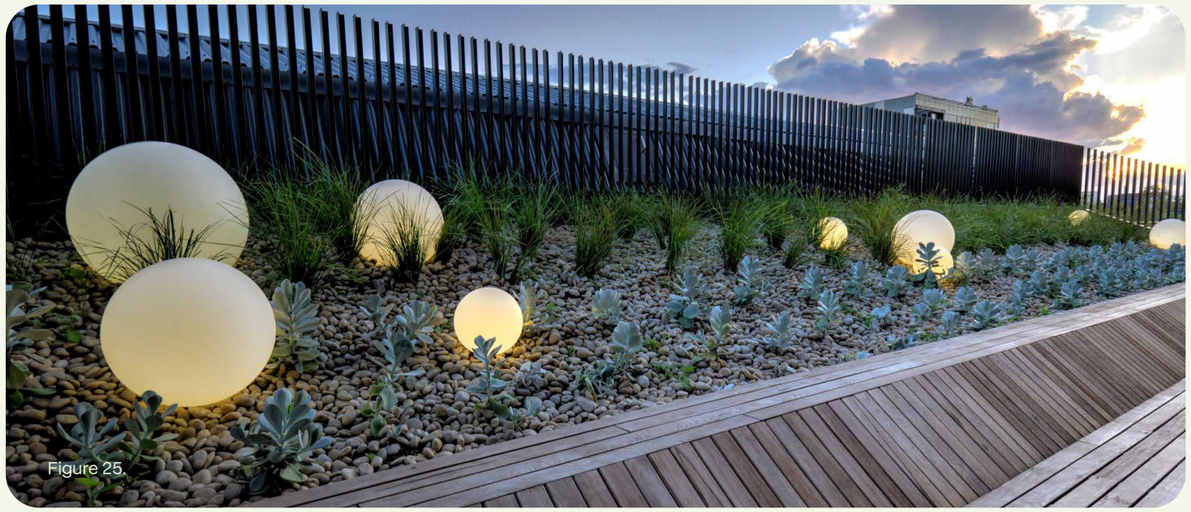
Figure 25.

Figure 24. Maintaining key sightlines with sensitive micro-climate planting is essential to rooftop settings. Casselden rooftop.
Figure 25. Robust, attractive planting to perimeter of functional spaces. Ilk Apartments, South Yarra, Victoria.

Case Study: Burnley Living Green Roofs

Location: Wurundjeri Country, Burnley, VIC

Developer: University of Melbourne

Landscape Architect: Hassell and University of Melbourne

Completed: 2013

Nature based features:

These green roofs are designed to be a demonstration, training and research facility. It tests various plant types, substrates depths and irrigation. One roof is designed to enhance biodiversity by incorporating indigenous plants, ponds and specific habitat features such as logs and rocks for burrowing and nesting of local fauna.

Key takeaways:

- Successful gardens can be created with a relatively shallow soil profile.
- Green roofs can provide habitat for local fauna.
- Green roofs can reduce stormwater by absorbing rainfall.

Links:

https://landezine.com/burnley-living-roofs-by-hassell/

Figure 26. Burnley Living Green Roofs. Image credit: John Rayner

3.6 Green walls

Green walls offer a densely formed, vertical planting solution – often used to screen blank façades on multi– storey buildings or vegetate an internal environment.

They offer instant, highly visual, dense 'green' outcomes, can aid cooling and improve environmental well– being. Most typically for commercial developments, these systems are designed and built as proprietary systems with integrated drainage, irrigation and media in a contained, modular format.

They require a high degree of specialist, technical advice which considers available light levels, ongoing plant nutrition and replacement.

These systems are attractive and durable, with minimal spatial footprints (if designed, implemented and maintained well), but attract high initial costs and ongoing maintenance.

Failure in these systems is usually due to lack of services coordination, inappropriate placement, waterproofing and maintenance.

Maintenance cost: High installation & maintenance

Consider incorporating green walls to:

- Areas which can be serviced with additional lighting and water
- Low plant stress environments (i.e. low exposure to heat and wind)
- Low amenity areas

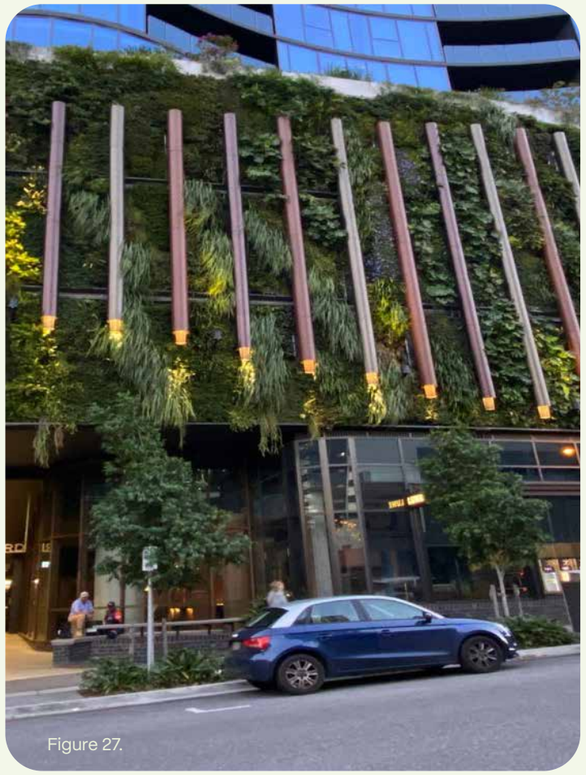

Figure 27.

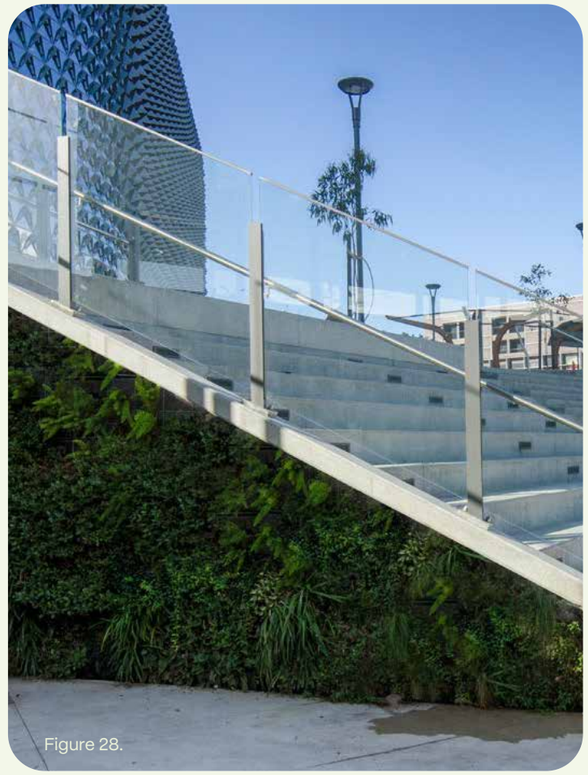

Figure 28.

Figure 27. Integrated green walls at the streetscape level offer internal cooling and within the public domain. West End, Brisbane, Queensland.
Figure 28. Green walls can be used to hide unattractive blank spaces. Royal Adelaide Hospital, South Australia.

3.7 Green façades

Green façades integrate climbing and/or trailing plants to the façades of building. Typically, planting will be provided in conventional planters integrated with climbing support structures, such as tensioned wires, mesh balustrades or masonry walls.

Green façades are often incorporated on low height, multi-storey façades to improve visual outcomes at key interfaces and offer thermal & shading benefits. When integrated into the street wall, green façades improve the broader biodiversity outcomes by providing faunal 'stepping stones' with street tree canopies and other open space networks.

Green façades systems provide the framework to enable self-attaching, twining and clinging vines to grow vertically (usually). Most systems require a framework support to grow upon, however self-attaching species (such as Boston Ivy), will adhere to masonry walls. Consideration for solar aspect, sightlines, shading, vertical fire prevention and wind exposure are key to the design of successful green façades, with plants available in both evergreen and deciduous forms.

Green façades can vary in application and appearance from a single wire to a closely spaced mesh (which can act as a dual barrier function).

Typically, they require standard raised planter infrastructure, with a climbing wire or trellis that is offset from the building surface.

Green façades improve biodiversity by offering vertical stepping stones for fauna.

Framework directly fixed to building façades can expose plants to high heat levels and moisture evaporation through both heat absorbent colour selection and thermal material properties. This leads to plants unable to thrive in a stressful environment and low vegetative coverage.

Whilst material types and costs vary significantly, the system is typically a low cost and easy to implement solution. The disadvantage of these systems is that they can have a low coverage, low quality appearance and limited lifespan, if poorly implemented or maintained.

Implementation costs: Moderate, (but variable costs system due to design & materials), less than Green Walls

Consider providing green façades to:

- Entry pergolas & threshold structures
- Balustrades & balcony edges (tensile structures)
- Façade skins (in lieu of shade screening)


Figure 29.

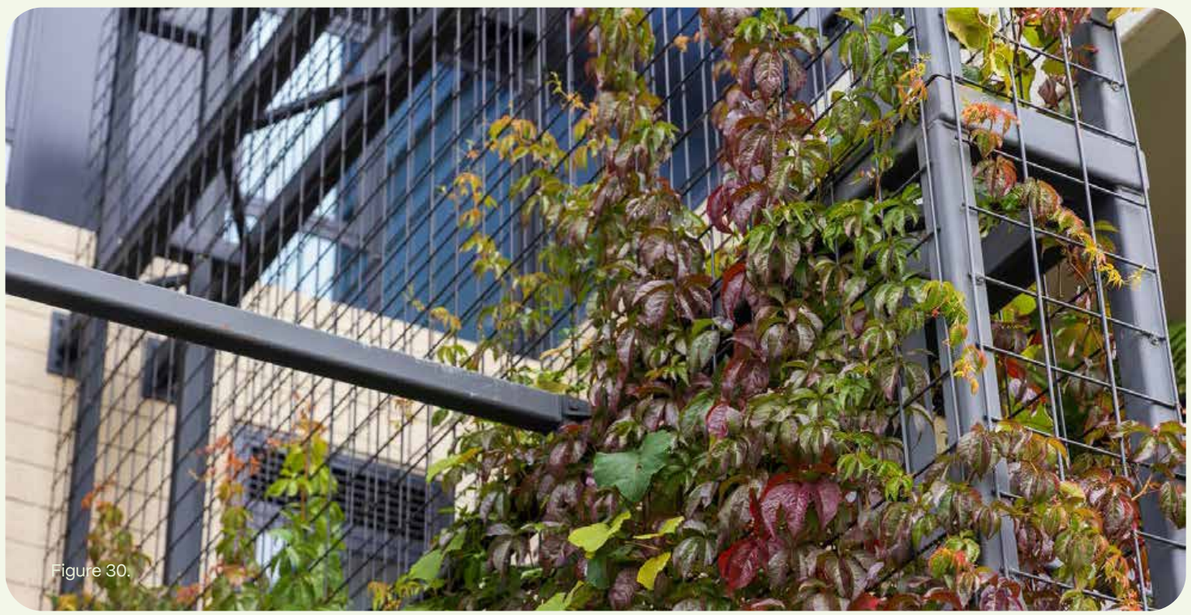
Figure 30.

Figure 29. Facade and perimeter edge planters can assist with soften utility areas. Westmead Hospital. Image credit: Brett Broadman.
Figure 30. Integrated balcony planters & climbing frames can enhance biodiversity and bring nature close to residents. Thomas Street Apartments, Moonee Ponds, VIC.

Case Study: The Commons

Location: Wurundjeri Country, Brunswick, VIC

Developer: Nightingale Housing

Architect: Breathe Architecture

Completed: 2013

Nature based features:

The north facade has a generous green façade consisting of Wisteria climbing on robust chains spanning the residential levels of the building. Planters have been incorporated on every level to ensure good coverage. The Wisteria is a deciduous species that provides dense summer coverage, autumnal foliage, light penetration in winter and flowers in spring. As it is a vigorous climber, a robust growing structure of vertical chains has been provided to support the vines.

Key takeaways:

- Consider using deciduous creepers particularly on north facing facades in temperate climates
- Ensure an automatic irrigation system is installed to guarantee long term success
- Ensure the growing frame is suitable for the climbers specified
- Consider views, natural light and seasonal variation when planning for green facades

Links:

https://www.archdaily.com/921283/the-commons- housing-breathe-architecture
https://www.nightingalehousing.org/project/the- commons

Figure 31. Climbing plants growing on the facades of The Commons, Brunswick, Melbourne, Victoria.

3.8 Productive gardens

Productive gardens offer building occupants the opportunity to garden, engage with ecological systems and secure sustainable food sources. Productive gardens are often incorporated in sunny locations at podium or rooftop levels to enhance amenity through low-cost infrastructure. They should be supported by other social activities and include adequate seating, dining opportunities and shading.

Typically, the infrastructure will be based upon on- structure techniques, but the design should allow for adequate circulation, water accessibility and maintenance. Material stores, gardening sheds and waste disposal should be incorporated into the design to enable good community ownership and practical, seasonal maintenance. Planters should be of a height that are accessible (800-900mm), located in an area with minimum of 6 hours of sunlight and protected from prevailing winds.

Productive gardens are also a good opportunity to use indigenous food plants and connect the narrative to indigenous culture and traditional food sources in the area.

Implementation cost: Low to Moderate

Figure 32.

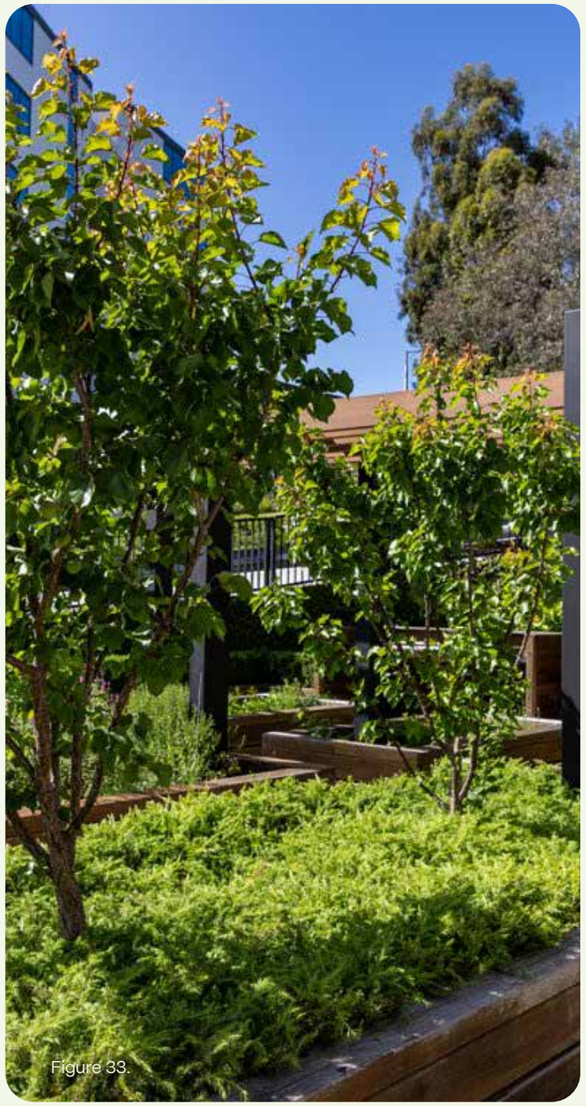

Figure 33.

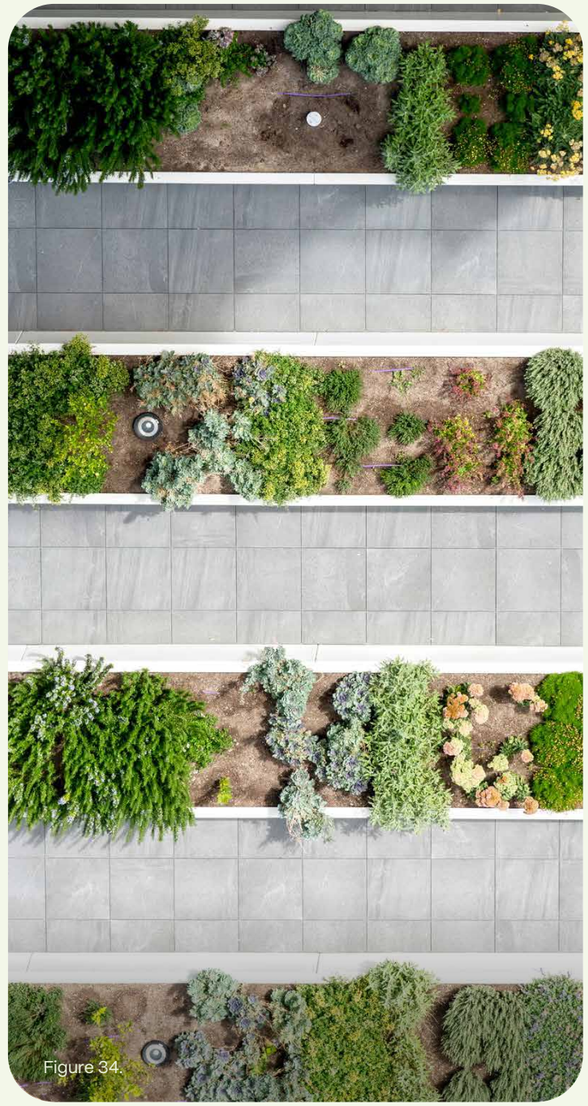

Figure 34.

Figure 32. Exotic plants at elevated levels can increase biodiversity and faunal connections where birds and bees are limited in diversity. Kodo Apartments, Adelaide.

Figure 33. Productive gardens can be integrated in open areas as a low-cost element. Tullamore Apartments, Doncaster, VIC

Figure 34. Diverse planting in productive areas can enhance the external visual aspect. Kodo Apartments, Adelaide.

Case Study: Burwood Brickworks

Location: Wurundjeri Country, Burwood, VIC

Developer: Frasers Property Australia

Completed: 2022

Nature based features:

Known as the world's most sustainable shopping centre, the roof of this development includes a 2500 square metre urban farm. The farm is managed by a not-for-profit group that produces food that is distributed throughout Melbourne whilst providing education form members of the community.

Key takeaways:

- Productive gardens that involve the community is an effective way of creating social connections, celebrating cultural diversity and enhancing wellbeing.
- Productive gardens can be co-located with cafes and restaurants using seasonal, locally grown ingredients.

Links:

https://www.cultivatingcommunity.org.au/urban- rooftop-farm-burwood

Figure 35. Productive gardens on the roof of the Burwood Brickworks Shopping Centre

3.9 Indoor planting

Indoor planting offers environmental comfort and can improve occupant well-being. Research compiled by RMIT for Greener Spaces Better Places found that adding just one plant to an average sized room (4 x 5m) has the capacity to reduce air borne toxins by as much as 25%. At 5 plants the potential is for the air to be 75% cleaner.

RMIT also investigated the direct mental health benefits of indoor plants, such as improved mood and concentration, and indirect benefits, such as productivity and positive social behaviour, that indoor plants might have caused.

They found that there is very little well-being benefit in just one plant, but once you start to create a 'look' in your space, well-being begins to increase significantly. Perhaps not surprisingly, size, species and complexity matters too. The greater the mix of sizes and varietals, the greater the benefits.

When it comes to air quality, species, total leaf area and the size of the root-ball are important (so go for bigger leaves and bigger plants with adequate or good soil volumes). Some information is conflicting however NASA's Clean Air Study is a good source of information.

Owing to a number of complexities, the selection of indoor plant species is usually undertaken by a specialist horticulturist as lux levels are critical to plant selection and establishment and decrease rapidly with distance to windows etc.. In addition, consideration for solar exposure, air circulation, temperature, humidity, drainage, watering and specialist substrates and soil media form the basis for a successful outcome. Like other on-structure landscapes, planters can be built in or free-standing and moveable.

Adequate space and positioning will be required for drainage, artificial lighting and maintenance. Further, planter heights and sightlines are integral with the design and safety outputs. As with all designed landscapes and planting interventions, early consideration is vital for success.

Implementation costs: Moderate, (but variable due to design & materials)

Figure 36.

Figure 37.

Figure 36. Internal and threshold planting aids cooling and creates comfortable environments for occupants.
Figure 37. Integrated planters along external walls enhance sightlines, whilst providing adequate light for growth.

04

Reference Documents & Further Reading

4.1 Reference documents and further reading

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