Creating healthy places: railway stations, biophilic design and the Metro Tunnel Project

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Railway Stations, Biophilic Design and the Metro Tunnel Project

Paul Downton, David Jones, Josh Zeunert and Phillip Roös

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Abbreviations

Deakin	Deakin University
MMRA	Melbourne Metro Rail Authority
MTP	Metro Tunnel Project
MCC	City of Melbourne Council
PPC	City of Port Phillip Council
HV	Heritage Victoria
PS	Planning Scheme

Biophilic design:

translating the human affinity for nature

into the design of the built environment

Credit: P Downton

With partnership support from the Melbourne Metro Rail Authority, this international technical benchmark report has been prepared by Deakin University. *Creating Healthy Places* provides guidance as to the feasibility and opportunities for *Biophilic Design* to be considered and potentially incorporated in the Metro Tunnel Project (MTP) railway stations designs to elevate their sustainability accountability and innovative design responsiveness.

Biophilic Design is a nature-informed approach to quality environmental design that draws from the Biophilia thesis proposed by North American biologist and myrmecologist EO Wilson (Wilson, 1984). The term 'biophilia' means 'love of life or living systems'.

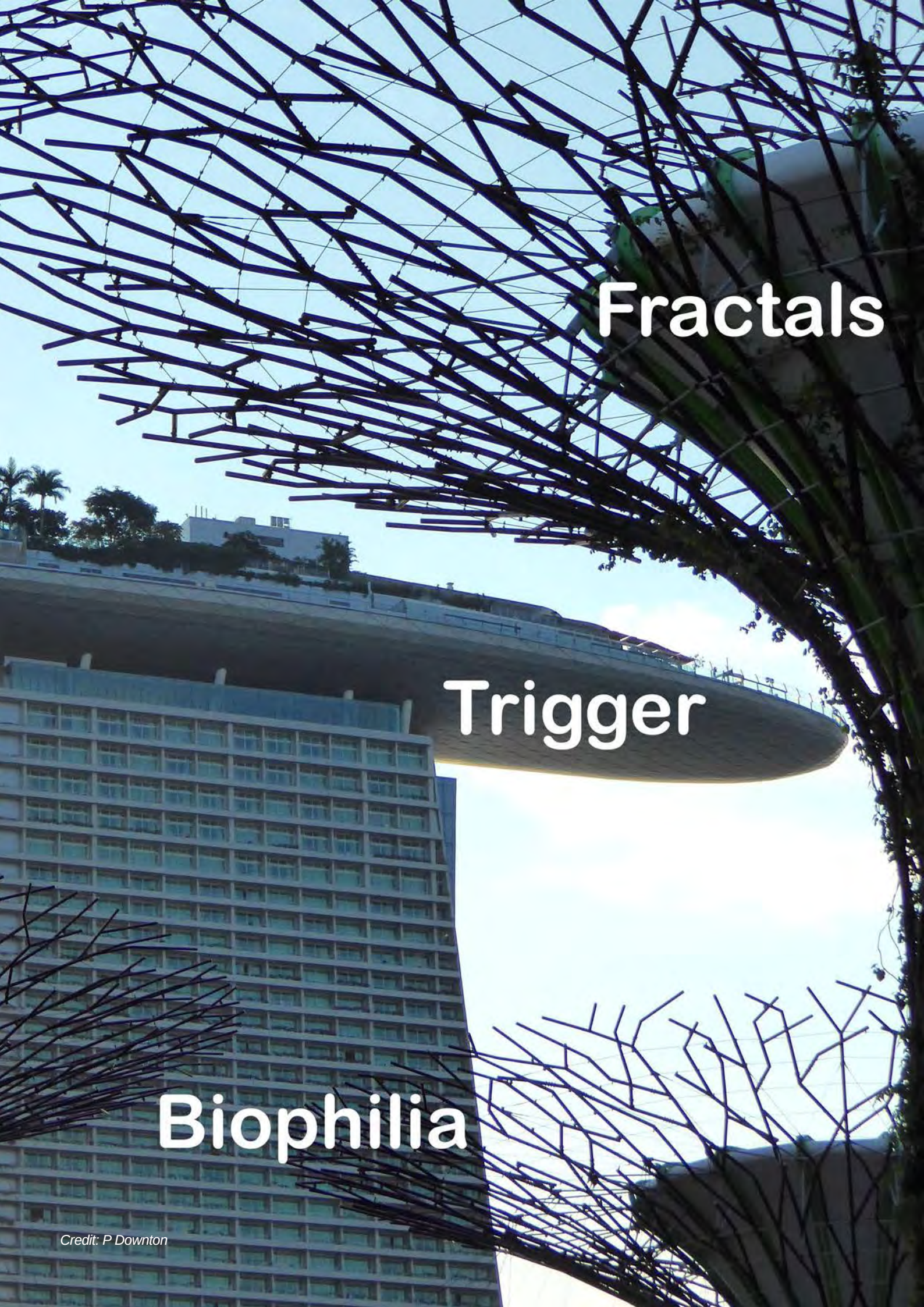
Creating Healthy Places seeks to offer *Biophilic Design* insights and performance guidelines towards the enrichment of each of the proposed Metro Tunnel Project railway stations to provide opportunities for *Biophilic Design* to be incorporated in the design process. It also offers avenues and principles that may better address the Project's sustainability alignment as well as achieve certification of the railway stations under the Green Building Council of Australia-Green Star Rating system and supporting the potential achievement of a 6 Green Star rating.

Internationally, *Biophilic Design* is increasingly being acknowledged by designers and academics as a design approach that can reduce human stress, enhance human creativity and clarity of thought, improve human well-being and expedite human self-healing. These qualities are ever more important, as the world population continues to urbanize, but they are also essential ingredients in a 'Liveable City' and positioning Melbourne as an internationally recognised 'EcoCity' which are core strategic aims of the *Melbourne 2030* (2015) and the *Melbourne City Council: Council Plan 2013-17* (2013).

Terrapin Bright Green LLC (2014) has advanced *Biophilic Design* further by proposing 14 patterns for "Improving Health & Well-Being in the Built Environment" that underpin and can serve as evaluative guidelines towards quality *Biophilic Design* outcomes. Building upon this work, this report proposes an additional pattern to Terrapin's 14 patterns and offers a 'Toolkit' of 17 recommendations that are specifically applied to the MTP. These are outlined in Chapter 8.

Creating Healthy Places offers guidelines and strategies as to how the proposed Metro Tunnel Rail Stations may enable and support these aspirations, and enliven the health of Melbourne's residents and commuters.

This report will be considered and utilised by the MMRA as a guidance document only, for where Biophillic Design may be considered in the Metro Tunnel Project railway station design process.



Credit: P Downton

ii Acknowledgements

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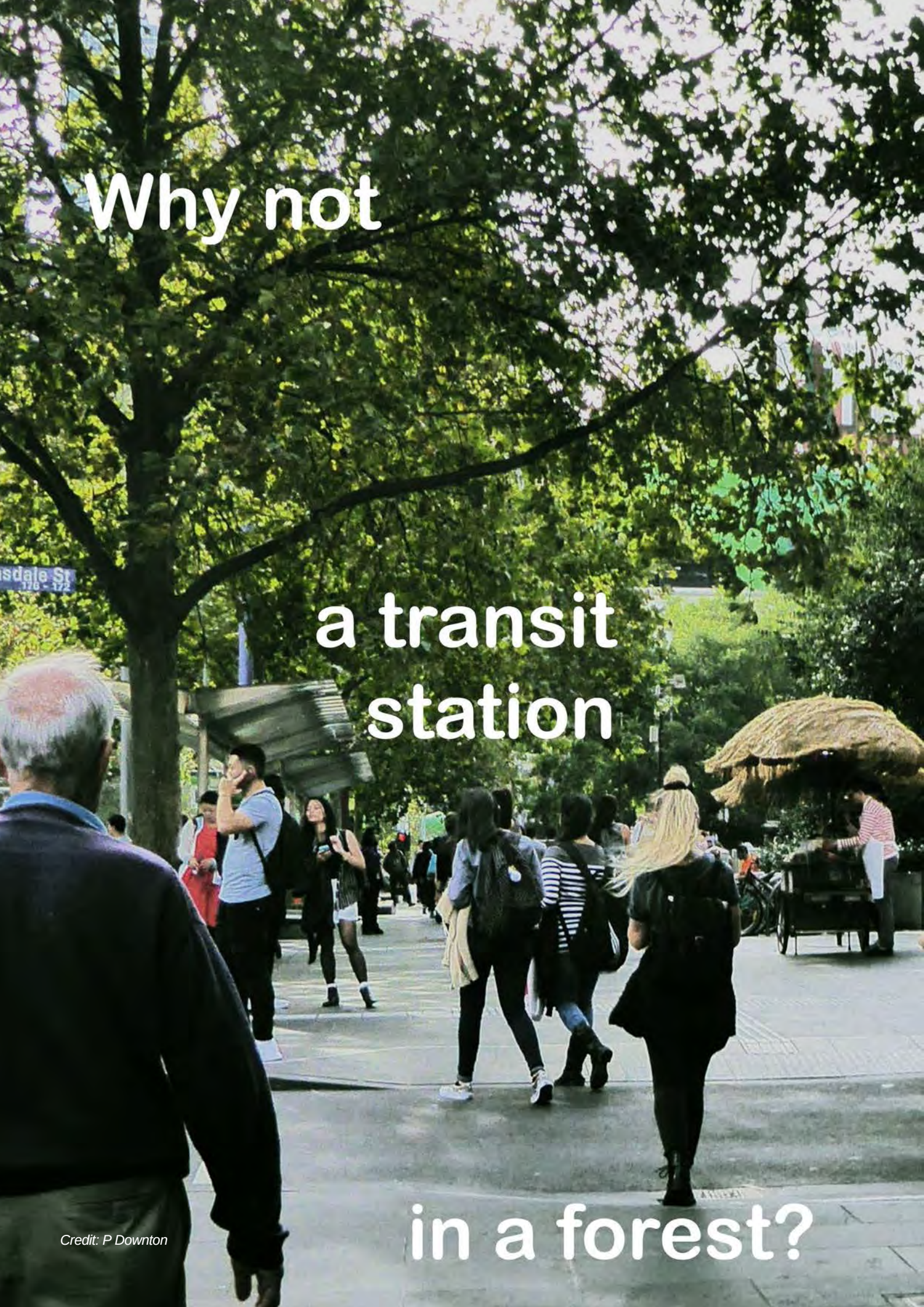
In addition, academic and professional staff at the University of Virginia, Curtin University, the City of Melbourne Council, McGregor+Coxall, TAFE SA, and the School of Architecture & Built Environment and Deakin Research–Commercial at Deakin University facilitated this project.


Why not
a transit
station
in a forest?
Credit: P Downton

The Need for Biophilic Transit Design

Biophilic design is important to the design and planning of new public transit infrastructure. Cities invest in better public transit for many important reasons: reduction of greenhouse gas emissions, enhanced and more equitable forms of mobility, creation of more walkable, liveable urban environments. Well-functioning transit systems create the conditions for lives spent, at least partially, outside the sphere of cars. In many ways, then, public transit lays a foundation for more time spent outside, more walking, and more opportunity to be in and enjoy the public realm.

In these ways, transit planning can already be considered biophilic. There is a considerable and growing body of research supporting the idea of biophilia- the belief that we have co-evolved with the natural world that we possess an innate need to connect with nature. Nature in cities, we increasingly recognize, is not something optional, but absolutely essential to leading a happy, healthy and meaningful life. And this extends to the design of every element in the city, including transit stations.

Transit design can and should be biophilic at its core, and the MMRA's *Sustainability Principles and Approach* (2016) to prioritise this aim demonstrate this is instrumental in a city that is seeking to advance its ecocity credentials. Transit stations, and spaces, around them, can be profoundly more natureful-from interior living walls and natural daylight, for instance, to the trees, native shrubs, gardens, and water elements that might be designed-in. Biophilic design helps to enhance our places much higher. Might we re-imagine the very nature of a transit trip? Could it be not simply a trip to work or a travel to the high street, but perhaps a visit to the forest, a chance to hear and celebrate native birdsong, or a chance encounter with a butterfly. Perhaps food-production becomes part of transit design, so that one picks a tomato or a desert plum on the way to catch the train. In our new global Biophilic Cities Network, partner cities are re-defining even the nature of a city, and imagining a profoundly more nature-immersive urban environments: a city as a garden, as a park. Melbourne's new urban forest strategy calls for implementing a vision of the City in a Forest. Why not a transit station in a forest?

We know that modern urban life entails many kinds of stress, and that such stresses have serious health implications. A recent study by researchers at the University of Minnesota (Lagune-Reutler et al 2015) found that perceived waiting times at bus stations were lower when there were trees and greenery around them. Nature has the power to ease and relieve many of these urban stresses, and as the Minnesota study concludes, can also significantly enhance the experience of riding transit. Again, biophilic design re-imagines transit trips: rather than stressful, an opportunity to enjoy in the course of one's daily life a bit of nature-connection, a bit of nature-therapy, a chance to enjoy the natural world, a chance to see our lives differently.

Riding the train, or bus, or tram is good of the earth, to be sure. But it could also be uplifting and restorative and wondrous if we give nature its due. These transit design guidelines show what is possible and are an important step in advancing the larger vision and agenda of biophilic cities.

Professor Tim Beatley

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1

Introduction

Credit: P Downton

1.0 Introduction

In 1865 North American landscape architect Frederick Law Olmsted expressed his physical and psychological joy after visiting Yosemite and the Mariposa Grove in California for the first time. His investigations form the basis of the recommendation to the US President to reserve Yosemite as one of the United States' first national parks. Yosemite prompted Olmsted to observe that

> *"…the enjoyment of scenery employs the mind without fatigue and yet exercises it, tranquilizes it and yet enlivens it; and thus, through the influence of the mind over the body, gives the effect of refreshing rest and reinvigoration to the whole system."*
>
> *Frederick Law Olmsted, 1865, Introduction to Yosemite and the Mariposa Grove: A Preliminary Report, cited in A Clearing in the Distance: Frederick Law Olmsted and America in the 19th Century by Witold Rybczynski*

Biophilia suggests that there is an instinctive bond between human beings and other living systems. Recent research has demonstrated that by scaffolding and engaging in components of biophilia through biophilic design applications, the approach offers positive benefits to humans and wildlife alike. Healthy humans are productive, lessen the load upon our community health infrastructure and are readily prepared to engage in life, work, learning and play.

Biophilic design is an advanced methodology of Ecologically Sustainable Design that goes beyond the status quo of sustainability. It is an innovative approach that emphasises the necessity of maintaining, enhancing, and restoring the beneficial experience of nature in the built environment. Vegetation is not only used in the context of green landscaping, but rather becomes a progressive functioning living system in the built environment of ecological and biodiversity factors that includes human wellbeing; thus the wider health of humans, places and their ecologies. The benefits and qualities for contemporary humans in these Biophilic inspired and created urban habitats include the reduction of stress, the enhancement of creativity and clarity of thought, the improvement of human well-being, the enhancement of healing that collectively can be referred to as 'The Architecture of Life' and thus the inherent 'liveability of cities and their occupants'

North American biologist and myrmecologist Edward O Wilson introduced and popularized the hypothesis in his book, *Biophilia* (1984) wherein he defined 'biophilia' as "*the urge to affiliate that enhance with other forms of life.*" In urban areas this embraces crafting places that are sustainable, enhances biodiversity and urban greening, and offer psychological, physical health and educational benefits to humans and wildlife within these places.

North American planner and designer Tim Beatley, in arguing for the adoption of Biophilic Design, explains that "*Biophilic cities are cities of abundant nature in close proximity to large numbers of urbanites; biophilic cities are biodiverse cities, that value, protect and actively restore this biodiversity; biophilic cities are green and growing cities, organic and natureful.*" (http://biophiliccities.org/). "

In its simplest form, design making (Potteiger & Purinton 1998) and Biophilic Design (Terrapin Bright Green 2014: 9-10) propose the following strategies and patterns respectively:

Design Strategies	Patterns of Biophilic Design		
	Nature in the Space	Natural Analogues	Nature of the Space
Design Narratives	• Visual Connection with Nature • Non-Visual Connection with Nature • Non-Rhythmic Sensory Stimuli • Thermal & Airflow Variability • Presence of Water • Dynamic & Diffuse Light • Connection with Natural Systems	• Biomorphic Forms & Patterns • Material Connection with Nature • Complexity & Order	• Prospect • Refuge • Mystery

Figure 1.1: Design Narratives and Biophilic Design Patterns

1.1 Brief Aims

This research project is specifically focused upon two key outcomes:

- Interrogation of the Biophilia (and quality urban design) possibilities of the 5 new MTP railway stations (Arden, Parkville, CBD North, CBD South, Domain) in terms of their underground concourse areas and vertical circulation area, as well as their above ground plazas, entrances and integration with the larger streetscape and immediate environments, and
- Contributing practice-rich knowledge and exemplars to inform the MTP project as to key opportunities, issues and ideas for Biophilic Design formulation of the overall project.

Strategically the design-based applied research project seeks to take the principles of environmental design further. It further aims to include biophilic design in creating healthy places for patrons and users, and identify the indoor and ambient (outdoor) environmental qualities for these stations to consider outcomes (e.g. daylight, water, air, visual, nutrients, etc.) in supporting successful biophilic principles articulated by Terrapin Bright Green LLC (2014). In addition, this research aims to support the larger greening of the above ground environment in line with the City of Melbourne's Greening Agenda contained in their *Urban Forest Strategy: Making A Great City Greener 2012-2032* (2012), and the City of Melbourne's desire to craft Melbourne as a "eco city" (within which Biophilia theory resides).

The aims of this research project are to:

- Explore and propose opportunities to craft the MTP new stations with an international level of biophilic and greening design that enriches human experience of the places, elevates the green credentials of the overall project, and further enhances Melbourne's greening strategies;
- Provide opportunities and guidance to assist MMRA to achieve enhanced sustainability outcomes for the MTP Project including striving to achieve a potential six star Green Building Council of Australia Green Star rating and capturing additional credit points under the Innovation credit for the Infrastructure Sustainability Council of Australia (ISCA) rating;
- Prepare an international benchmark review report of Biophilic Design about biophilic influenced railway stations and allied exemplars, performance benchmarks and design, and to provide guidance to the MTP as to potential key opportunities, issues and ideas for Biophilic Design formulation of the overall project. This report informs the MTP Railway Stations: Biophilic Design Guidelines to identify key opportunities, issues and ideas for Biophilic Design in the overall design process;
- Include opportunities for alternative vegetation options other than the replacement of trees, feeding into the MMRA Project *Green Infrastructure Strategy* (2016) and *Urban Design Strategy* (2016), for Biophilic Design in the overall design process.

1.2 Report Constraints

In seeking to better inform and further enhance the sustainability outcomes of the Metro Tunnel Project as it relates to the railways stations, this Biophilic Design technical report was partnered by the MMRA in June 2016.

The constraints imposed upon the formulation of this technical report include:

- The ongoing and dynamic design process;
- The authors were availed only of portions and select technical reports prepared by the AJM Joint Venture and associated consultants prior to the 25 May 2016 release of the *Melbourne Metro Environment Effects Statement* (2016), with which to investigate Biophilic Design possibilities for the railway station complexes;
- The chambers comprising the station levels and platforms will have a controlled environment, with no train-generated air movement due to the platform screen door system, thus creating an artificial office-like air conditioned environment, less the concourse levels that are directly affected by natural weather conditions;
- That, as a consequence, the only spaces that could be considered for biophilic design opportunities were the underground railway station chambers, pedestrian platforms, concourses and circulation routes, and the above ground spaces immediately above the station concourses.

1.3 Report Spatial Context

This investigative research focuses only upon the 5 railway station complexes proposed in the Metro Tunnel Project. These are depicted as follows:

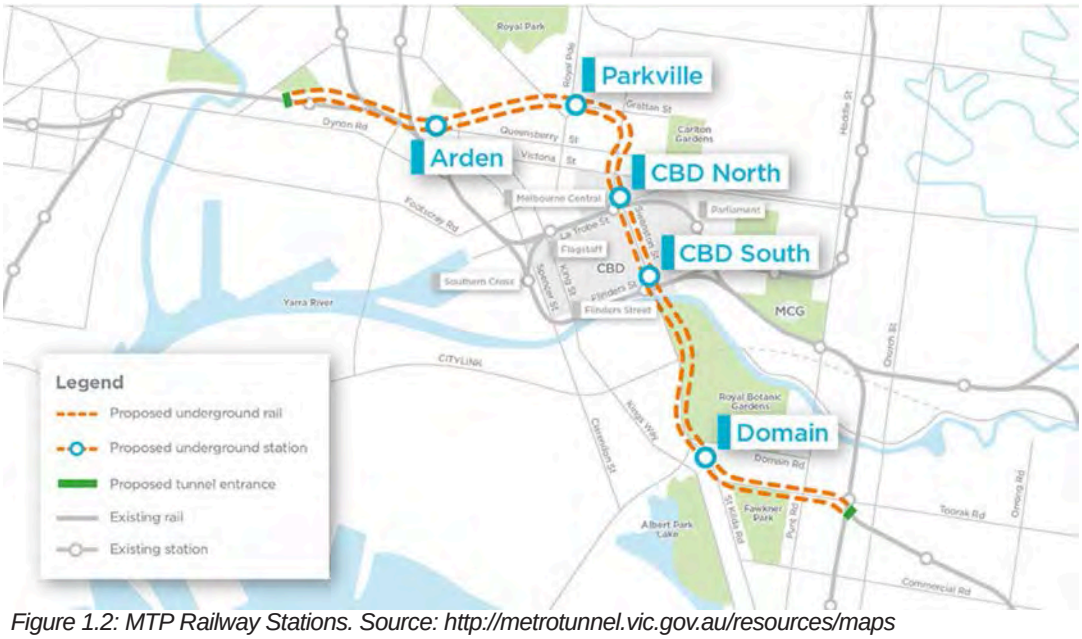


Figure 1.2: MTP Railway Stations. Source: http://metrotunnel.vic.gov.au/resources/maps

1.4 MMRA Sustainability Principles and Approach

The MMRA, in their *Sustainability Principles and Approach* (2016), affirmed their alignment to the first internationally recognised and most frequently cited definition of the concept being:

> *Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*
>
> *- World Commission on Environment and Development 1987, (Our Common Future) The Report of the Brundtland Commission*

The Brundtland Commission's definition engages with the principles of environmental protection, social equality and economic growth (IISD, 2015).

The MMRA (2016: 3) has expressed its Sustainability Policy as:

> *Through our delivery of Major Projects we're committed to connecting communities in the healthiest, most sustainable way possible. We'll help to ensure a lasting legacy for present and future generations for a more liveable Victoria - environmentally, socially and economically.*

To achieve this Vision the MMRA has committed to the following 5 Sustainability Policy Commitments:

- Optimising the Projects' design to ensure it is delivered to operate sustainably
- Managing resources efficiently through embedding energy, water and material saving initiatives into the design, construction and operation of the Projects
- Avoiding, minimising and offsetting harm to the environment and the loss of biodiversity
- Protecting and conserving the natural environment
- Preparing for the changes presented by climate change

The MMRA *Sustainability Strategy* (2016) incorporates the Sustainability Policy and specific target themes for integration into the project planning and design, procurement, construction and operational stages, that are summarised in the Sustainability Targets as follows:

Sustainability Themes	Icon	Sustainability Objectives
Excellence		Demonstrate leadership in the commitment to a prosperous and integrated economic, social and environmental sustainable future.
Urban Ecology and Vegetation		Protect and enhance vegetation, functioning of ecosystems and maintain biological diversity.
Climate Resilience		Respond to the challenges of climate change impacts through adaptation and resilience planning and design.
Supply Chain		Demonstrate commitment to sustainable procurement.
Communities		Support and enhances social, cultural and community wellbeing.
Workforce		Facilitate economic prosperity and development and providing a resilient local workforce.
Energy		Promote energy efficiency throughout design and delivery and implement innovative uses of renewable energy on site.
Materials and Waste		Reduce the impact of materials over the lifecycle, and provide healthy environments through the reduction of emissions, pollution and waste.
Water		Reduce water through an energy efficient design and identify and use non-potable water from local sources.

Figure 1.3: Sustainability Targets, Themes and Objectives

The Strategy identified the following tools as international benchmarks and the MTP will seek formal certification under these:

Infrastructure Sustainability Council Australia (ISCA) IS Rating Scheme Tool; and

Green Building Council of Australia (GBCA) – Green Star Design & As Built Melbourne Metro Rail Tool.

In terms of Biophilic Design, while the over-arching Sustainability Policy vision is directly relevant, the Excellence, Water, Urban Ecology and Vegetation and the Communities themes are most relevant.

1.5 Report Structure

The following chapter strategy has been employed in this document:

1. **Introduction sets forth the introductory and investigation terms of reference;**
2. **Discusses Biophilia, Biophilic Design and associated theoretical and practical contextual information;**
3. **Summarises the spatial and temporal context of this investigation;**
4. **Considers the MTP railway stations within the context of Biophilic Design;**
5. **Considers international and national Biophilic Design exemplars;**
6. **Considers relevant performance measures pertinent to the MTP;**
7. **Discusses resilience and climate change considerations;**
8. **Provides recommendations;**
9. **Provides a bibliography;**
10. **Provides various Appendices.**

2

Biophilia, Biophilic Design & Designing

Credit: P Downton

2.1 Biophilia

Biophilia is "*the inherent human inclination to affiliate with nature*" (Kellert & Calabrese 2015: 3).

The relationship of aesthetics to one or another idea of human comfort has been acknowledged and treated with guidelines, commentaries, codes or prescriptions for millennia. The connectivity of current thinking about aesthetics and nature reaches back to D'Arcy Thompson and the mysteries of sacred geometry and forward to the concepts of biophilia. Both make claim for a kind of 'hard-wired' aesthetic preference for nature in the human psyche.

The first publication to specifically explore, "*the need for nature*" premise was EO Wilson's, Biophilia (1984), in which he proposed that this human behavioural trait was a hereditary response and named the phenomenon 'biophilia'.

It is now accepted in the professional practice and academic realms that biophilia is a real phenomenon and part of what makes us human. We understand the world as a living place. If we have "the innate tendency to focus on life and lifelike processes" (Wilson 1984: 1) then it may be inevitable that we view cities as, at the very least, simulacrums of life.

The idea of biophilia supports the proposition that urban environments need to be integrated with nature for reasons of psychological health as well as environmental fit.

> *Over thousands of generations the mind evolved within a ripening culture, creating itself out of symbols and tools, and genetic advantage accrued from planned modifications of the environment. The unique operations of the brain are the result of natural selection operating through the filter of culture. They have suspended us between the two antipodal ideas of nature and machine, forest and city, the natural and artifactual, relentlessly seeking, in the words of the geographer Yi-Fu Tuan, an equilibrium not of this world (Wilson 1984: 12).*

The idea of ecological cities, which incorporates biophilia as a core value, may be the most complete attempt to find that equilibrium in this world (Downton 2009).

Biophilia is evidenced in human behaviour. Given the freedom to choose the setting of their home or workplace, people favour environments with the following characteristics (adapted from Wilson in Kellert et al 2008: 23):

- elevated position looking down (hill, upper slope)
- open, savanna-like terrain (scattered trees and copses)
- proximity to a body of water (river, lake)
- retreat in which to live
- a viewpoint with a generous prospect

Add to that what might be considered a simple 'love of nature' and an agenda for design begins to emerge. This has been the focus of an increasing amount of research since Wilson's initial hypothesis with one result being the emergence of codified practice guidance that connects biophilia to functional design outcomes in the form of biophilic design.

2.2 Biophilic Design

Biophilic design "*seeks to create good habitat for people as a biological organism in the built environment that advances people's health, fitness and wellbeing*" (Kellert & Calabrese 2015: 6).

New research supports measurable, positive impacts of biophilic design on health, strengthening the empirical evidence for the human-nature connection and raising its priority level within both design research and design practice; however, little guidance for implementation exists. It is hoped that this paper will help to close the gap between current research and implementation.

Biophilic design is not solely about introducing vegetation to the constructed environment, although it is often interpreted that way. Biophilic design is about eliciting biophilia responses as part of the overall experience of the built environment and this experience includes elements that are not plants, as the 14 Patterns show (see below). Moreover, some biophilia effects can be achieved with no physically tangible link to nature at all. Even illusions of nature can generate biophilic psycho-physiological responses.

Biophilic responses can be triggered through indirect experiences of nature, including purely artistic representations of nature. Biophilic effects are measurable in some un-natural environments (like hospital rooms) when people are exposed to images or illusions of nature like artificial sky. Such illusory, or virtual, systems have a place in the suite of biophilic design tools. They are particularly valuable for environments that cannot readily accommodate real biological systems, such as MRI rooms buried inside multi-storey, deep-plan buildings (Downton 2016a). The subterranean environment of the Metro Stations may include places where 'virtual' biophilia (biophilia generated by virtual experience) can make a positive contribution to pyschological health and well-being.

The role of virtual reality and similar illusory systems has not been interrogated to any great extent in research literature to date and is not specifically identified in the 14 Patterns. Accordingly, this paper proposes an additional pattern to specifically address virtual connection with nature.

2.3 Biophilic Design Principles and Patterns

Protagonists of biophilic design include theorists and practitioners.

> *The concept of biophilia can permeate every facet of planning and design, celebrating the regional landscape, ecological restoration, appropriate horticulture, and buildings that reach out and interact with the landscape. This approach will allow us to create landscape designs that are far more beautiful, complex, and engaging than either traditional or sustainable landscape architecture (ASLA 2010: 1).*

2.3.1 The Principles and Benefits of Biophilic Design

Kellert and Calabrese (2015) have identified fundamental conditions for the effective practice of biophilic design, including:

1. **Biophilic design requires repeated and sustained engagement with nature.**
2. **Biophilic design focuses on human adaptations to the natural world that over evolutionary time have advanced people's health, fitness and wellbeing.**
3. **Biophilic design encourages an emotional attachment to particular settings and places.**
4. **Biophilic design promotes positive interactions between people and nature that encourage an expanded sense of relationship and responsibility for the human and natural communities.**
5. **Biophilic design encourages mutual reinforcing, interconnected, and integrated architectural solutions.**

The biophilic experience often depends on repeated exposure. It "*needs to be nurtured and developed to become functional*" (Kellert & Calabrese: 2015: 4). Urban environments provide unique opportunities to nurture biophilic awareness by offering repeated biophilic experiences. Urban design strategies can place biophilic experiences so that they are enjoyed as a matter of routine. Biophilic design can become part of people's everyday experience as they walk or cycle to work, school, play and entertainment – travelling at a pace suited to observing and appreciating their surroundings. Parks and green spaces should be located within easy reach of city inhabitants so they can be easily visited on a regular basis. Episodic experiences such as bus and train stops also offer potential sites for providing multiple biophilic experiences that are repeatable on a daily basis (Downton 2016a).

Biophilia is a relatively new and rapidly growing field of study. An overview of the literature on biophilia indicates that there is substantial room for original research (Downton 2016a). There is substantial scope for including monitoring and study of the impact of biophilic design features in the new Metro Tunnel Project (MTP).

Biophilic design can be an educational tool for helping to build ecologically viable urban environments. A biological substrate supports the existence of all human society from the simplest to the most technologically complex. As an integrated element in urban design biophilic design has the potential to raise citizens' awareness of ecological processes and to value that substrate.

SCOPE FOR RESEARCH

The range of biophilic design strategies that may be encompassed by the MTP have additional potential for providing case study based research on aspects of biophilia that are presently poorly represented in the literature. These include:

- Does a biophilic illusory effect need to be in 'real' time to work?
- Do speeded up clouds or diurnal cycles (sunrise to sunset) spoil the illusion in biophilic terms by being not as restful, familiar, or realistic, for instance?
- What is the threshold at which the graphic or pictorial representation of nature becomes too abstract to be effective?
- What is the minimum level of 'nature' required to have a biophilia effect?
- Is there a reality/artificiality 'Truman Show' boundary to biophilic experience?

Source: Downton 2016a.

Figure 2.1: Possible Research Options

There are two aspects to biophilic urbanism as it seeks to bring nature into every element of the built environment: the creation of more natural systems between buildings, and the creation of natural systems on the surface of buildings. Singapore offers a prime example of where a city's planning and development has adopted this approach (Newman 2013).

The greening of Singapore between buildings can be seen overall by comparing two satellite photos from 1986 and 2007, which show that green canopy cover has increased by 20%, despite a 70% increase in population (see Figure 14) (National Parks 2009a). As with the community gardens, which are moving onto building rooftops, there is an increasing sense that the next major phase in biophilic urbanism in Singapore will be on the façades of buildings: green roofs, green walls and green balconies. Newman (2013) has observed that Singapore's biophilic agenda in landscaping buildings is found in both the public and private sectors. This agenda has been specifically articulated in planning regulations that require greenery in (and on) buildings, in the Sky-Rise Greenery Initiatives program that subsidises biophilic initiatives and in the BCA Greenmark scheme which evaluates the sustainability of new developments.

14 PATTERNS OF BIOPHILIC DESIGN

Nature in the Space

1. **Visual Connection with Nature:** A view to elements of nature, living systems and natural processes
2. **Non-Visual Connection with Nature:** Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.
3. **Non-Rhythmic Sensory Stimuli:** Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
4. **Thermal & Airflow Variability:** Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
5. **Presence of Water:** A condition that enhances the experience of a place through seeing, hearing or touching water.
6. **Dynamic & Diffuse Light:** Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
7. **Connection with Natural Systems:** Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.

Natural Analogues

8. **Biomorphic Forms & Patterns:** Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.
9. **Material Connection with Nature:** Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.
10. **Complexity & Order:** Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. .

Nature of the Space Patterns

11. **Prospect:** An unimpeded view over a distance, for surveillance and planning.
12. **Refuge:** A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
13. **Mystery:** The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.
14. **Risk/Peril:** An identifiable threat coupled with a reliable safeguard.

Source: Terrapin 2014: 9-10.

Figure 2.2: 14 Patterns of Biophilic Design

There is, in effect, a spectrum of biophilic design responses. These range from living, biological interventions such as trees, green wall and green roofs, to more tokenistic features such as zoomorphic or biomorphic imagery, and the achievement of biophilia responses by illusory means such as artificial sky, projected images of nature, and screens showing natural or nature inspired scenes.

There is an associated energy and resource gradient associated with these responses. The energy, water and resource cost of living gardens may be at least partially offset by the fact that they are, to a degree, biologically functional and making a contribution ecosystem services and the living systems ecology of the place. The use of biophilic imagery can be very low cost, in terms of resources, energy and money or very high cost depending on how elaborate and extensive the items are.

Illusory biophilia can be understood as 'virtual biophilia' in which electronic (often digital) techniques are used to create the illusion of viewing nature, eg. projections of blue sky above hospital beds. These can have proven effects similar to the biophilic effects of direct (unmediated) connection with nature. However, because a clear distinction can be made between 'actual' and 'virtual' connections with nature it can properly be identified as an additional 'pattern' to add to the table compiled by Terrapin Bright Green LLC (Figure 2.4).

As images become more abstract they are less likely to retain their biophilia affect. At the same time there seems to be a point at which naturalistic realism can give way to more abstract representations of natural forms provided the fractal dimension of the image is between 1.3 and 1.5 (Joye 2007).

Figure 2.3 illustrates the functions of each of the 14 Biophilic Design Patterns proposed by Terrapin Bright Green LLC in supporting stress reduction, cognitive performance, emotion and mood enhancement and the human body.

		14 PATTERNS	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE
NATURE IN THE SPACE	1	**Visual Connection with Nature**	Lowered blood pressure and heart rate *(Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)*	Improved mental engagement/ attentiveness *(Biederman & Vessel, 2006)*	Positively impacted attitude and overall happiness *(Barton & Pretty, 2010)*
	2	**Non-Visual Connection with Nature**	Reduced systolic blood pressure and stress hormones *(Park, Tsunetsugu, Kasetani et al., 2009; Hartig, Evans, Jamner et al., 2003; Orsega-Smith, Mowen, Payne et al., 2004; Ulrich, Simons, Losito et al., 1991)*	Positively impacted cognitive performance *(Mehta, Zhu & Cheema, 2012; Ljungberg, Neely, & Lundström, 2004)*	Perceived improvements in mental health and tranquility *(Li, Kobayashi, Inagaki et al., 2012; Jahncke, et al., 2011; Tsunetsugu, Park, & Miyazaki, 2010; Kim, Ren, & Fielding, 2007; Stigsdotter & Grahn, 2003)*
	3	**Non-Rhythmic Sensory Stimuli**	Positively impacted heart rate, systolic blood pressure and sympathetic nervous system activity (Li, 2009; Park et *al, 2008; Kahn et al., 2008; Beauchamp, et al., 2003; Ulrich et al., 1991)*	Observed and quantified behavioral measures of attention and exploration *(Windhager et al., 2011)*	
	4	**Thermal & Airflow Variability**	Positively impacted comfort, well-being and productivity *(Heerwagen, 2006; Tham & Willem, 2005; Wigö, 2005)*	Positively impacted concentration *(Hartig et al., 2003; Hartig et al., 1991; R. Kaplan & Kaplan, 1989)*	Improved perception of temporal and spatial pleasure *(alliesthesia) (Parkinson, de Dear & Candido, 2012; Zhang, Arens, Huizenga & Han, 2010; Arens, Zhang & Huizenga, 2006; Zhang, 2003; de Dear & Brager, 2002; Heschong, 1979)*
	5	**Presence of Water**	Reduced stress, increased feelings of tranquility, lower heart rate and blood pressure *(Alvarsson, Wiens, & Nilsson, 2010; Pheasant, Fisher, Watts et al., 2010; Biederman & Vessel, 2006)*	Improved concentration and memory restoration *(Alvarsson et al., 2010; Biederman & Vessel, 2006)* *Enhanced perception and psychological responsiveness (Alvarsson et al., 2010; Hunter et al., 2010)*	Observed preferences and positive emotional responses *(Windhager, 2011; Barton & Pretty, 2010; White, Smith, Humphryes et al., 2010; Karmanov & Hamel, 2008; Biederman & Vessel, 2006; Heerwagen & Orians, 1993; Ruso & Atzwanger, 2003; Ulrich, 1983)*

		14 PATTERNS	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE
	6	**Dynamic & Diffuse Light**	**Positively impacted circadian system functioning** *(Figueiro, Brons, Plitnick et al., 2011; Beckett & Roden, 2009)* **Increased visual comfort** *(Elyezadi, 2012; Kim & Kim, 2007)*		
	7	**Connection with Natural Systems**			Enhanced positive health responses; Shifted perception of environment *(Kellert et al., 2008)*
NATURAL ANALOGUES	8	**Biomorphic Forms & Patterns**			Observed view preference *(Vessel, 2012; Joye, 2007)*
	9	**Material Connection with Nature**		Decreased diastolic blood pressure *(Tsunetsugu, Miyazaki & Sato, 2007)* Improved creative performance *(Lichtenfeld et al., 2012)*	Improved comfort *(Tsunetsugu, Miyazaki & Sato 2007)*
	10	**Complexity & Order**	Positively impacted perceptual and physiological stress responses *(Salingaros, 2012; Joye, 2007; Taylor, 2006; S. Kaplan, 1988)*		Observed view preference *(Salingaros, 2012; Hägerhäll, Laike, Taylor et al., 2008; Hägerhäll, Purcella, & Taylor, 2004; Taylor, 2006)*
NATURE OF THE SPACE	11	**Prospect**	Reduced stress *(Grahn & Stigsdotter, 2010)*	Reduced boredom, irritation, fatigue *(Clearwater & Coss, 1991)*	Improved comfort and perceived safety *(Herzog & Bryce, 2007; Wang & Taylor, 2006; Petherick, 2000)*
	12	**Refuge**		Improved concentration, attention and perception of safety *(Grahn & Stigsdotter, 2010; Wang & Taylor, 2006; Petherick, 2000; Ulric et al, 1993)*	
	13	**Mystery**			Induced strong pleasure response *(Biederman, 2011; Salimpoor, Benvoy, Larcher et al, 2011; Ikemi, 2005; Blood & Zatorre, 2001)*

		14 PATTERNS	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE
	14	**Risk/Peril**			Resulted in strong dopamine or pleasure responses *(Kohono et al, 2013; Wang & Tsien, 2011; Zald et al, 2008)*

Figure 2.3: Biophilic Design Patterns and Biological Responses.

		ADDITIONAL PATTERNS	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE	EMOTION, MOOD & PREFERENCE
	15	**Virtual Connection with Nature**	Lowered blood pressure and heart rate *(Brown, Barton & Gladwell, 2013; van den Berg, Hartig, & Staats, 2007; Tsunetsugu & Miyazaki, 2005)*	Improved mental engagement/ attentiveness *(Biederman & Vessel, 2006)*	Positively impacted attitude and overall happiness *(Barton & Pretty, 2010)*

Figure 2.4: Additional Biophilic Design Pattern and Biological Response

The proposed additional pattern recognises similar, albeit weaker effects to Pattern 1 but are generated by virtual connections with nature viewed through mediated means or evoked by simulacrums of nature, living systems and natural processes. Examples include artificial skies, animatronics and portrayal of nature via virtual reality.

1	**Visual Connection with Nature: A view to elements of nature, living systems and natural processes**
+1	**Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes**

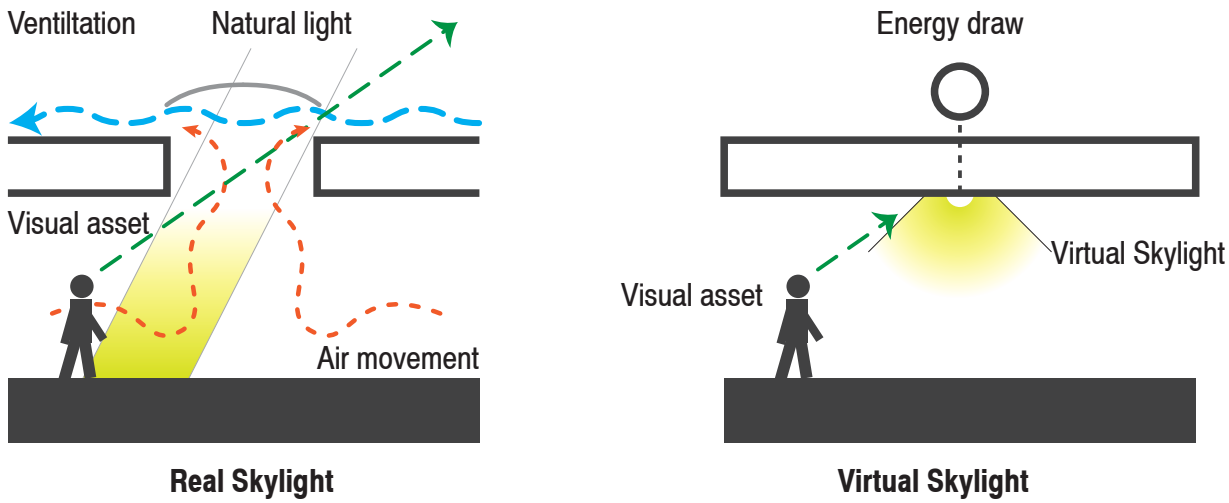


Figure 2.5: Although virtual connections with nature can have a biophilic affect, the difference between 'real' and 'virtual' has a number of aspects as this comparison between skylights indicates.

2.4 Design Narrative Making

Potteiger and Purinton (1998:16) claim that design narratives are possessed of three realms:

1. **the story;**
2. **the context/intercontext, and**
3. **the discourse.**

The story realm seeks to create meaning to place within the elements of the design story crafting characteristics, plots, events, celebratory points in time. Stories also directly engage with context and other texts. The contextual / intercontextual realm is predicated upon the reader, the commuter, the community, and or their memory, creating or inspiring the narrative. The discourse realm is linked to the authorship of the story, whose story is being told and what ideologies have shaped and influenced the lens of the story.

All three realms are interwoven in design making. Design making is essential to the formulation of the spirit of the place that will evolve with the Railway Station design. It is not just wayfinding, literacy of the place, but it possesses the magic, the voices and characteristics of the place expressed through the lens of the designer in the formulation of the qualities and placemaking of the Railway Stations and their adjacent environments.

The built environment professions use design narrative(s) to express and argue for the merits and qualities of design proposals, especially in terms of their innate qualities and not just their responsiveness to client, approvals and policy expectations and requirements.

Thus, to craft a quality railway station, it is not just performance standards, planning requirements, design trends or styles, occupation health and safety requirements that are important, nor the wayfinding, legibility and commercial viability of sub-spaces within the Stations that are important, but it is the magic of the story – the narrative – that will be created that contributes directly to human stimulation, enrichment and satisfaction that will be equality important. Thus the construction of a robust narrative, exploiting many of the biophilic design patterns, will not only create employable railway station complexes but also contributes to satisfying the well-being and healthy city patterns in Biophilic Design as well as MMRA and local council strategic aims and policies.

Potteigger & Purinton (1998: 11) observe that that are 9 types of narratives, of the following summarises the narrative type but also offers a MTP Railway Station related example:

Narrative Type:	MTP Railway Station Example:
Narrative Experiences: routines, rituals, or events that represent of follow narrative structures, e.g. festivals, processions, re-enactments, pilgrimage, daily journeys, cross-the threshold;	• Daily home-work journeys; • Weekend commute to football matches • Venue of Fed Square as a public gathering place
Association and References: Elements: in the landscape that become connected with experience, events, history, religious allegory, or other forms of narrative.	• The Shrine as a place and mental landmark • University of Melbourne as a place and destination

Narrative Type:	MTP Railway Station Example:
Memory Landscapes: Places that serve as the tangible locus of memory, both public and personal. This may develop through implicit association or by international acts of remembering (and forgetting); e/g., monuments, museums, preserved buildings, districts, and regions.	• Flinders Street Clocks as a meeting point • The Shrine and St Kilda Road as interlined war memorial 'sacred' places • Venues of University of Melbourne and RMIT as places of formative tertiary education
Narratives Settings and Topos: A setting is the spatial and temporal circumstances of a narrative. It can recede to the background or figure prominently. A narrative topos is a highly conventionalised settling linked with particular events, which is evoked in repeatedly in a culture's narratives. In Western culture epiphanies occur on mountaintops, and chance meetings take place on the road.	• Sense of arrival coming up the escalators at Melbourne Central being greeted by the Atrium skylight and Shot-tower • State Library lawns as a lunch venue
Genres of Landscape Narratives: Places shaped by culturally defined narratives forms or "genres', e.g., legend, epic, biography, myth.	• Stories and statues of European people who constructed the wealth and leadership of Melbourne, and discovered parts of the Australian continent
Processes: actions or evets that are caused by some agency (wind, water, economies) and occur in succession or proceed in stages towards some end (progress, entropy). Erosion, growth, succession, restoration, demolition, and weathering are visible records or change that inscribe time into landscape forms.	• Floods in Elizabeth Street • Autumnal changes in The Domain, St Kilda Road, Grattan Street and Royal Parade
Interpretative Landscapes: Elements and programs that tell what happened in a place. The intent is to make existing or ongoing narratives intelligible.	• Statues, plaques, fountains as individual features • Building 8 at RMIT, by Edmond Corrigan, as an essay in suburbia house paraphilia and accruements
Narrative as Form Generation: using stories as a meanings of giving order (selecting, sequencing, etc.,) or developing images in the design process. It is not necessary that the story be explicitly legible in the final design forms.	• Swanston Street as an integrated contemporary urban design narrative • William Barak Building, by ARM, as an integrated façade narrative of a past Indigenous leader William Barak
Storytelling Landscapes: Places designed to tell specific stories with explicit reference to plot, scenes, events, character, etc. The stories may be either existing literacy or cultural narratives or produced by the designer.	• The Shrine, and its associated courtyards as stories of segments of wars that instilled and demonstrated the Australian archetype

Figure 2.6: Narrative Types.

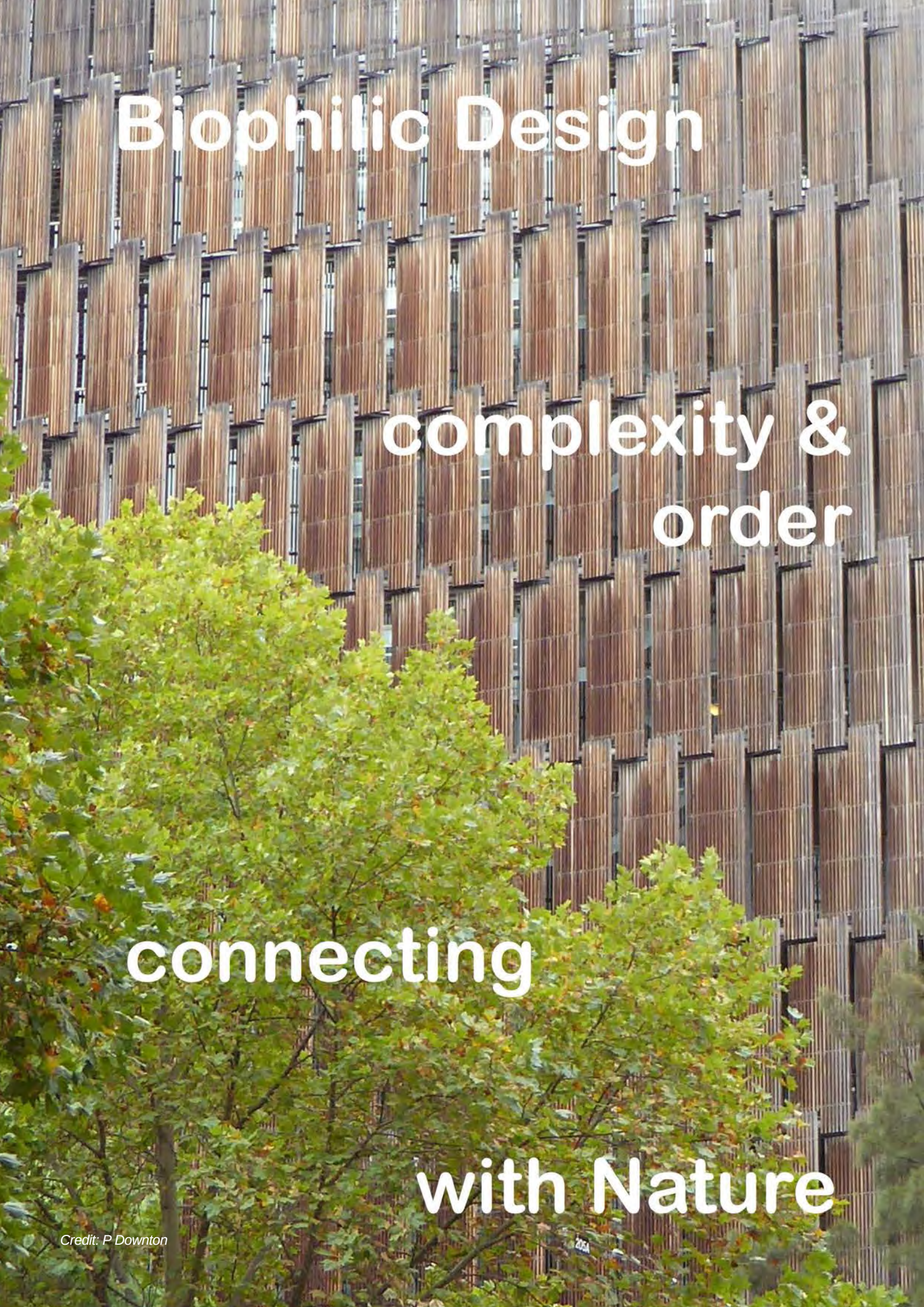
2.5 A Biophilic Design Tool-Kit

Biophilic design is a rapidly evolving discipline and is aspires to become a vital part of making the kind of modern, livable ecocity that Melbourne aspires to become. The MMRA project offers a unique and exciting opportunity to demonstrate how the theoretical benefits of biophilia can be incorporated in a practical manner to the conceptualisation and design of streets, precincts and major urban infrastructure and result in distinctive, healthy and memorable station experiences.

With this in mind, and taking its cue from the success that the '14 Patterns' are beginning to enjoy in the international practice environment, this report concludes by translating biophilic design techniques into a set of 17 recommendations presented in the form of a practice-oriented 'toolkit' that may be considered in the final design and embedded narratives of the five Metro Tunnel stations and their immediate environs.

3

Metro Tunnel Project Context


Biophilic Design
complexity &
order
connecting
with Nature
Credit: P Downton

3.1 Metro Tunnel Project

This is a summarised review of contextual information that only pertains to the MTP railway station complexes, and not to the overall project sites and associated sites. A more detailed review is provided in Appendix 10.1. The purpose of this review is to contextually analyse instruments and documents that are relevant to Biophilic Design as may be applicable for the MTP proposed railway stations.

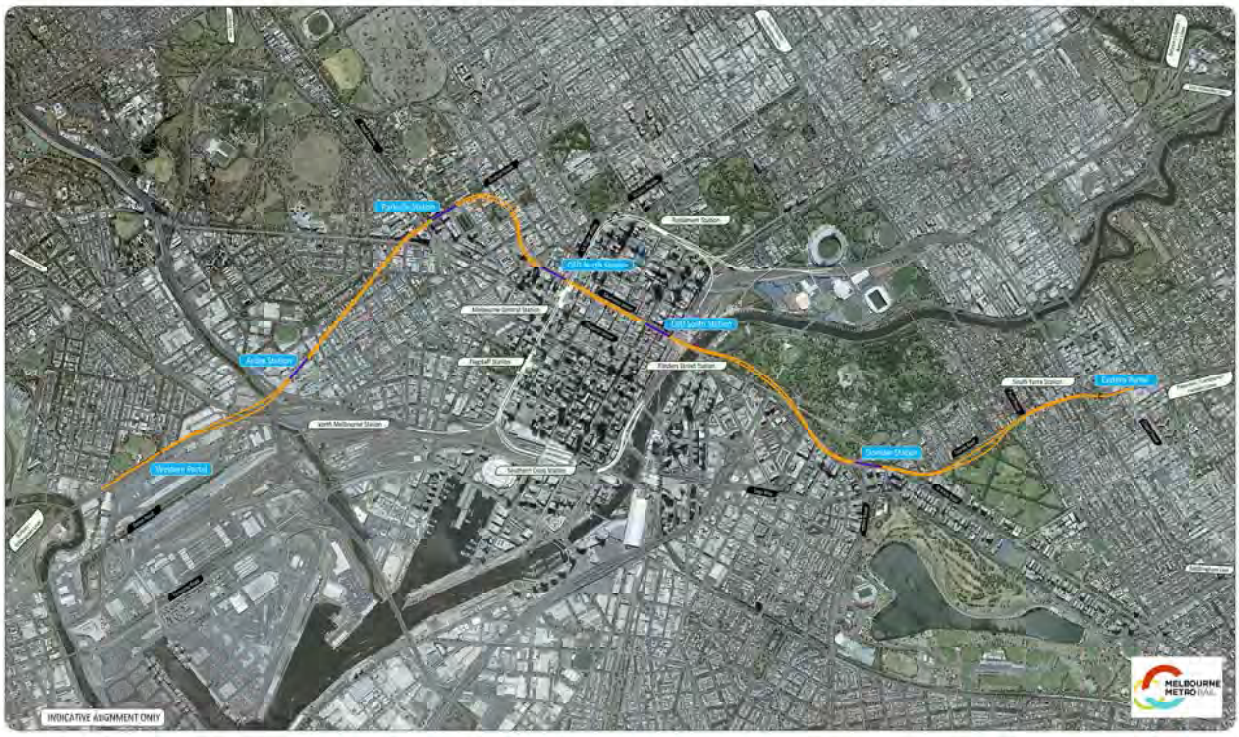


Figure 3.1: Spatial Context of the MTP Railway stations. Source: http://metrotunnel.vic.gov.au/resources/maps

3.2 Australia

The following documents are relevant under this sub-section:

United Nations Conference on Environment and Development (UNCED)

United Nations Conference on Environment and Development

The United Nations Conference on Environment and Development (UNCED), also known as the Rio de Janeiro Earth Summit, was a major United Nations conference held in Rio de Janeiro in 1992.

In terms of Biophilic Design, the intent of both the Rio Declaration and Agenda 21 are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

3.3 Victoria

The following documents are relevant under this sub-section:

Planning & Environment Act 1987

Heritage Victoria (2016), Assessment of Cultural Heritage Significance and Executive Director Recommendation To The Heritage Council: St Kilda Road

Heritage Victoria (2016), Assessment of Cultural Heritage Significance and Executive Director Recommendation To The Heritage Council: Fawkner Park

Heritage Victoria (2013), Decision of Council: Domain Parklands

Planning & Environment Act 1987

The objectives of planning in Victoria are articulated in Section 4(1) of the Planning & Environment Act 1987.

In terms of Biophilic Design, the objectives of "*the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity*" and to "*secure a pleasant, efficient and safe working, living and recreational environment*" are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

Heritage Victoria

Heritage Victoria has recently gazetted two inclusions to the Victorian Heritage Register under the Heritage Act 1995 [Section 32 (1)(a)], pertaining to St Kilda Road and Fawkner Park, that are pertinent to the Domain Station precinct.

In terms of Biophilic Design, there is a minor applicability in these registrations linked to Biophilic Design, mostly in terms of memorial familiarisation of places, cultural and heritage connections, and including mental wayfinding.

3.4 Melbourne Metropolitan Region

The following documents are relevant under this sub-section:

Victoria (2002), Melbourne 2030 - Planning for sustainable growth. Melbourne: Government of Victoria.

Melbourne City Council (2016), Resilient Melbourne: Viable Sustainable Liveable Prosperous Strategy. Melbourne: City of Melbourne Council.

Melbourne 2030 - Planning for sustainable growth

Melbourne 2030 - Planning for sustainable growth (2002) was released by the State of Victoria in October 2002 as a 30 year plan to manage urban growth and development across metropolitan Melbourne.

In terms of Biophilic Design, the Directions 7 and 8 of "*a greener city*" and "*better transport links*" are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

Resilient Melbourne: Viable Sustainable Liveable Prosperous Strategy (2016)

In May 2016 the City of Melbourne Council released the Resilient Melbourne: Viable Sustainable Liveable Prosperous (2016) strategy is joint project of 32 metropolitan Melbourne councils, Melbourne's academic, business and community sectors, and the Victorian Government.

In terms of Biophilic Design, the Objective of "*Our Share Places: Create and sustain buildings, infrastructure and activities that promote social cohesion, equality of opportunity and health links*" is directly aligned and applicable to the execution of successful Biophilic Design outcomes.

3.5 Melbourne Metro Rail Authority Assessments

The following documents are relevant under this sub-section:

AJM (2016), Aboriginal Cultural Heritage Impact Assessment.

AJM (2015), Adoption of Climate Change Scenarios and Projections Report.

AJM (2016), Aquatic Ecology and River Health Impact Assessment.

AJM (2016), Climate Change Adaptation Plan.

AJM (2016), Climate Change Adaptation Plan Reference Design Report.

AJM (2016), Climate Change Risk Assessment Report.

AJM (2016), Design for Climate Change Framework.

AJM (2016), Drainage and Flooding Reference Design Report.

AJM (2016), Public Realm Reference Design Report. Melbourne: AJM.

AJM (2016), Terrestrial Ecology Impact Assessment.

Aurecon (2016), Melbourne Metro Rail Project: Daylight Modelling Report.

Golder Associates (2016), Contaminated Land Assessment – EES Summary Report.

Golder Associates (2016), Regional Groundwater Numerical Modelling – EES Summary Report.

John Patrick Pty Ltd (2016), Arboricultural Impact Assessment Report: Melbourne Metro Rail Authority

Lovell Chen (2016), Predictive Archaeological Assessment: Prepared for AJM Joint Venture.

Lovell Chen (2016), Melbourne Metro Rail Project: Historical Heritage Impact Assessment.

MMRA (2016), EES Chapter 16 Landscape and Visual Technical Report.

Urbis (2016) Melbourne Metro Rail Project: Landscape and Visual Impact Assessment.

Victoria (2017), Melbourne Metro Rail: Urban Design Strategy.

The above reports, summarised in the below discussion, have been mapped against the Biophilic

Design patterns in terms of relevance, as follows (high (H), medium (M) and low (L)):

	Narrative	Visual Connection with Nature	Non-Visual Connection with Nature	Non-Rhythmic Sensory Stimuli	Thermal & Airflow Variability	Presence of Water	Dynamic & Diffuse Light	Connection with Natural Systems	Biomorphic Forms & Patterns	Material Connection with Nature	Complexity & Order	Prospect	Refuge	Mystery	Risk/Peril	Virtual Connection with Nature
AJM (2016), Aboriginal Cultural Heritage Impact Assessment.	L							L								
AJM (2015), Adoption of Climate Change Scenarios and Projections Report.		L	L		L			L							M	M
AJM (2016), Aquatic Ecology and River Health Impact Assessment.						M										
AJM (2016), Climate Change Adaptation Plan		L	L		L			L							M	M
AJM (2016), Climate Change Adaptation Plan Reference Design Report.		L	L		L			L							M	M
AJM (2016), Climate Change Risk Assessment Report		L	L		L			L							M	M
AJM (2016), Design for Climate Change Framework.		L	L		L			L							M	M
AJM (2016), Drainage and Flooding Reference Design Report.						M									M	
AJM (2016), Public Realm Reference Design Report. Melbourne: AJM	L	L	L			L		L	L	L	L					
AJM (2016), Terrestrial Ecology Impact Assessment		L						L								
Aurecon (2016), Daylight Modelling Report.							M									
Golder Associates (2016), Contaminated Land Assessment				M				M								
Golder Associates (2016), Regional Groundwater Numerical Modelling						L									M	
John Patrick Pty Ltd (2016), Arboricultural Impact Assessment Report		M						M		M						
Lovell Chen (2016), Predictive Archaeological Assessment.	L															
Lovell Chen (2016), Historical Heritage Impact Assessment.	L							L								
MMRA (2016), EES Chapter 16 Landscape and Visual.																
Urbis (2016) Landscape and Visual Impact Assessment		H										M	M	M		
Victoria (2017), Metro Tunnel: Urban Design Strategy.	H										M	M	M	M	L	

Figure 3.2: MMRA Report mapping to 14 Biophilic Design Patterns

These reports and assessments are considered in the following subsections.

Climate Change Assessments

Various climate change risk assessment evaluations, cited above, have been undertaken by the MMRA. The *Climate Change Adaptation Plan* (2016) recognises the MMRA responsibility to consider climate change impacts.

In terms of Biophilic Design, there are evident warnings in these conclusions to better insulate and mediate the impacts of heat, drought, erratic weather patterns, and variable water tables upon the station areas, their designs and the spaces created to accommodate humans and biodiversity.

Aboriginal Cultural Heritage Impact Assessment

The Aboriginal Cultural Heritage Impact Assessment sought to provide an understanding of the Aboriginal cultural heritage present within the Metro Tunnel study area and to identify potential risk, as it relates to Aboriginal cultural heritage.

In terms of biophilic design, there is little pertinence in the appraisals and recommendations, less clues that the bio-geography of the landscape pre-contact offers ecological and ethnobotanical resources and properties that could be scaffolded into the patterns.

Predictive Archaeological Assessment

The Predictive Archaeological Assessment (2016) sought to review archaeological sites included on the Victorian Heritage Inventory (VHI) and to assess the potential for additional previously unmapped post-settlement (ie, non-Indigenous) sites at these locations.

In terms of biophilic design, there is little pertinence in the appraisals and recommendations, less clues that excavations may identify archaeological evidence of old underground service infrastructure.

Historical Heritage Impact Assessment

This report provides an assessment of the potential historical cultural heritage issues and impacts of the Metro Tunnel Project. These include potential physical and visual impacts on heritage places or objects from the construction works and permanent infrastructure associated with Metro Tunnel .

In terms of biophilic design, there is strong pertinence in the appraisals and recommendations as it relates to the appearance, character, physical and mental engagement with the station users and care should be taken to delimit loss of built form and natural form elements, visual attributes, landscape and built form characteristics and qualities.

Arboricultural Impact Assessment

The Arboricultural Impact Assessment (2016) provides an evaluation of potential impacts to trees associated with the construction and operation of the MTP including trees managed by the City of Melbourne and the City of Port Phillip, the University of Melbourne as well as other trees located within publicly owned (VicTrack) land at Arden. The Metro Tunnel alignment and associated infrastructure potentially interacts with trees at locations where works at, or close to, ground level would occur, including proposed stations, emergency access shafts and construction work sites.

In terms of Biophilic Design, the assessment offers an insight as to the extent of tree vegetation removal only that may occur as a consequence of the MTP construction and allied works.

Drainage and Flooding

The Drainage and Flooding Reference Design Report (2016) investigated drainage Infrastructure for, inter alia, for the tunnels and stations, and flooding impact to the tunnels. The engineering design, accordingly, assumes that tunnel drainage "is designed primarily to remove flows from the tunnel and stations caused by operation of the fire hydrants, with a secondary function of removing any ground water seepage that may occur".

In terms of Biophilic Design, the assessment offers little applicability and the disappointment is that no capacity in the station designs has been made available for water harvesting and storage that would have aided, supported biophilic design initiatives and improved overall sustainability performance.

Aquatic Ecology and River Health Assessment

The Aquatic Ecology and River Health Assessment (2016) provides an assessment of the potential impacts on water quality, stream health and aquatic biodiversity in waterways from activities associated with construction and operation. The focus for the assessment was upon the natural and man-made waterways that lie within the tunnels alignment or that could be impacted by stormwater runoff from associated construction and operational activities and improved overall sustainability performance.

Terrestrial Ecology Impact Assessment

The Terrestrial Ecology Impact Assessment (2016) report provides an assessment of the potential impacts on terrestrial flora and fauna and relevant environmental management requirements associated with the construction and operation of the MTP. These include potential threatened species issues and other impacts to matters listed under relevant state and federal environmental legislation, including the loss of vegetation.

In terms of biophilic design, the assessment is only concerned with the connection between endangered species (principally avifaunal) and tree loss, and does not concern itself with common native and introduced fauna and avifaunal that are present and will likely continue to be present in and at the railway station sites.

Daylight Modelling Report

The Daylight Modelling Report (2016) sought to assess the simulated performance of the train stations against the Green Building Council of Australia 'Green Star' daylighting criteria for train stations. It specifically focuses on the criteria 'IEQ credit 16.1 Daylight' that aims to encourage and recognise designs that have good levels of natural light. The station platforms have been excluded from this study due to their depth underground and having no access to natural daylight.

In terms of biophilic design, there considerable importance in maximising natural daylight into the station platforms, concourses and associated spaces to aid both human and vegetation access to this resource.

Urban Design Strategy

The Urban Design Strategy (2017:3) seeks to provide urban design guidance relating to the design, procurement and implementation of the Metro Tunnel , and in particular:

- State the broad urban design expectations for Metro Tunnel .
- Ensure that the project's landscape and visual impacts are addressed in a way that maximises the project's positive contribution to Melbourne.
- Set out design guidelines that, along with further detailed content, will inform the technical specifications for the project's procurement phase.
- Identify areas of concern to be assessed through an expert peer review process during the development and finalisation of designs for the project.

In terms of biophilic design, this carefully conceived Urban Design Strategy (2016) is closely aligned to Biophilic Design patterns and outcomes. It offers a set of Aims, Objectives and Design Guidelines in which to scaffold a comparable set of aims, objectives and guidelines to permit both documents to synergistically work together to aid designers and tenderers.

Landscape and Visual

Chapter 16 of the EES addresses Landscape and Visual considerations provides an assessment of the landscape and visual qualities and impacts associated with the construction and operation of Metro Tunnel .

In terms of Biophilic Design, the quality of resolution set out in the Chapter as to the landscape and visual qualities of the proposed railway station sites, during and after construction is superficial, lacking any guidance so as to inform and influence the quality physical forms of structures and landscape engagement that could occur.

Landscape and Visual Impact Assessment

The Landscape and Visual Impact Assessment (2016) report assessed the potential landscape and visual impacts of the project including those on recreational values. While noting that the majority of the proposed rail alignment and subsequent works are to be located underground, such locations were within close proximity to several above ground structures that would experience some level of landscape and visual impacts during the project's construction and operation phase. Additionally, it recognised that the project area includes several high quality streetscape environments defined by their canopy trees including the significant Royal Parade, Swanston Street and St Kilda Road boulevards.

In terms of Biophilic Design, the quality of investigation offers valuable insights as to visual qualities and attributes of places, corridors, trees and associated vegetation, key characteristics, and a social perspective about the qualities of the city per place analysed. The latter in particular is relevant to Biophilic Design.

Soils and Geology

A review of the soils and geology of the landscape traversed through by the MTP project are contained in the Groundwater EES chapter and associated Technical Reports. The route of the underground line passes through several geological Periods, Epochs and Stratigraphic Units. In essence, land to the north of the River Yarra is heavily influenced by volcanic layers of the Pliocene and Oligocene to Miocene Epochs (of harder and younger

geological layers) whereas land to the south is more influenced by the Pleistocene epoch (of softer and older geological layers).

In terms of Biophilic Design, the attribute here is the geological profile and potential narrative that the tunnels and station complexes can articulate about the geological history of Melbourne. This is especially so given the prolific use of the sawn volcanic basalt as a keynote material in formulating Melbourne urban design character.

Surface Drainage

A review of the surface drainage patterns of the landscape traversed through by the MTP project are contained in the Surface Water EES chapter and associated Technical Report. The route of the underground line passes underneath various topographical undulations and surface permanent, intermittent and flood-activated drainage lines. While the River Yarra is a permanent watercourse, drainage lines through the University of Melbourne, down the Elizabeth Street corridor, along the Kings Way corridor connecting to Albert Park Lake and the expansive flood plains of the Moonee Ponds Creek present risks and opportunities to the project. The main floods risks are associated with Arden Station, and to a far lesser extent Parkville and Domain stations because of surface water drainage patterns and pondings.

In terms of Biophilic Design, the attribute here is the need to accommodate existing surface drainage patterns, and infrequent flood events and pondings. Additionally, and more importantly, calibrate these patterns in climate change modelling to cater for increased frequency of rain events (and thus flooding), but also to consider the capacity of Melbourne's existing underground infrastructure to cater for increased flow and volume loads.

3.6 City of Melbourne Council

The following documents are relevant under this sub-section:

City of Melbourne (2013), Melbourne City Council: Council Plan 2013-17. Melbourne: City of Melbourne Council.

City of Melbourne (2012), Urban Forest Strategy: Making a great city greener 2012-2032. Melbourne: City of Melbourne.

City of Melbourne (2016), Draft Urban Ecology and Biodiversity Strategy: The city as an ecosystem. Melbourne: City of Melbourne Council

City of Melbourne (2016), Melbourne Planning Scheme.

Melbourne's Council Plan 2013-17 (2013)

The City of Melbourne' Strategic Plan articulates a "*Vision to create a bold, inspirational and sustainable city.*" The 8 goals of this Plan (2013) focus upon creating: "*a city for people, a creative city, a prosperous city, an eco-city, a connected city, that resources are managed well, that resources are managed well, and to create an accessible, transparent and responsive organisation*" (MMC page 6).

This Plan (2013) sets a goal forth of creating "an eco-city' with benchmarks that seek to enhance the greening of the city against current vegetation patterns, densities and canopies in the City of Melbourne.

Melbourne's Urban Forest Strategy (2012)

This Strategy (2012) is one of the most comprehensive urban forest strategies being implemented in the world. At the core of this strategy is "*a vision to create a resilient, healthy and diverse forest for the future*" that respects Melbourne's unique character, responds to climate change and urban expansion, and underpins the health, liveability and wellbeing of the city and its inhabitants. To create resilient landscapes, community health and wellbeing and a liveable, sustainable city, this vision seeks to make the City of Melbourne greener – "*to create a city within a forest rather than a forest within a city*" (MMC 2012: 5).

In terms of biophilic design, the Urban Forest Strategy (2012) recognises the key urban ecology variables of an urban environment, and it particular the significant and value of green foliage as aiding the overall health of the city. In support of the City of Melbourne Council Plan and Urban Forest Strategy objectives, MMRA has developed performance requirements to minimise impacts on trees across the project and enhance canopy growth through the planting of advanced trees in improved growing conditions. Trees will be replaced and additional trees will be planted to provide for a doubling of tree canopy across the project by 2040, as compared to the base case. The performance requirements are set in the *Living Infrastructure Plan* (LIP, 2017)

Draft Urban Ecology And Biodiversity Strategy: The city as an ecosystem (2016)

A companion to the Urban Forest Strategy (2012), the Draft Urban Ecology and Biodiversity Strategy (2016) that has been recently released for public consultation, envisages that "*The City of Melbourne will support a diverse, resilient and healthy ecosystem that contributes to the health and wellbeing of our community and the foundation of a liveable city*" (MMC 2016: 6).

In terms of Biophilic Design, this Draft Urban Ecology and Biodiversity Strategy (2016) is instrumental in recommending ground surface level and upper storey initiatives and actions aligned to the overall Urban Forest Strategy (2012). It offers valuable insights as to existing technological and environmental design knowledge, and articulates the need for flexibility to accommodate future knowledge recognising that this realm is rapidly changing. The latter in particular is relevant to biophilic design.

Melbourne Planning Scheme (2016)

The Melbourne Planning Scheme (2016) sets out policies and requirements for the use, development and protection of land.

In terms of biophilic design, the Goal to become an ecocity strongly engages with Biophilia and biophilic design Patterns, and is very relevant to this investigation.

3.7 City of Port Phillip Council

The following documents are relevant under this sub-section:

City of Port Phillip (2016), Port Phillip City Council: Council Plan 2013-17 (rev 2016). St Kilda: City of Port Phillip Council.

City of Port Phillip (2009), City of Port Phillip Open Space Strategy. St Kilda: City of Port Phillip Council.

City of Port Phillip (2016), Greening Port Phillip: Street Tree Planting Guide: 2010-2015. St Kilda: City of Port Phillip Council

City of Port Phillip (2016), Port Phillip Planning Scheme.

Port Phillip City Council: Council Plan 2013-17

The City of Port Phillip's Council Plan 2013-17 (2016) consists of 16 strategic objectives in four areas of:

- Healthy - A healthy, creative and inclusive City
- Engaged - A well governed City.
- Resilient - A strong, innovative and adaptive City
- Vibrant - A liveable and connected City

In terms of Biophilic Design, the Council Plan (2016) has little articulation to policy commitments to urban ecology enhancement, biodiversity conservation, except in terms of "*Reduction in Council's total greenhouse gas emissions per annum (reported annually)*" (PPC 2016: 17), nor to the Council's Greening Port Phillip Strategy (2010).

City of Port Phillip Open Space Strategy (2009)

The Open Space Strategy (2009) seeks to guide the actions of the Council "to continue to offer open space that is diverse and can accommodate the future needs of a growing population in an established urban environment and in a sustainable way" (PPC 2009: 4). The Vision for the City of Port Phillip's Public Open Space is:

A city where public open spaces define the city's character and respond to its people's need for places to rest, recreate and be inspired (PPC 2009: 4).

In terms of Biophilic Design, the Open Space Strategy (2016) substantially seeks the maintenance, and sustainable enhancement of existing open space resources and infrastructure. There is little articulation to policy commitments to urban ecology enhancement, biodiversity conservation, and a cursory link to the Council's Greening Port Phillip Strategy (2010).

Greening Port Phillip: Street Tree Planting Guide: 2010-2015

The Greening Port Phillip Strategy (2010) perceives that the mix of public and private trees and other vegetation collectively comprise an urban forest that provides:

… shelter, shade, beauty, cleans the air, regulates the temperature, reduces energy needs of nearby spaces, treats and cleans stormwater, reduces loads on stormwater drains, protects and increases the life of infrastructure and provides habitat. An urban forest is defined as the 'sum total of all trees and associated vegetation growing within an urban area (PPC 2010: 3).

In terms of Biophilic Design, the Greening Port Phillip Strategy (2016) has a strong alignment to the vegetative, aesthetic, wellbeing and biodiversity patterns of biophilic design.

Port Phillip Planning Scheme (2016)

The Port Phillip Planning Scheme (2016) sets out policies and requirements for the use, development and protection of land.

In terms of Biophilic Design, while not explicit in the City of Port Phillip's Council Plan (2016), the Greening Port Phillip Strategy (2010) charts alignment to the concepts of Biophilic Design, and is very relevant to this investigation.

Refer to Appendix 10.1 for additional detail and background on the context of the Metro Tunnel Project.

4

Metro Tunnel Project Railway Stations

Metro Biophilic Design

Credit: P Downton

4.1 Introduction

Strategically the design-based applied research project seeks to take the principles of environmental design further, and to include biophilic design in creating healthy places for patrons and users, and identify the indoor and ambient (outdoor) environmental qualities for these stations to consider in supporting successful biophilic outcomes (e.g. daylight, water, air, visual, nutrients, etc.) as well as supporting the larger greening of the above ground environment in line with the City of Melbourne's Greening Agenda contained in their *Urban Forest Strategy: Making A Great City Greener 2012-2032* (2012), and the City of Melbourne's desire to craft Melbourne as an "eco city" of which biophilia theory resides within.

In this chapter, the typology of each of the five MTP Stations is analysed on the basis of their comparative underground and above ground profiles. Each station profile is assessed for its biophilic design opportunities and biophilic design principles are matched against the MMRA Urban Design Strategy on a station-by-station basis. The toolkit for applying those principles is given in Chapter 8 Recommendations.

4.2 Metro Tunnel Project Railway Stations

Figure 4.1 Metro Tunnel Rail Stations and Conceptual Rail Route

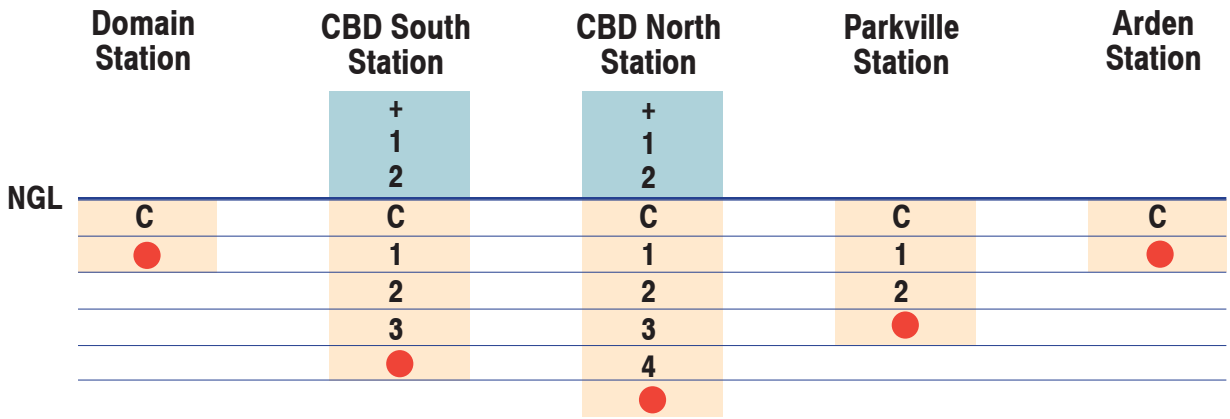


Figure 4.1: Comparative underground and above ground profile of the MTP Rail Stations indicating nominal ground level (NGL).

4.3 Typologies

Based on the biophilic design opportunities of each station and its immediate environs including (but not exclusively) the following areas/zones related to each station:

- ISE **Integration with streetscape and environments – ISE**
- UC **Underground concourse areas – UC**
- ES **Escalator shafts – ES**
- P **Plazas – P**
- E **Entrances – E**
- MC **Movement corridors – MC**
- SP **Station platforms – SP**

Effective biophilic design will not be achieved solely by relying on the growing of living plants in the station environments – there are many limitations on the location and type of vegetation that might be successfully introduced in the stations and their immediate environs. Fortunately, the palette of biophilic design stretches from living plants to the choice of (non-living) materials, and from biomorphic forms and patterns to the play of light and soundscape and air movement to 'seeing the outside'. Not least, there is potential for public art to be employed in some form throughout the stations, integrated with the built form, and where the environment is subterranean and unable to accommodate any kind of natural light, there is always the option of achieving a virtual connection with nature, perhaps using electronic means and the little researched technology of virtual reality.

The following analyses identify biophilic design opportunities on a station-by-station basis and should be read in conjunction with Chapter 8 Recommendations that describe a set of tools for achieving biophilic design.

4.4 Domain Station

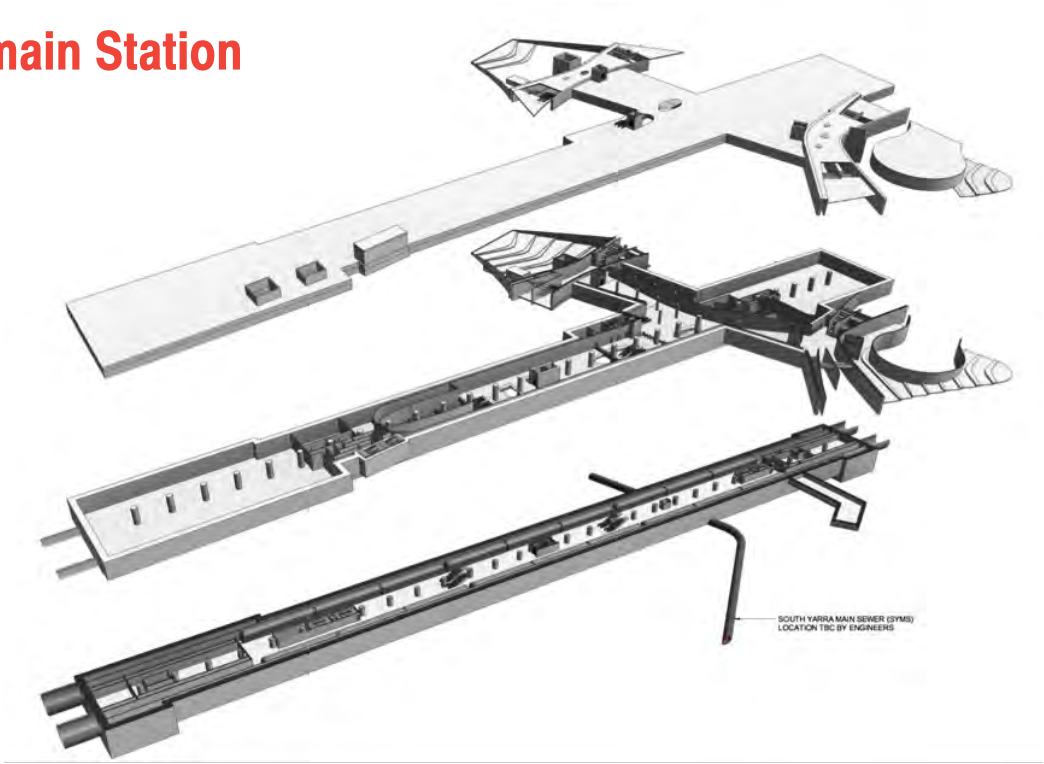
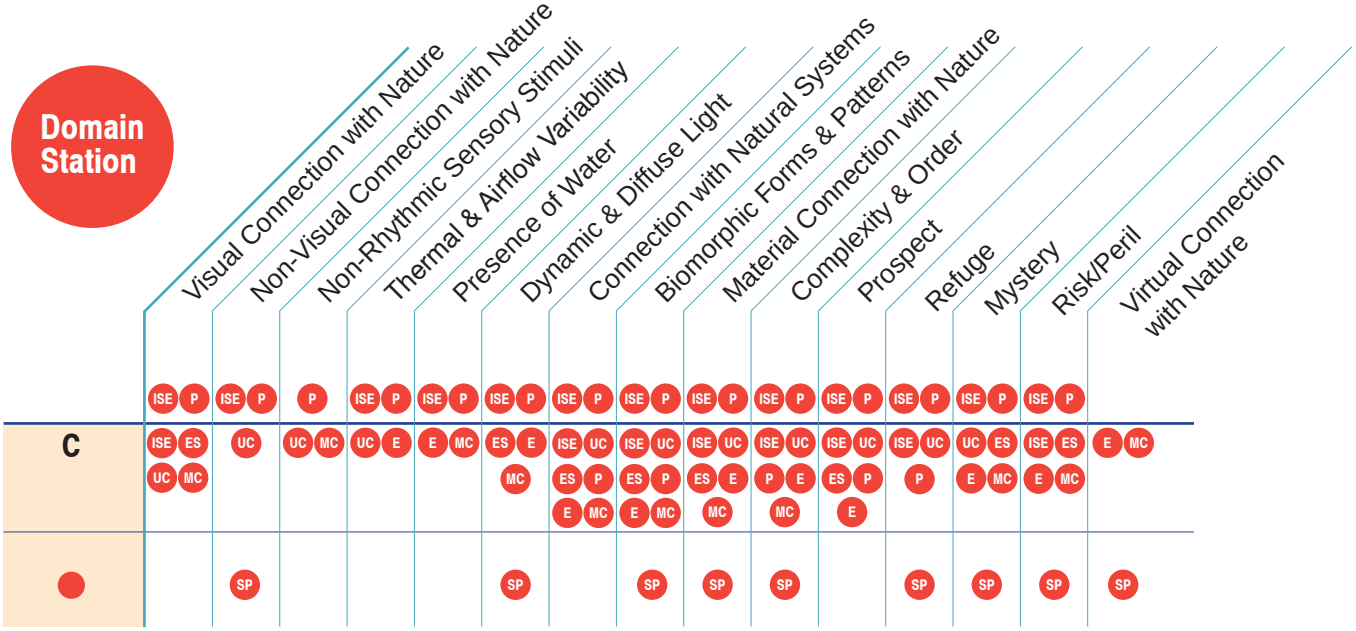


Figure 4.2: Biophilic Design Opportunities Domain Station per Pattern



KEY to Location of Biophilic Design Opportunities

- ISE **Integration with streetscape and environments – ISE**
- UC **Underground concourse areas – UC**
- ES **Escalator shafts – ES**
- P **Plazas – P**
- E **Entrances – E**
- MC **Movement corridors – MC**
- SP **Station platforms – SP**

The Domain Station has only two levels and is not heavily overshadowed by existing structures. Its potential for employing natural light is relatively good, although dependent on the availability of affordable light channelling technologies in the context of a constrained engineering environment. The station's entry and underpass suggest strong possibilities for addressing prospect as a biophilic design element, along with non-visual connections with nature by paying attention to the ambient acoustic environment and exploring the potential for managing the soundscape of the station as a means of reinforcing its connection with the above-ground Domain environment.

Despite being designed primarily as a place for exotics and introduced species, the Domain Parklands remain home to native fauna, including Brush-tailed and Ring-tailed possums, Tawny Frogmouths, Magpies, Gould's wattled bats, Eastern Freetailed bats and Grey headed flying foxes, Native water rats (Rakali), Kookaburras and several varieties of waterbirds. Connection with these denizens of natural systems could be identified and celebrated in related biomorphic forms and patterns, public art, and the creation of virtual connections with nature. (RBGV 2016).

The underpass/entry zone also offer opportunities to take the inevitably variable thermal and airflow characteristics of the environment as positive means for connecting the station experience to diurnal and seasonal variations in the weather.

The concepts and experience of refuge, and risk/peril might be positively linked to a theme of conflict and resolution.

Figure 4.4 Station Characteristics Domain Station

Domain Station	Pre-European	Early European	C20th & Present Day
Culture	Boon Wurrung/ Bunnerong Wurundjeri	South African Soldiers Memorial Royal Botanic Gardens Pioneer Women's Memorial Garden	Music Bowl World Wars Memorials Shrine of Remembrance
Biology	Brackish wetland/swamp Ecology dominated by indigenous species	Swamps filled in Shift from saline to freshwater Ecology changed by exploitative use	Human dominated Formal European character Mostly introduced, exotic & ornamental species of fauna & flora
Geology	Sedimentary/alluvial		
Theme	Conflict & resolution, remembrance & reflection		

Figure 4.5 Biophilic Design Principles

	MMRA Urban Design Strategy		Biophilic Design Principles
	St Kilda Road Sub-Precinct	Albert Road Reserve Sub-Precinct	
Aim	St Kilda Road's character as one of Melbourne's iconic, tree-lined formal boulevards will be protected and enhanced, with the new tram interchange making a positive civic contribution to this setting and contributing to better pedestrian connectivity across the intersection.	The Albert Road Reserve and Albert Road between St Kilda Road and Kings Way will be improved as a high quality pedestrian environment with better connectivity and opportunities for casual recreational use, and as a green link between Albert Park and the Domain parklands.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P11 Prospect: An unimpeded view over a distance, for surveillance and planning. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)
	1. Create an integrated multi-modal transport interchange.	1. Enhance walking and cycling links through the area.	P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal
	2. Protect and enhance St Kilda Road's formal boulevard character.	2. Enhance the extent and amenity of usable public open space.	P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
		3. Respect and integrate with the heritage values and civic character of the area.	P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)
	1. Consider stakeholder requirements for St Kilda Road from Toorak Road to Dorcas Street, and ensure the potential for integration of works in the project area with future implementation of streetscape improvements by others beyond the project area.	1. Consider stakeholder requirements for Albert Road and ensure the potential for integration of works in the project area with future implementation of streetscape improvements by others beyond the project area.	P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)
	2. Provide convenient pedestrian access across St Kilda Road via both the proposed station subway and by improving the safety and amenity of street level crossings.	2. Respect the heritage values of the reserve and memorials in it.	P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

Figure 4.5 Biophilic Design Principles

	MMRA Urban Design Strategy		Biophilic Design Principles
	St Kilda Road Sub-Precinct	Albert Road Reserve Sub-Precinct	
	3. Provide protected bicycle lanes, connecting safely and conveniently to bike lanes north and south of the project area.	3. Minimise the loss of trees and replant where appropriate in order to: -- Enhance local amenity. -- Reinforce the geometry of the street layout. -- Contribute to a green link between the Shrine Reserve and Albert Park.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)
	4. Complement St Kilda Road's formal boulevard character: -- Maintain or recreate a generally symmetrically balanced layout, with regular kerb alignments typically set parallel to the road's centreline, and large canopy trees. -- Design the island tram stop/interchange as a high quality public space with a formal design character that complements the boulevard setting. -- Coordinate or integrate passenger shelters at the tram stop with weather protection for the Metro Tunnel station entry. -- Arrange tram overheads to minimise visual clutter and to allow for tree planting. -- Minimise commercial advertising except as allowed under current PTV contracts with providers of tram shelters.	4. Minimise impacts on culturally significant features and fabric: --Maintain the South African Soldiers Memorial's formal visual links to St Kilda Road and the Shrine of Remembrance. --Sensitively reinstate or relocate other existing memorials as required. -- Retain or replace significant trees.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes) P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics) P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place. P11 Prospect: An unimpeded view over a distance, for surveillance and planning.
	5. Reconstruct the area of the existing tram interchange, north of the new one, to a design complementing and transitioning back into the typical boulevard layout of St Kilda Road with side service roads separated from the central carriageway by treed medians.	5. Enhance pedestrian and cyclist access to the new station: -- Widen and repave footpaths. -- Connect bike paths through the area and provide bicycle parking.	P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

Figure 4.5 Biophilic Design Principles

	MMRA Urban Design Strategy		Biophilic Design Principles
	St Kilda Road Sub-Precinct	Albert Road Reserve Sub-Precinct	
	6. Locate and design vent shafts to minimise their visual impacts: -- Minimise impacts on important views, in particular the Shrine of Remembrance vista. -- Ensure safe sightlines at intersections and pedestrian crossings. -- Integrate with the design of passenger shelters and weather protection for the Metro Tunnel entries, where possible. -- Allow for integration with necessary signage. -- Complement the formal design character of St Kilda Road.	6. Create a high quality open space and facilities to support local residents' and office workers' social and passive recreational activities. -- Provide spaces for seating and casual social interaction. -- Avoiding fragmenting useable open spaces with busy pedestrian routes. -- Rationalise and reduce trafficable road space and car parking areas and convert to pedestrian use where possible.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics) P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
		7. Provide for vehicular access to properties, car parks and for servicing.	P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
	++St Kilda Road North Precinct Plan, City of Port Phillip, updated 2015.43 ++St Kilda Road Precinct: Public Realm and Linkages Opportunities Study, City of Port Phillip, 2011.44 ++Sustainable Transport Management in St Kilda Road Precinct, Ratio Pty Ltd for the City of Port Phillip, 2011.45 43. portphillip.vic.gov.au/stkilda-rd-precinct-review.htm 44. portphillip.vic.gov.au/default/StrategicPlanningDocuments/Public_Realm_and_Linakges_Opportunties_Study_October_2011_(with_Disclaimer).pdf (Continue) 45. portphillip.vic.gov.au/default/Sustainable_Transport_Management_in_St_Kilda_Road__Draft_Study_October_2011_(with_Disclaimer_and_maps).pdf		

4.5 CBD South Station

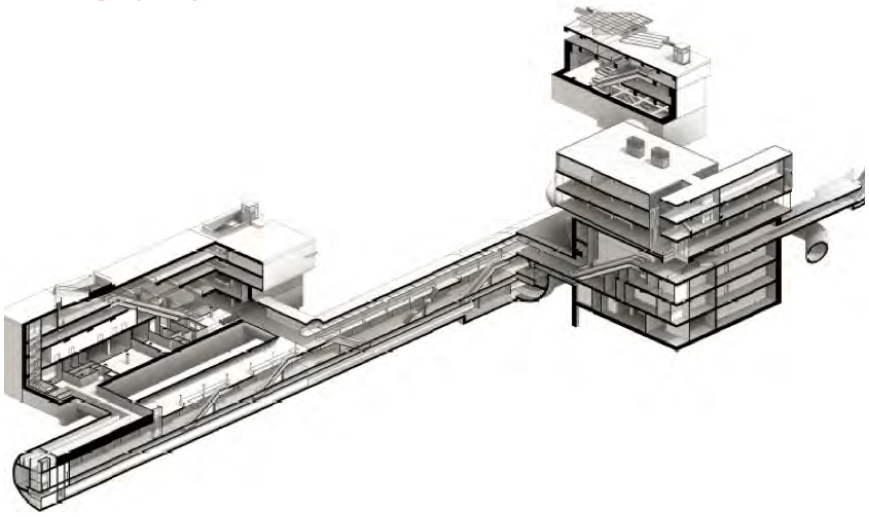


Figure 4.6: Project Drawing Number: MMR-GRM-UGCS-DR-AA-740000 – Revision 3.10

CBD South Station

	Visual Connection with Nature	Non-Visual Connection with Nature	Non-Rhythmic Sensory Stimuli	Thermal & Airflow Variability	Presence of Water	Dynamic & Diffuse Light	Connection with Natural Systems	Biomorphic Forms & Patterns	Material Connection with Nature	Complexity & Order	Prospect	Refuge	Mystery	Risk/Peril	Virtual Connection with Nature
+	E ES	E ES	E ES	E ES	E ES	E ES	E ES	E	E	E	E	E ES	E ES		
2	E	E		E	E	UC E	E	MC	E	E		E	E		
1	ISE P E	ISE	ISE	ISE P E	ISE P E	ISE	ISE P E	ISE P E	ISE P	ISE P	P		ISE E		
C	UC ES	UC ES	UC ES	UC ES	UC ES	UC ES	UC	UC ES	UC ES	UC ES		UC ES	UC ES	UC ES	UC
1	ES	MC		ES		ES		ES MC	MC	ES	ES		ES MC	ES	E
2		MC						MC	MC				MC		MC
3		MC						MC	MC				MC		MC
●		SP						SP						SP	MC SP

KEY to Location of Biophilic Design Opportunities

- ISE **Integration with streetscape and environments – ISE**
- UC **Underground concourse areas – UC**
- ES **Escalator shafts – ES**
- P **Plazas – P**
- E **Entrances – E**
- MC **Movement corridors – MC**
- SP **Station platforms – SP**

The Skylight Water Feature (Project drawing # MMR-GRM-WOCS-DR-AA-742101) is an intrinsically biophilic design feature with potential to be further developed.

The Open Void adjacent to Flinders Lane has significant biophilic design potential.

Together, the skylight and open void together offer an opportunity to create a powerful biophilic impact by modelling the underground built form in such a way that it meets the ground (street) level of City Square with landscaping forms (possibly terraced) that transition from the surface to the subterranean levels with strong articulation, extensive vegetation, water elements and textural/haptic experiences.

The potential for inspired use of vegetation (including tree planting), with the opportunity to restate and renew the prominence of City Square appears possible.

The water of the Skylight Water Feature might be circulated in three dimensions to:

- Add positive visual, acoustic and air quality elements to the station;
- Be part of water quality management (water sensitive design);
- Create a feature in City Square to build on to the legacy of the existing landscape;
- Create a tourism destination (the concourse would be freely accessible to people whether or not they are paying Metro passengers.

There is potential to penetrate (with light tubes or similar technology) the Concourse and Public Space down to the upper plant level and intervening levels with light tubes (or similar technology).

Figure 4.7 Station Characteristics CBD South Station

CBD South Station	Pre-European	Early European	C20th & Present Day
Culture	Riverine culture Gathering place Accommodation between human needs & other species	Batman Burke & Wills Gold Wool	Gathering place Federation Square Cultural centre Clocks Cathedral Free thinking / Chloe (Young & Jackson Hotel) Flinders Street railway station
Biology	Ecology dominated by indigenous species	Ecology damaged by exploitative use	Human dominated Mostly introduced & exotic species of fauna & flora
Geology	Basalt		

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
Aim	The station entry at Flinders and Swanston streets will be integrated into an over site development that supports the animation and amenity of adjoining street spaces, and that makes a positive civic architectural contribution to the precinct	St Paul's Court will be maintained and enhanced in accordance with the aims of the competition-winning design for Federation Square to build on relationships with the surrounding city and to create a variety of adaptable spaces for civic events	Existing valued qualities and features of City Square will be maintained in a new design for the space, including: a 24 / 7 public open space that celebrates informal and formal activities a civic centrepiece for the precinct between the Town Hall and Cathedral a flexible event space in the central city Swanston Street tree arbour and wide footpath occupiable edges and seating opportunities greenery in the city activity fronting the square opportunities for unstructured play accessibility, permeability and visibility public art and civic markers	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes. P4 Thermal & Airflow Variability: Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes) P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place. P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	1. Create a station entry that is integrated with the precinct built form while clearly defining the Metro Tunnel entry.	1. Ensure respectful integration of new structures and open space treatments with the Federation Square design.	1. Create an integrated new design for the City Square that incorporates the aboveground Metro Tunnel infrastructure.	
	2. Connect passengers to Flinders Street, Swanston Street and Flinders Lane including to other transport services.	2. Re-accommodate civic uses within a redeveloped western shard if complementary to the station entrance design.	2. Redevelop the basement car park for uses that complement City Square and the new station.	P1 Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes. P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead. P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. (continue) P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
	3. Make a high quality positive architectural contribution to one of Melbourne's most important and recognisable precincts.			P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)
	4. Facilitate the redevelopment of properties acquired for the project to improve land utilisation and urban amenity in the precinct.			

Figure 4.8 Biophilic Design Principles CBD South Station				
	MMRA Urban Design Strategy			**Biophilic Design Principles**
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	5. Accommodate a mixture of uses that contribute to: -- the accessibility and amenity of the station entry -- retail activation of adjoining streetscapes -- complementary civic and community purposes -- commercial returns from the properties.			

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
Design guidelines	1. Contribute to an integrated network of safe, high quality pedestrian routes: -- Locate and design station access stairs, escalators and lifts to distribute pedestrian traffic safely in relation to the capacity of surrounding routes. -- Improve pedestrian accessibility, safety and amenity in laneways connecting to the station entry. -- Ensure safe conditions in nearby laneways when the station entry is closed. -- Create active frontages along streets and laneways connecting to the station entry. -- Provide appropriate weather protection along Swanston Street and Flinders Street footpaths. -- Provide for safe crossings of Flinders Lane.	1. Maintain Federation Square's inter-relationships with Flinders Street, Swanston Street and St Paul's Cathedral: -- Protect the framed vista from Federation Square to St Paul's Cathedral from intrusive or disruptive structures. -- Ensure permeability, visual links and pedestrian accessibility between the Flinders Street footpath and Federation Square. -- Create an architectural element that holds the corner at the intersection of Swanston and Flinders streets.	1. Maintain a respectful relationship with nearby civic buildings: -- Minimise the size and visual prominence of the station entry, so that it does not appear to be disproportionately grand in relation to other civic stairs on Swanston Street. -- Maintain uncluttered views to St Paul's Cathedral from the square, in particular to the facade and altar window facing Flinders Lane. Mirror the offset of the Westin Hotel facade from the Cathedral's central axis to define a view corridor along the axis, and avoid locating aboveground infrastructure within this corridor if possible. -- Maintain views of the Town Hall clock tower from the square.	P3 Non-Rhythmic Sensory Stimuli: Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely. P4 Thermal & Airflow Variability: Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments. P5 Presence of Water: A condition that enhances the experience of a place through seeing, hearing or touching water. P11 Prospect: An unimpeded view over a distance, for surveillance and planning. P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead. P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	2. Allow for servicing, deliveries, and waste removal from the station and over site development, so as not to compromise frontage activation objectives.	. Maintain usable and activated open spaces: -- Maintain or provide new seating ledges. -- Maintain or provide new level areas of a size and character suitable for a range of events and activities.	2. Minimise net loss or fragmentation of public open space: -- Locate the entry and other aboveground infrastructure near to Collins Street to minimise impacts on usable public open space. --Where possible, locate lifts and other aboveground infrastructure within the Westin Hotel built form. --Where possible, co-locate aboveground infrastructure that must be in the square with the station entry or with other aboveground structures. -- Provide pedestrian access, egress and dispersal from the station via the street, not through the body of the square. -- Maintain generous soil depths to allow for tree planting.	(Continue)

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	3. Address issues of servicing neighbouring properties	3. Maintain and enhance the civic character and identity of Federation Square: -- Achieve design integration with Federation Square as a whole. -- Respond positively to the context established by the design of Federation Square. -- Consider rebuilding the western shard in keeping with the original design intent, increasing its height in order to reinstate its tall vertical proportions	3. Create a high quality civic open space that accommodates passive recreational use and staged events, and achieves a balance of qualities as a place of respite and a prominent and actively used civic space: -- Maintain or increase space for casual use including public seating. -- Maintain accessibility for events including a large open level space equivalent to that provided in the square today, with vehicular loading capacities and surface treatment suitable for staging events without damage and / or without costly reinstatement requirements. -- Provide vehicle access for events bump in / bump out. -- Design so that, the square has a mix of large and more intimate spaces that can be used separately during public events.	(Continue)

Figure 4.8 Biophilic Design Principles CBD South Station				
	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	4. Integrate over site development with the station and associated infrastructure.		4. Maintain and enhance active frontages onto and overlooking the square: -- Maximise activation of the square by tenancies within the ground floor of the Westin Hotel. -- Maintain a level paved frontage along the Westin Hotel, providing access to adjoining tenancies and associated outdoor dining / cafe spaces. -- Maintain physical demarcation of outdoor spaces leased or licenced to adjoining hospitality businesses, to assist in their ongoing management (e.g. as with the existing water feature). -- Consider options for replacement of the existing cafe tenancy to minimise space occupied within the square. -- Maintain views between the Swanston Street footpath and tram stops and the open space within the square.	(Continue)

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
	5. Create clear delineation between private-sector building and station infrastructure for ease of maintenance and operation		5. Maintain a generous shaded pedestrian promenade along Swanston Street: -- Maintain circulation space with no less capacity than exists at present. -- Maintain accessible tram stop facilities. -- Maintain a double row of Plane trees.	(Continue)
			6. Locate and design the station entry and the square as a whole to integrate with surrounding footpath levels: -- Orient the station entry towards Swanston Street. -- Locate and design required aboveground infrastructure to help resolve level transitions between the square and surrounding footpaths.	

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
			7. Protect, relocate and / or restore existing artworks and monuments as appropriate: -- Retain the Burke and Wills Monument in its existing location if possible. If not, re-install the monument in its original form at a new site to be approved by the City of Melbourne. Undertake adaptive site works as required to integrate the monument with the new site. --Work with City of Melbourne to maintain or appropriately relocate or reimagine the Mockridge Fountain. -- Consult with the City of Melbourne to determine their intent to retain other existing artworks in the City's collection (and reinstall in the City Square or relocate as appropriate) or to de-accession. Incorporate works to be retained at the site into the new design.	(Continue)

Figure 4.8 Biophilic Design Principles CBD South Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	Cocker Alley Sub-Precinct	Federation Square: St Paul's Court Sub-Precinct	City Square Sub-Precinct	
			8. Adapt the remaining space after the provision of the station entry below the City Square for a civic facility: -- Minimise the extent of the existing space occupied by station infrastructure, where possible using the lower levels for service functions and allowing for active uses near ground surface level. -- Consult with the City of Melbourne to resolve the functional brief for the facility. -- Create a more direct and positive relationship between the open space and the new civic facilities in the basement than currently exists between the car park and the square. -- Continue to accommodate public amenities and site services as appropriate.	

4.6 CBD North Station

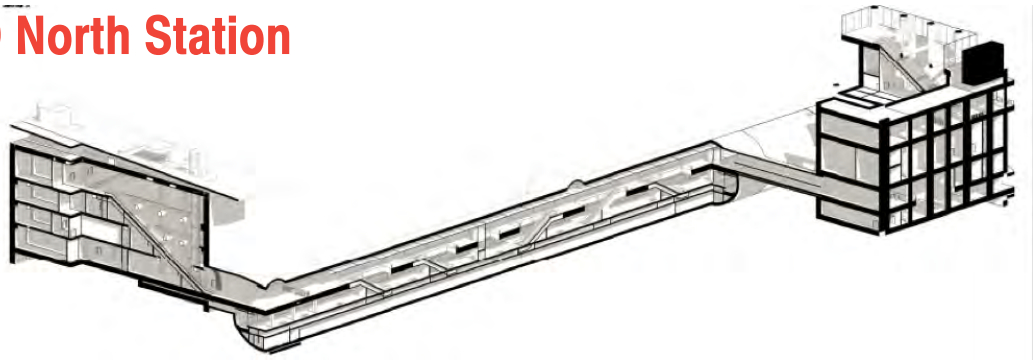


Figure 4.9: Project Drawing Number: MMR-GRM-WOCN-DR-AA-730000 – Revision P1.11

KEY to Location of Biophilic Design Opportunities

- ISE **Integration with streetscape and environments – ISE**
- UC **Underground concourse areas – UC**
- ES **Escalator shafts – ES**
- P **Plazas – P**
- E **Entrances – E**
- MC **Movement corridors – MC**
- SP **Station platforms – SP**

The CBD North Station is set within urban 'canyons' but has significant potential for being opened up to take advantage of what natural light does reach the street level, particularly on Franklin Street.

The above ground structures should be designed with the biophilic design agenda in mind, bearing in mind the full spectrum of biophilic design options that are embodied in the 14+1 Patterns and the 17 Recommendations in the Biophilia Toolkit (Chapter 8).

Figure 4.10 Station Characteristics CBD North Station

CBD North Station	Pre-European	Early European	C20th & Present Day
Culture	Accommodation between human needs & other species	Lower and upper classes in conflict	Cultural intelligensia Upper meets lower class
Biology	Freshwater creek Ecology dominated by indigenous species	Ecology damaged by exploitative use	Human dominated Mostly introduced & exotic species of fauna & flora
Geology	Basalt		
Theme	Diverse & inspirational 'Burrow'		

Figure 4.11 Biophilic Design Principles CBD North Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	LaTrobe – Little LaTrobe Street Sub-Precinct	Franklin Street Sub-Precinct	A'Beckett Street and Stewart Street	
Aim	The station entry at La Trobe and Swanston streets will be integrated into an over site development that supports the animation and amenity of adjoining street spaces, and that makes a positive civic architectural contribution to the precinct.	Franklin Street will be an activated, people-oriented street connecting RMIT and the CBD North station to the Queen Victoria Market precinct, with priority given to walking, cycling and local property access, and with generous greened pedestrian spaces supporting a range of social and informal recreational activities.	A'Beckett Street between Swanston Street and Stewart Street will be a pedestrian open space encouraging social and recreational engagement by local students and residents.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes. P6 Dynamic & Diffuse Light: Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes) P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.
Objectives	1. Create a station entry that is integrated with the precinct built form while clearly defining the Metro Tunnel entry.	1. Improve Franklin Street as a pedestrian and cyclist link across the north side of the CBD	1. Improve A'Beckett Street to enhance pedestrian capacity and links west towards Flagstaff Gardens, and to provide a usable and high-amenity public open space.	
	2. Connect pedestrians from the station entry into the local streets and to other transport services in Swanston Street and La Trobe Street.	2. Connect pedestrians from the station entry into local streets and to other transport services in Swanston Street	2. Maintain local vehicular access to properties in A'Beckett Street to the west of the proposed closure at Swanston Street.	
	3. Protect the amenity of the State Library forecourt as one of the central city's key public open spaces.			
	4. Facilitate the redevelopment of properties acquired for the project to improve land utilisation and urban amenity in the precinct.			

Figure 4.11 Biophilic Design Principles CBD North Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	LaTrobe – Little LaTrobe Street Sub-Precinct	Franklin Street Sub-Precinct	A'Beckett Street and Stewart Street	
	5. Accommodate a mixture of uses that contribute to: -- the accessibility and amenity of the station entry -- retail activation of adjoining streetscapes -- commercial returns from the properties.			(Continue) P6 Dynamic & Diffuse Light: Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature. P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes) P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics) P11 Prospect: An unimpeded view over a distance, for surveillance and planning. P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.
	6. Make a positive architectural contribution to one of Melbourne's most important civic precincts.			
	1. Contribute to an integrated network of safe, high quality pedestrian routes: -- Locate and design station access stairs, escalators and lifts to distribute pedestrian traffic safely in relation to the capacity of surrounding routes. -- Locate and design entry points for over site development to respect pedestrian desire lines and to avoid major congestion points. -- Create frontage activation along streets and laneways. -- Provide appropriate weather protection to Swanston Street and La Trobe Street footpaths.	1. Consider stakeholder requirements for the length of Franklin Street between Victoria and Queen Streets, and ensure the potential for integration of works in the project area with future improvements beyond the project area.	1. Create a public plaza in A'Beckett Street between Swanston Street and Stewart Street. -- Close the street to private vehicular traffic. -- Create a public plaza area catering to local recreational and social needs. -- Provide for emergency access via removable bollards or an equivalent. -- Incorporate canopy tree planting.	

Figure 4.11 Biophilic Design Principles CBD North Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	LaTrobe – Little LaTrobe Street Sub-Precinct	Franklin Street Sub-Precinct	A'Beckett Street and Stewart Street	
	(Continue) --Widen the footpath as appropriate on the west side of Swanston Street between La Trobe Street and Little La Trobe Street.			(Continue) P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment. P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
	2. Allow for servicing, deliveries, and waste removal from the station and over site development, so as not to compromise frontage activation objectives.	2. Maintain clear pedestrian circulation space along the building frontages on both sides of the street, no less than and preferably wider than at present.	2. Manage local traffic in A'Beckett Street to safely return to the wider road network.	
	3. Address issues of servicing neighbouring properties.	3. Provide expanded pedestrian space for seating and other uses with enhanced amenity including plantings of new canopy trees, upgraded street lighting, etc.	3. Provide clear pedestrian circulation space along the building frontages on both sides of the street, preferably wider than s currently provided.	
	4. Integrate over site development with the station and associated infrastructure.	4. Minimise carriageway widths while accommodating appropriate vehicular access including services access to the City Baths and RMIT.	4. Provide for servicing of adjacent properties.	
	5. Create clear delineation between private-sector building and station infrastructure for ease of maintenance and operation.	5. Create a safe bicycle route along Franklin Street.	5. Above ground elements of the maintenance access and vent structure should be located and designed to ensure optimal flexibility in use of the public open space and to minimise visual impacts:	

Figure 4.11 Biophilic Design Principles CBD North Station

	MMRA Urban Design Strategy			Biophilic Design Principles
	LaTrobe – Little LaTrobe Street Sub-Precinct	Franklin Street Sub-Precinct	A'Beckett Street and Stewart Street	
			(Continue) -- Minimise aboveground structures' width, breadth and visual bulk, especially with respect to any element higher than 1m above surrounding paving levels.	(Continue)
	6. Development must not cast any additional shadows across the State Library forecourt between 11.00 am and 2.00 pm from 22 March to 22 September.	6. Minimise conflicts between turning vehicular traffic and Swanston Street trams.	-- Use sustainable cladding materials and a high standard of architectural detailing to ensure the structures present well to nearby pedestrians, and are durable and easy to maintain in good condition.	
			-- Consider potential integration with other streetscape elements, such as lighting and signage, in order to minimise clutter in the street space.	

4.7 Parkville Station

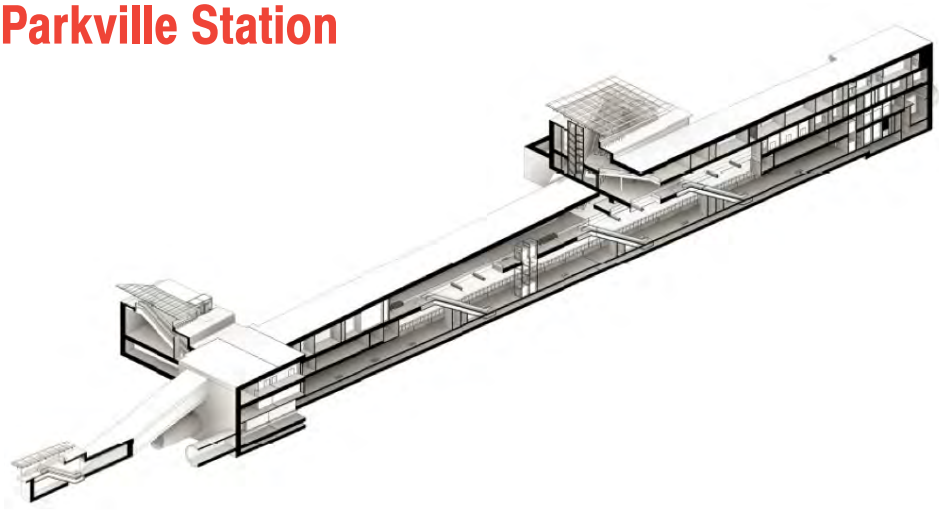


Figure 4.12: Project Drawing Number: MMR-GRM-WOPV-DR-AA-720000– Revision P1

Parkville Station

	Visual Connection with Nature	Non-Visual Connection with Nature	Non-Rhythmic Sensory Stimuli	Thermal & Airflow Variability	Presence of Water	Dynamic & Diffuse Light	Connection with Natural Systems	Biomorphic Forms & Patterns	Material Connection with Nature	Complexity & Order	Prospect	Refuge	Mystery	Risk/Peril	Virtual Connection with Nature
	ISE E	ISE E	ISE	ISE E	ISE E	ISE E	ISE	ISE E	ISE	ISE E	ISE E	ISE E	ISE E	ISE E	
C	UC ES	UC ES	UC	UC ES	UC	UC ES	UC	UC ES	UC ES	UC	UC ES	UC ES	UC ES	UC ES	UC
1	ES	MC		ES		ES		ES MC	MC	ES	ES		ES MC	ES	E
2		MC						MC	MC				MC		MC
●		MC						MC SP	MC SP	SP			MC SP	SP	MC SP

KEY to Location of Biophilic Design Opportunities

- ISE **Integration with streetscape and environments – ISE**
- UC **Underground concourse areas – UC**
- ES **Escalator shafts – ES**
- P **Plazas – P**
- E **Entrances – E**
- MC **Movement corridors – MC**
- SP **Station platforms – SP**

Health and well-being are indirectly and directly affected by biophilia and this station precinct, more than any other, is linked to the provision of health. This would ideally be reflected in the aproaches taken to the development of biophilic design for this station.

Its relative proximity to Australia's oldest zoo, the Royal Melbourne Zoological Gardens, suggests that this station's biophilic design could legitmately incorporate both overt and subtle references to the world's wildlife, its beauty, its threats, and its connection to the broader issues of species extinction, the health of the biosphere, and the global ecological crisis.

Figure 4.13 Station Characteristics Parkville Station

Parkville Station	Pre-European	Early European	C20th & Present Day
Culture	Wurundjeri encampments Accommodation between human needs & non-human species	University of Melbourne 1853 Royal Park (now home to many native animals) Royal Melbourne Zoological Gardens	Hospital & health services Transition in careers & health Middle class Olympic Games Athletes' Village
Biology	Stream running through Ecology dominated by indigenous species	Early ecology damaged by exploitative use Royal Park supported introduced & native flora & fauna	Mostly introduced & exotic species of fauna & flora Rich native birdlife
Geology	Alluvial/basalt		
Theme	Health & well-being Respite & tranquility Biosphere health		

Figure 4.14 Biophilic Design Principles Parkville Station

	MMRA Urban Design Strategy				Biophilic Design Principles
	Royal Parade Sub-Precinct	Grattan Street Sub-Precinct	University of Melbourne Interface with Grattan Street Sub-Precinct	University Square, Barry Street and Leicester Street	
Aim	Royal Parade's heritage values and landscape character as one of Melbourne's iconic, tree-lined formal boulevards will be protected and restored.	Grattan Street will be a transport spine for the Parkville Station, University and Biomedical precinct, with priority given to active transport modes and intermodal transfers, and to the creation of an activated and people oriented public realm.	The University of Melbourne buildings and spaces will, in time, be enhanced and redeveloped to create a more active interface between the traditional campus to the north and Grattan Street while protecting important heritage structures and values.	University Square will be transformed into a contemporary public place in the heart of Carlton, reclaiming space from streets to enlarge the park, planting a new generation of trees, giving priority to pedestrians, preserving open lawn areas, injecting life and activity, and responding to a changing population and climate.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.
Objectives	1. Create an integrated transport interchange between Metro Tunnel and tram services in Royal Parade.	1. Use the new station to catalyse a new civic heart for the Parkville Station, University and biomedical precinct.	1. Preserve and support options for future redevelopments within university of Melbourne land holdings to integrate with Metro Tunnel infrastructure.	1. Preserve and support options to improve University Square as per the City of Melbourne's current plans.	
	2. Protect heritage and civic qualities of Royal Parade.	2. Enhance Grattan Street as a public transport, pedestrian and cycling corridor, including facilities for interchanges between Metro Tunnel and bus services.	2. Protect heritage qualities of buildings and spaces within the university campus.		P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

Figure 4.14 Biophilic Design Principles Parkville Station

	MMRA Urban Design Strategy				Biophilic Design Principles
	Royal Parade Sub-Precinct	Grattan Street Sub-Precinct	University of Melbourne Interface with Grattan Street Sub-Precinct	University Square, Barry Street and Leicester Street	
		3. Enhance the amenity of Grattan Street with new canopy trees and upgraded lighting, paving and furniture.	3. Protect and reinforce formal spatial relationships between Gate 10 and spaces inside and beyond the traditional campus area.		P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.
			4. Avoid confusion resulting from the location of station entries within the university campus, including issues relating to the distinct corporate identities of the University and Metro Tunnel, and public expectations of access and appropriate behaviour in public and university spaces.		P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)
Design Guidelines	1. Retain and protect existing trees along Royal Parade.	1. Consider stakeholder requirements for Grattan Street between Flemington Road and Swanston Street, and ensure the potential for integration of works in the project area with future improvements by others beyond the project area.	1. Design the station entries as parts of key entries to the campus, providing a high quality arrival experience, meeting places, links to circulation routes into the main campus, and a direct connection to an information centre in the Gatekeeper's Cottage.	1. Integrate aboveground Metro Tunnel infrastructure with the proposed design for University Square, Barry Street and Leicester Street, including:	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

Figure 4.14 Biophilic Design Principles Parkville Station

	MMRA Urban Design Strategy				Biophilic Design Principles
	Royal Parade Sub-Precinct	Grattan Street Sub-Precinct	University of Melbourne Interface with Grattan Street Sub-Precinct	University Square, Barry Street and Leicester Street	
				(Continue) -- Coordinate the location of ventilation shafts with existing ventilation and access structures for the underground car park and with the layout of proposed features in Barry, Leicester and Grattan streets. -- Integrate aboveground elements of the chiller plant with the proposed design for the are	(Continue) P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)
	2. Where tree removal is unavoidable, plant new trees in the same locations, creating favourable growing conditions with soil preparation throughout the anticipated root zone.	2. Minimise the carriageway width while providing for local vehicular traffic and appropriate kerbside space for bus stops, loading, taxis, and emergency vehicles including ambulances (especially but not only in the block west of Royal Parade).	2. Provide a design response that is respectful of the historic Gatekeeper's Cottage and Vice Chancellor's House, including their landscape settings.	2. Implement the proposed design for University Square, Barry Street and Leicester Street within the project area, and allow for its future complete implementation by others beyond the project area.	
	3. Design any aboveground Metro Tunnel structures located within Royal Parade to minimise their visual bulk or solidity, especially for elements at or above eye level.	3. Provide dedicated bike lanes in each direction, either on street or with separation from motor vehicles and pedestrians.	3. Retain the remnant of the university's historic perimeter fence near Royal Parade.		P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.

Figure 4.14 Biophilic Design Principles Parkville Station

	MMRA Urban Design Strategy				Biophilic Design Principles
	Royal Parade Sub-Precinct	Grattan Street Sub-Precinct	University of Melbourne Interface with Grattan Street Sub-Precinct	University Square, Barry Street and Leicester Street	
	4. Integrate with the proposed tram super stop in Royal Parade.	4. Maximise the southern footpath width to create space for the station infrastructure and to make more generous provision for pedestrian movement.	4. Allow for future redevelopment of the university's Royal Parade Biosciences Zone to the northeast of the Royal Parade / Grattan Street intersection and between the two proposed station entries.		P11 Prospect: An unimpeded view over a distance, for surveillance and planning.
		5. Provide clear pedestrian circulation space along the building frontages on both sides of the street, preferably wider than is currently provided.	5. Ensure that paving and street furniture within the university campus adhere to the university's design standards while those within the Grattan Street road reserve adhere to City of Melbourne standards, and resolve an appropriate interface between these two sets of standards without compromising either one.		P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)
		6. Provide passenger waiting areas and shelters at bus stops.			P11 Prospect: An unimpeded view over a distance, for surveillance and planning. P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

Figure 4.14 Biophilic Design Principles Parkville Station

	MMRA Urban Design Strategy				Biophilic Design Principles
	Royal Parade Sub-Precinct	Grattan Street Sub-Precinct	University of Melbourne Interface with Grattan Street Sub-Precinct	University Square, Barry Street and Leicester Street	
		7. Include new plantings of large canopy trees.			P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.
		8. Widen signalised pedestrian crossings, potentially with carriageway pavement levels flush with footpath levels to improve accessibility near University Square.			P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
		9. Maintain access and sightlines to all building entries.			P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

4.8 Arden Station

Figure 4.15: Project Drawing Number: MMR-GRM-WOPV-DR-AA-720000– Revision P1

KEY to Location of Biophilic Design Opportunities

- **Integration with streetscape and environments – ISE**
- **Underground concourse areas – UC**
- **Escalator shafts – ES**
- **Plazas – P**
- **Entrances – E**
- **Movement corridors – MC**
- **Station platforms – SP**

Health and well-being are indirectly and directly affected by biophilia and this station precinct, more than any other, is linked to the provision of health. This would ideally be reflected in the aproaches taken to the development of biophilic design for this station.

Figure 4.16 Station Characteristics Arden Station

Arden Station	Pre-European	Early European	C20th & Present Day
Culture	Accommodation between human needs & non-human species Movement corridor for Wurundjeri	Industrial & warehousing hub Major economic centre Processing products from the rural hinterland (wool, wheat, etc.)	Industrial heritage Urban renewal North Melbourne Football Club Transition to knowledge economy
Biology	Saltwater Ecology dominated by indigenous species Water & food source for Wurundjeri	Ecology damaged by exploitative use Moonee Ponds Creek	Human dominated Mostly introduced & exotic species of fauna & flora Urban greening
Geology	Alluvial with high salt water table Rising seas		
Theme	Industrial transition Changing land use Flood & Water		

Figure 4.17 Biophilic Design Principles

	MMRA Urban Design Strategy	Biophilic Design Principles
	Arden Station Precinct	
Aim	Arden station will act as a catalyst for redevelopment of the precinct. In the short-term, the entry to Arden station will be set in an open space that provides access for the population working and living in surrounding neighbourhoods. In the future, Arden station will be incorporated as a focal point of the intensive transit-oriented mixed-use development of the VicTrack site and the Arden-Macaulay Precinct	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes. P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes. P3 Non-Rhythmic Sensory Stimuli: Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely.
Objectives	1. Use the station design to facilitate a significant urban renewal precinct.	P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes. P6 Dynamic & Diffuse Light: Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature. P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics) P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place. P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)
	2. Address issues of flooding on the site and protect the station from inundation.	P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
	3. Facilitate the future intensive redevelopment of the publicly owned (VicTrack) land.	

Figure 4.17 Biophilic Design Principles

	MMRA Urban Design Strategy	Biophilic Design Principles
	Arden Station Precinct	
	4. Allow for the integration of the station with future over-site development and redevelopment of surrounding areas.	P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes. P4 Thermal & Airflow Variability: Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments. P5 Presence of Water: A condition that enhances the experience of a place through seeing, hearing or touching water. P6 Dynamic & Diffuse Light: Leverages varying intensities of light and shadow that change over time to create conditions that occur in nature.
	5. Provide a high standard of amenity at and near the station before and during any wider redevelopment of the site.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.
	1. The design of Metro Tunnel must create inviting, safe and comfortable conditions that support use of the station before and during any wider redevelopment of the site. -- Create a station building and associated open space of high design quality that integrates with and serves as a benchmark for surrounding development. -- Provide temporary hoardings, fencings, screens and plantings of fast-growing trees to provide amenity and shelter for public spaces near the station entry. -- Protect the station and other Metro Tunnel infrastructure from flooding and ingress of water, while providing for access from existing nearby street levels and allowing for adaptation in response to future new development.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes. P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes. P3 Non-Rhythmic Sensory Stimuli: Stochastic and ephemeral connections with nature that may be analyzed statistically but may not be predicted precisely. P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.
	2. The new station and future redevelopment of the publicly owned (VicTrack) land must be integrated with surrounding areas, ensuring high levels of accessibility between the station and nearby land uses. -- Ensure that the station and infrastructure align with the directions of the Arden Framework Plan. -- Minimise the land area occupied by Metro Tunnel infrastructure in order to maximise the potential for future redevelopment on surrounding sites.	P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes. P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics) P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

Figure 4.17 Biophilic Design Principles

	MMRA Urban Design Strategy	Biophilic Design Principles
	Arden Station Precinct	
	(Continue) -- Enable future vertical loading for a mixed-use building above the station. -- Allow for future extension of nearby streets into the site and make provision for future new station entrance(s) connecting to these. -- Upgrade Laurens Street between Queensberry Street and Arden Street to provide a pedestrian friendly environment with improved bike lanes, taxi rank, and limited parking. -- Upgrade Barwise Street to provide a pedestrian friendly environment, and improved access to the new station. -- Ensure a high degree of visual prominence for the station and its public realm to assist with wayfinding.	

5

International Examples

Biophilic Design

narrative

& education

Credit: P Downton

5.0 International Examples

There are very few examples of railway or metro stations that have been designed with the specific intention to evoke biophilia from their users. There are, however, stations that have been designed with elements that are intrinsically biophilic. There are also public sector/ infrastructure buildings, urban spaces and landscapes that are strongly biophilic and several examples are included in this section. One notable example is Singapore's extraordinarily successful and well-visited 'Gardens by the Bay' where the specific intention to evoke biophilia is, arguably, the primary driver of the project.

As outlined in detail in Chapter 8, a summary of 'Toolkit' recommendations for MTP's possible Biophilic Design Program are provided. The 17 recommended themes are individually examined in Chapter 8, however, they are used here to assess the following exemplar projects to demonstrate all 17 possible outcomes.

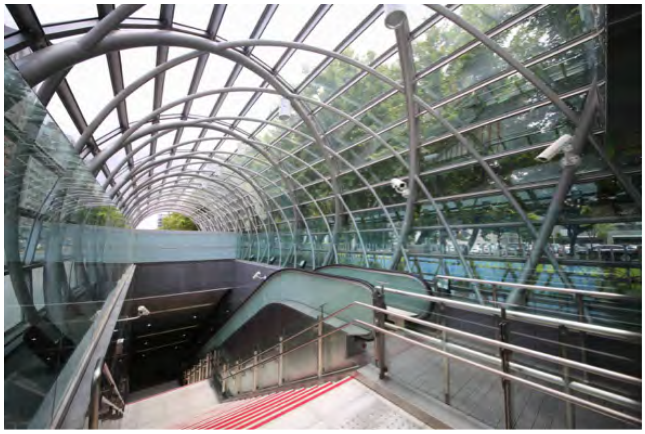
THE TOOLKIT'	
1	Adopt a Biophilic Design Program for MTP Railway Stations
2	Make Judicious Use of Planting, Green Roofs and Walls
3	Maximise use of Natural Light
4	Apply Controlled Air Movement
5	Make Creative Use of Water
6	Manipulate the Soundscape & Olfactory Landscape to Reinforce Biophilic Effects
7	Incorporate Biomorphic Forms & Images
8	Use Materials as Natural Analogues
9	Create Distinct Spatial Environments
10	Layer Texture & Modelling over Undifferentiated Planar Surfaces
11	Explore Transitioning of Biophilia Effects
12	Use Signage and Wayfinding to Raise Public Awareness of Local Nature
13	Apply Fractal Design Techniques
14	Use Public Art to Achieve Biophilic Effects
15	Avoid Abstraction
16	Make Visible & Incorporate the Skyline
17	Make Visible & Incorporate the Local Pre-European/Pre-Industrial Environment

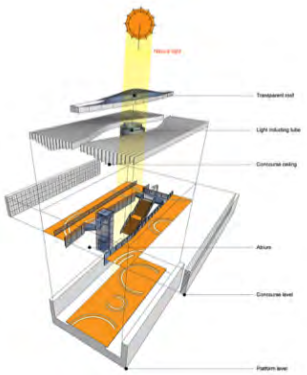
Figure 5.1: Summary of 17 possible biophilic actions, see Chapter 8 for further detail.

Dingpu Metro Station, Taiwan

Toolkit Qualities

1,3,16





Dingpu Metro Station serves as the terminus of an underground line that will connect to a future elevated railway line. This station is of particular interest because of its attempt to bring natural light well into the building, to both the concourse and down to the platform, two levels below the street.

> *"The use of natural light as a sustainable design element also sets a precedent for subterranean transit stations in Taiwan. Sunlight is captured through a row of reflective solar tubes running the length of the station mezzanine. Accompanied by supplemental light fixtures, natural light from the collectors resembles vibrant sunbeams that create virtual atriums, intuitively guiding passengers through high traffic areas."*

The play with light that is the theme of the design continues with light fixtures which express light waves, halos and radiance, in an abstract way, appearing as patterns on the ceiling, floor and walls. 'Ceiling panels are arranged in accordance with the floor pattern. Programmable colorful LED light fixtures embedded in the concourse wall poetically reflect the changing environment.' The portal above the concourse at one of the metro entrances is a transparently glazed, lightweight steel trellis that allows natural light to penetrate directly to the concourse below.

Figure 5.2: Dingpu Metro Station. Images: http://www.archdaily.com/787043/dingpu-metro-station-jj-pan-and-partners

Atocha Railway Station, Madrid

Toolkit Qualities

1,2,3,5,6,9,16

Atocha Railway Station's concourse includes a 4,000m2 covered garden arranged in neat garden beds. Around 260 species and over 7,000 plants improve the internal ambience, climate and environmental air quality of the station.

Figure 5.3: Atocha Railway Station. Images: David, flickr. Spixey, flickr.

Low Line Lab, New York

Toolkit Qualities

1,2,3,7,9,11,12,13

The Low Line is a proposed underground park in New York City pioneered by James Ramsey. The Low Line Lab is an underground space at 140 Essex St in New York's Lower East Side where the park concept is being tested. It currently includes underground landscaping lit solely by sunlight through solar fibre optics mirrored collectors and polycarbonate tubes fitted with mirrors and lenses that bring sunlight from the roof to the interior of the lab. Anodized aluminium canopies reflect light and planting experiments include edible plants, which typically require high light levels.

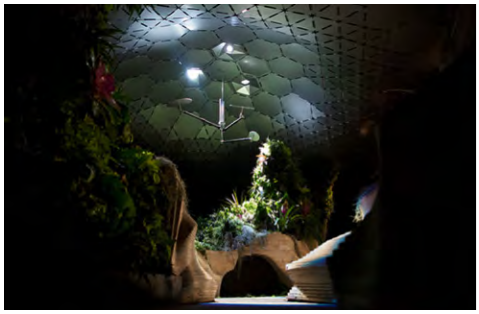


Figure 5.4: Low Line Lab. Images: John Taggart

Stockholm Metro, Sweden

Toolkit Qualities

1,7,8,9,10,11,13,14,15

As an example, the MTP could adopt an approach like the Stockholm Metro, it is used here to show how distinctiveness can be created in otherwise typically generic and placeless metro station environments.

> *"The Stockholm Metro is one gigantic art gallery. More than 90 of the 110 stations feature artworks created by some 150 artists...For the price of a Stockholm Metro ticket you can see sculptures, mosaics, paintings, art installations, inscriptions and reliefs from the 1950s through to the 2000s at most Stockholm Metro stations…T-centralen station check has 1950s tiling and reliefs on the walls, while at the Arsenalsgatan, exit of Kungsträdgården station (blue line), you'll see an archaeological dig consisting of ancient columns and details…Solna Centrum station (blue line) stands out for its cavernous, bright red ceiling that seems to 'weigh down' on the platform. Meanwhile the walls of the station depict a spruce forest that is one kilometre long."*

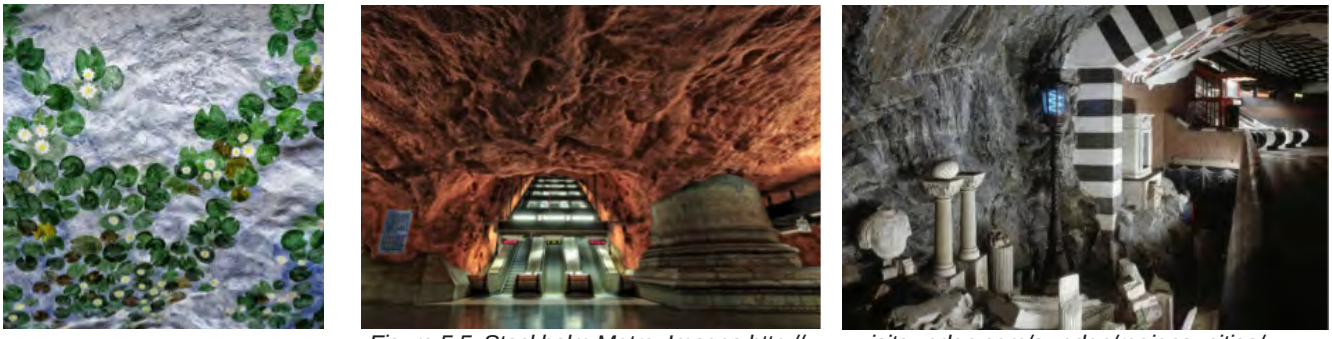


Figure 5.5: Stockholm Metro. Images:http://www.visitsweden.com/sweden/regions--cities/stockholm/culture-in-stockholm/stockholm-metro-art/

Stuttgart Airport, Terminal 3

Gare do Oriente Train Station, Lisbon, Portugal

Toolkit Qualities

1,7,9,10,13,14

This project is similar to Frei Otto's 1960 research project 'Tree Structures' conducted on structural columns which were inspired by the neighbouring Black Forest.

Calatrava's station resembles a substantial forest canopy and demonstrates some contemporary influence from Gothic architecture.

Figure 5.6: Stuttgart Airport. Images: John Bell

Figure 5.7: Gare do Oriente Train Station. Images: Zeunert

MetroNapoli, Naples, Italy

Toolkit Qualities

1,7,9,10,13,14

While not suggesting that MTP adopts an approach like the Naples Metro, it is used here to show how distinctiveness and commitment to concepts and ideas can be executed in otherwise typically generic and placeless metro station environments.

"MetroNapoli's publicly funded project transforms local metro stations into commuter-friendly art spaces that are some of the most impressive in Europe…Say the word subway and you think: dirty, dark and rats. But in Naples, Italy, an ongoing public art project has transformed 13 metro stations into works of art, with the most recent on Via Toledo being named one of The Daily Telegraph's most impressive undergrounds in Europe. The project began a decade ago as part of MetroNapoli's efforts to renew Naples' urban landscape. The Art stations originated from a project formulated by the city government with a view to make the urban area's public transport centers more attractive and to give everyone a chance to get an up-close look at prime examples of contemporary art. Under the direction of Achille Bonto Oliva, former director of the Venice Biennale, several stations have been converted into art galleries displaying over 180 works by more than 90 artists and architects such as Alessandro Mendini, Anish Kapoor, Gae Aulenti, Karim Rashid, and Sol LeWitt. Not only do these stations function as underground galleries, but they are architectural feats that stand alone as works of art.

The latest station, Metro Toledo, which is situated under one of Naples' main shopping streets, was designed around the theme of water and light with mosaics MetroNapoli's art stations make up a decentralized museum that is spread throughout the city. The project makes art integral to the cityscape, and more importantly, accessible to the everyday commuter. Instead of tired eyes gazing wearily at the evening paper, people are given an aesthetically-complex environment to interact and engage with – all for the small price of a metro ticket."

Figure 5.8: MetroNapoli. Images: http://www.psfk.com/2013/01/naples-art-subway.html

Biophilia as the basis for a tourist attraction

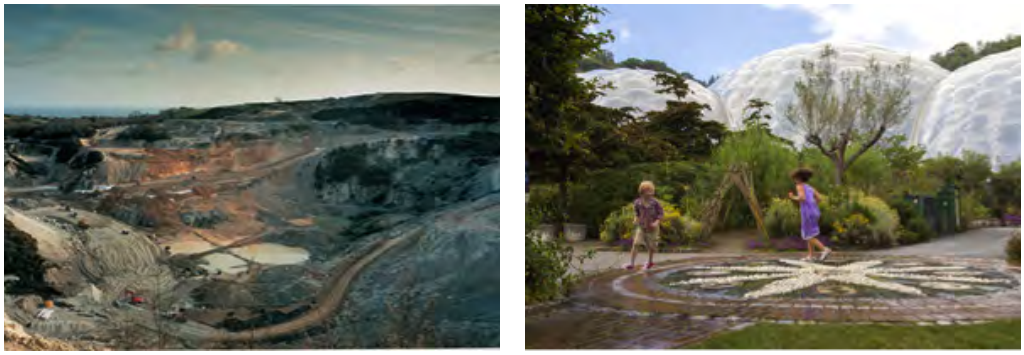
The Eden Project, St Austell, Cornwall, UK

Toolkit Qualities

ALL

Panorama of the Eden Project. Image: Downton

One of the best known examples of a project with a public purpose and an overt commitment to biophilic design and biomimicry, is the Eden Project in Cornwall, England. Formally a china clay quarry, the now iconic Eden Project attracts over 850,000 annual visitors to its 74 acre (30ha) gardens and biomes of around 2 million plants, beehives, art works and facilities. The Eden Projects iconic buildings include two biomes and various educational facilities, all dedicated to understanding the environment and its ecology. There are numerous artworks that all pursue a biophilic theme and the project operates a number of educational outreach programs that reinforce its central goal of providing pleasure and education to the general public. It is estimated to have contributed over $2 billion to the Cornish economy.



Before and after images of the site. Images: The Eden Project.

Figure 5.9: The Eden Project. The bee sculpture and the rainforest biome. Image: Downton

Gardens by the Bay, Singapore

Toolkit Qualities

1,2,7,9,10,11,12,13,14,15,16

Figure 5.10: Gardens by the Bay's 'Supertrees'. Image: Downton. *Spectacular biophilia by night. Image: Mac Qin.*

One of the most dramatic examples of public space dedicated to the celebration of biophilia is Singapore's 'Gardens by the Bay'.

"*A new and iconic garden is the development around the Marina Bay Sands development of 'Gardens by the Bay', which features some extraordinary natural systems built with S$1 billion to regenerate a reclaimed foreshore. The 'Super Trees' and display areas are all designed as educational features, which show people how natural systems and cycles work. As a symbol of how nature can be built into a city, they are dramatic.*" (Newman 2013:54).

Monash University, Sundial

In Melbourne at Monash University is a projection sundial that shows the potential for enlivening flat surfaces whilst playing with our biophilia instincts.The image below, the University's sundial indicates the time is almost 2.00 pm.

Sundial Concept by Prescription

Toolkit Qualities

8,10,11,15,16

Projects such as Prescription's sundials hint strongly at what might be possible in the design of station canopies, built form and landscape elements for the Metro Tunnel, notwithstanding cloudy skies. Mapping and demonstrating the apparent passage of the sun through the sky offers a powerful means
of expressing one of our deepest biophlic urges – to see and celebrate the sun.

Turtle Bay Sundial Bridge, California

Designed as a 'gateway' and tourist attraction the Turtle Bay Sundial Bridge was conceived and designed by architect and engineer Santiago Calatrava. Based on the form of a traditional sundial's gnomon and was Calatrava's first free-standing bridge in the United States.

Figure 5.11: Various Images.
Images: http://www.archdaily.com/786092/the-design-of-these-flower-like-sundials-is-unique-to-every-city
https://maas.museum/observations/2013/07/17/a-spectacular-projection-sundial-at-monash-university/
http://turtlebay.org/documents/TBMK-PressKit-Sundial-edit-1.pdf

Biomorphic Forms and Images

Park Güell, Barcelona, Antoni Gaudí

Toolkit Qualities

1,2,3,4,5,6,7,8,9,11,12,13, 14,15,16

Paris Metro

Toolkit Qualities

1,2,6,7,8,9,10,12,14,15,16

Mall, Dubai

Toolkit Qualities

7,9,10,14

Figure 5.12: Various Images. Image: Jones.

Planting Examples

Section 6.11 in Chapter 6 examines biophilic planting possibilities and categorises possible planting approaches into four categories: Horizontal planting at grade; Horizontal planting on slab; Climbing plants; and Vertical green walls. The following planting examples have been categorised into these for consistency.

Horizontal planting at grade:

Central Wharf Plaza, Reed Hilderbrand, Boston, Massachusetts, USA

Toolkit Qualities

2,9,10,16,17

This design creates a micro forest and demonstrates how designed urban forestry is possible in small and constrained sites. A 370m² traffic island has become a 1,200m² plaza and the densely planted island of 25 mixed-species oaks contrasts with nearly treeless adjacent areas, demonstrating the value of a high quality, below-grade infrastructure network and urban tree canopy stewardship. Key benefits include: urban heat island mitigation (10.4°F average reduction at ground-level); infiltrating all stormwater runoff for up to a 25-year, 24-hour storm event (1.4 million liters); annual carbon sequestration of over 1,600kg; 57% increased tree growth rate (compared to a typical urban oak by providing over 1,500 cubic feet of soil per tree); and high pedestrian usage (over 1,550 pedestrians observed in 5.5 hours (approximately 280 pedestrians per hour).

Figure 5.13: Central Wharf Plaza urban forest, before/after. Images: Reed Hilderbrand.

Cheonggyecheon Stream, Seoul, South Korea

Figure 5.14: Cheonggyecheon Stream, day/night. Image: riNux.

Toolkit Qualities

1,2,5,6,7,8,9,10, 12,14,16,17

Similar to 'Gardens by the Bay', this project has demonstrated how urban inhabitants crave a connection with 'nature', albeit highly stylized 'nature' in this context. This example of significant roadway reclamation (16 lanes) in a highly urbanized area prioritizes amenity and respite, significantly reducing urban heat island effect and offering urban corridor habitat to more than 40 bird and 20 fish species. The few pillars retained from the former highway stand as reminders of one of the city's most polluted areas, where traffic was further reduced by improving bus networks. Though on the site of a former stream, water from the Hangang River is pumped and treated, achieving permanent, significant flow but missing water sensitive urban design (WSUD) opportunities to cleanse the linear waterway's urban runoff and stormwater.

Horizontal planting on slab:

Promenade Plantée – Viaduc des Arts, Paris

Toolkit Qualities

1,2,3,6,7,8,9,10,11, 12,14,15,16

The High Line, James Corner Field Operations, Piet Oudolf, Manhattan, New York, USA

Figure 5.15: Various Projects. Image: Downton.

The Promenade Plantée in Paris is recognised as the world prototype for adaptive reuse of nineteenth century rail infrastructure and inspired New York's High Line Park. It took a huge slice of disused urban railway infrastructure and turned it into a great public park and garden, revitalising the whole area.

Image: Friends of the High Line.

An extraordinary 6 acre (2.4ha) linear public park across 23 city blocks in Manhattan's West Side was created through adaptive reuse of a disused, elevated post-industrial railway line. The project has transformed the district, demonstrating the power of the urban landscape and public space to catalyze social activation and financial investment.

Widely copied due to its success, most replications fail to acknowledge its unique characteristics (such as the existing railway infrastructure and Manhattan context), authentic response to place, and the highly skilled, contextual design response expressed through materials, furniture, lighting, details and planting.

Khoo Teck Puat Hospital, Singapore

Toolkit Qualities

1,2,5,6,7,8,9,10, 12,14,16,17

Figure 5.16 : Khoo Teck Puat Hospital. Images: CPG Consultants and RMJM.

This decidedly non-clinical 'Hospital in a Garden' utilizes existing site assets (in particular a large body of water), facilitating ventilation and day lighting. Densely planted terrace, roof, vertical, therapeutic, citrus and edible gardens, focus on a central courtyard designed to soothe and rejuvenate through biophilic design.

Madrid Rio, Spain

Toolkit Qualities

1,2,3,5,7,8,9, 10,14,16,17

Figure 5.17: Madrid Rio. Indicative planting and public domain over section of the 43km of tunnel. Image: West 8.

Part of the many public domain spaces created over the tunnel, the Puente de Segovia. Image: Municipality of Madrid

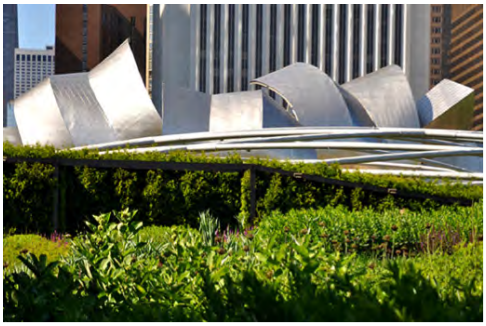
This ambitious project undergrounded 43km of Madrid's M-30 ring road motorway road within a single term of office. West 8's team were the only submission in the 2005 invited international competition to design the reclaimed area above the tunnel exclusively through landscape architecture. The '3 + 30' design divided the 198 acre (80ha) urban development into a trilogy of initial strategic projects for 47 subprojects initiated by the municipality, private investors and residents. With a combined total budget of € 410 million (around $USD450 million), the first subprojects were realised in 2007 and in April 2011 the entire project was complete and opened to the public. In addition to the various squares, boulevards and parks, a series of bridges improves connections between urban districts along the river.

Lurie Garden, Chicago, USA

Toolkit Qualities

1,2,7,9,10,14,16,17

Figure 5.18: Lurie Garden's sophisticated and low maintenance perennial planting (on slab).



Frank Gehry's Pritzker Pavilion in the background.

This on-structure/green roof project demonstrates skillful execution of perennial planting. Increased planting sophistication invokes heightened biophilic connections and responses. The Lurie Garden is one of Piet Oudolf's many triumphs of low water, perennial and xeriscape planting, where local vegetation species are generally conducive to reducing or eliminating supplementary irrigation.

Perth Cultural Centre Urban Wetland, Perth, Australia

Toolkit Qualities

1,2,5,8,9,10, 14,16,17

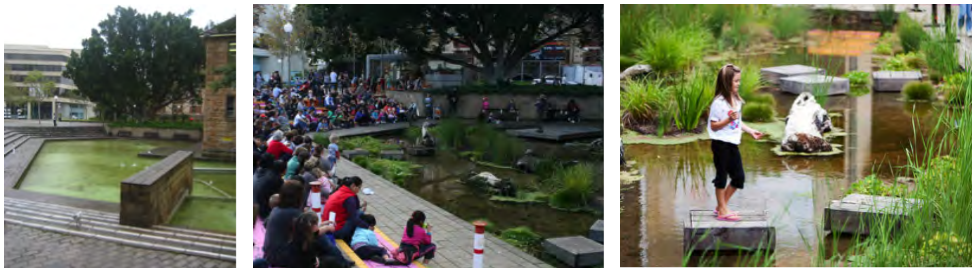


Figure 5.19: Perth Cultural Centre Before (left) and After. Images: Josh Byrne and Associates.

Decorative water features frequently fall into decay due to expensive maintenance and upkeep requirements for their complex infrastructure systems. Moreso, their chemical treatment processes preclude more biodiverse ecologies to form. As part of the Perth Cultural Centre Revitalization, an existing water feature has been retrofitted with an urban wetland that treats and filters water through natural processes. Such approaches provide for increased interaction and active rather than passive biophillia opportunities.

Planting Examples : Vertical precedents, climbing plants

MFO Park, Zurich, Switzerland

Toolkit Qualities
2,9,10,16

This innovative urban park has created a series of garden rooms, corridors and spaces at various levels under a structure reminiscent of the former engine factory on the site. A range of social programs and events take place amongst the climbing vegetation that displays spectacular colours over the seasons.

Figure 5.20: Vertical Gardens.

Planting Examples : Vertical precedents, green walls

Gardens by the Bay, Singapore

Figure 5.21: Gardens by the Bay. Images (L-R): choo chin nian; David Berkowitz; John Sonderman.

This innovative urban park has created a series of garden rooms, corridors and spaces at various levels under a structure reminiscent of the former engine factory on the site. A range of social programs and events take place amongst the climbing vegetation that displays spectacular colours over the seasons.

Le Mur Vegetal, Musée du quai Branly

Figure 5.22: Various Examples. Images (L-R): Inhabitat; http://www.biotecture.uk.com; Patrick Blanc

Edgware Road, London

Funded as part of a Clean Air Fund for London grant, this 180m2 green wall is situated on a tube station wall adjacent to busy roads.

One Central Park, Sydney

The world's tallest vertical garden addresses various technical challenges such as wind and maintenance.

Toolkit Qualities

1,2,3,5,6,7,8,9,10,16

6

Performance Evaluation & Possibilities

Credit: P Downton

6.1 Introduction

There are a number of ways to evaluate the performance of cities and their buildings. The choice of evaluation tools used in this report is directly related to core aspirations of the City of Melbourne Council and the specific requirements of the MMRA for measurable performance outcomes for the Metro Stations.

6.2 Ecocities

Ecocity Builders and the International Ecocity Advisory Committee (IEAC) have proposed an International Ecocity Framework and Standards (2011). Launched in 2010, the International Ecocity Framework and Standards (IEFS) initiative, is being prepared by the United Nations accredited not-for-profit Ecocity Builders (EB) and an international committee of expert advisors called the International Ecocity Advisory Committee (IEAC).

Ecocity Builders are the 'keepers of the flame' for the International Ecocity Conference series, one of the longest running series of conferences in the world. The first conference was held in 1990 in Berkeley, California. Adelaide, Australia took up the challenge of establishing a series of conferences by hosting the Second International Ecocity Conference in 1992. Since then, the conference has been hosted by not-for-profit organisations in Senegal, Brazil, Shenzhen, Bangalore, San Francisco, Istanbul, Montréal, Nantes and Abu Dhabi. In 2017, after 25 years, it returns to Australia and in 2017 is being hosted in Melbourne.

Figure 6.1: Masdar is one of the world's leading ecocity projects, situated in Abu Dhabi, host to the Ecocity World Summit in 2015. The most biophilic elements of the project's design uses fractal and biomorphic forms, seen here in a courtyard view within the city. Source: Downton.

6.2.1 Ecocity Definition

The IEAC defines an ecocity as:

> *… a human settlement modeled on the self-sustaining resilient structure and function of natural ecosystems. The Ecocity seeks to provide healthy abundance to its inhabitants without consuming more renewable resources than it replaces in its bioregion. It seeks to function without producing more waste than it can assimilate or recycle for new uses or than nature can dilute and absorb harmlessly, and without being toxic to itself or neighboring ecosystems. Its inhabitants' ecological impacts reflect planetary fundamental principles of fairness, justice, reasonable equity and consensus at ample levels of happiness* (EB & IEAC 2011: 5).

Contextually, ecocity-like initiatives and increased global awareness of ecocity ideas emerged following the First International Ecocity Conference in 1990 and the United Nations Rio de Janeiro 'Earth Summit' that was held in in 1992 associated with the launch of the sustainable development program 'Agenda 21'.

As a consequence, "ecocity" projects and the use of the term 'ecocity', has extensively been adopted and used in numerous of cities around the world. Many have sought to use the term and concept in developing integrated urban planning and management programs that address their city's social and ecological health. There is, however, no international standard to quantify the fundamentals of ecocity development and the urban condition from local, regional, national and or global whole systems perspective(s), nor to provide any internationally-benchmarked performance criteria (Alusi et al 2011). To understand a city's wholeness and full potential is to understand their measured potential in working towards a performance based set of International Ecocity Standards.

To aid an understanding of terminology, the IEAC have proposed the following definitions:

Term:	Definition:
Ecocity	An Ecocity is a human settlement modeled on the self-sustaining resilient structure and function of natural ecosystems. The Ecocity seeks to provide healthy abundance to its inhabitants without consuming more renewable resources than it replaces in its bioregion. It seeks to function without producing more waste than it can assimilate or recycle for new uses or than nature can dilute and absorb harmlessly, and without being toxic to itself or neighboring ecosystems. Its inhabitants' ecological impacts reflect planetary fundamental principles of fairness, justice, reasonable equity and consensus at ample levels of happiness. 1
Ecological Metropolis	An Ecological Metropolis, or "Ecopolis" is a cluster of Ecocities, towns and villages with open spaces between, which include waterways from large to very small streams, natural environments and agricultural and forest lands immediately adjacent, connected by public transit and bike-ped greenways.
Eco-Region or Bio-Region	An Ecological Metropolis occupies a portion of an even larger area, the Bio-Region or Eco-Region, which surrounds clusters of cities, towns and villages and their close-in open agricultural and natural environments and is characterized by a relatively consistent climate and population of species, often bordered by mountain ridges and/ or or edges of water bodies.

Term:	Definition:
Ecocity Network	A typical Ecocity functions within an Ecocity Network -- a regional and/or global urban super system within which Ecocity development is an adaptive process that supports the cultivation of localized urban strategies to best promote and advance the mechanism, institution, technology and culture for global sustainability according to ecological, economic and cultural principles.

Figure 6.2: Working definition adopted by Ecocity Builders and the International Ecocity Standards Advisory Team, 2/20/10, Vancouver, Canada.

The proposed IEFS seeks "*to provide an innovative vision for an ecologically-restorative human civilization*" informed and scaffolded by a practical assessment methodology to guide the measured realisation of such vision having regard to the definition of Ecocity. This proposed Ecocity Framework envisaged several steps in a city's realisation of becoming an 'ecocity' — from existing conditions to "threshold" Ecocity status and beyond. The Ecocity Framework provides an expert systems approach to measuring and assessing how a city is performing on a range of important measures, beginining from "unhealthy" through to multiple levels of "greener city," to "Ecocity", and finally to the whole earth level of "Gaia".

The Ecocity Framework includes:

1 primary ecocity urban design feature (access by proximity),

6 bio-geo-physical conditions of a healthy urban system (clean air, clean and renewable energy, nutritious and available food, responsibly managed resources and materials, healthy soil, and clean and available water),

3 ecological imperatives (healthy biodiversity, carrying capacity, and ecological integrity) and

5 socio-cultural dimensions for a healthy population (healthy culture, community capacity, lifelong education, healthy and sustainable economy and well-being).

In detail, these features and condition are summarised in the following table:

ECOCITY URBAN DESIGN FEATURE	
ACCESS BY PROXIMITY	The city provides the majority of its residents with walkable access from housing to basic urban services. It also provides walking and transit access to close-by employment options.
ECOCITY BIO-GEO-PHYSICAL CONDITIONS	
CLEAN AIR	The city maintains a level of air quality that is conducive to good health within buildings, the city's air shed, and the atmosphere.
HEALTHY SOIL	Soils within the city and soils associated with the city's economy, function and operations meet their ranges of healthy ecosystem functions as appropriate to their types and environments; fertility is maintained or improved.

CLEAN AND SAFE WATER	All residents are ensured access to clean, safe, affordable water; the city's water sources, waterways and water bodies are healthy and function without negative impact to ecosystems. Water consumed is primarily sourced from within the bioregion.
RESPONSIBLE RESOURCES/ MATERIALS	The city's non-food and non-energy renewable and non-renewable resources are sourced, allocated, managed and recycled responsibly and equitably, and without adversely affecting human health or the resilience of ecosystems. Resources/Materials are primarily sourced from within the bioregion.
CLEAN AND RENEWABLE ENERGY	The city's energy needs are provided for, and extracted, generated and consumed, without significant negative impact to ecosystems or to short- or long-term human health and do not exacerbate climate change. Energy consumed is primarily generated within the local bioregion.
HEALTHY AND ACCESSIBLE FOOD	Nutritious food is accessible and affordable to all residents and is grown, manufactured and distributed by processes which maintain the healthy function of ecosystems and do not exacerbate climate change. Food consumed is primarily grown within the local bioregion.
ECOLOGICAL IMPERATIVES	
HEALTHY BIODIVERSITY	The city sustains the biodiversity of local, bioregional and global ecosystems including species diversity, ecosystem diversity and genetic diversity; it restores natural habitat and biodiversity by its policy and physical actions.
EARTH'S CARRYING CAPACITY	The city keeps its demand on ecosystems within the limits of the Earth's bio-capacity, converting resources restoratively and supporting regional ecological integrity.
ECOLOGICAL INTEGRITY	The city maintains essential linkages within and between ecosystems and provides contiguous habitat areas and ecological corridors throughout the city.
ECOCITY SOCIO-CULTURAL FEATURES	
HEALTHY CULTURE	The city facilitates cultural activities that strengthen ecoliteracy, patterns of human knowledge and creative expression, and develop symbolic thought and social learning.
COMMUNITY CAPACITY BUILDING	The city supports full and equitable community participation in decision making processes and provides the legal, physical and organizational support for neighborhoods, community organizations, institutions and agencies to enhance their capacities.
HEALTHY AND EQUITABLE ECONOMY	The city's economy consistently favors economic activities that reduce harm and positively benefit the environment and human health and support a high level of local and equitable employment options that are integrated into the ecocity's proximity based layout and policy framework – the foundation for "green jobs" and "ecological development."

LIFELONG EDUCATION	All residents have access to lifelong education including access to information about the city's history of place, culture, ecology, and tradition provided through formal and informal education, vocational training and other social institutions.
WELL BEING – QUALITY OF LIFE	Citizens report strong satisfaction with quality of life indicators including employment; the built, natural and landscaped environment; physical and mental health; education; safety; recreation and leisure time; and social belonging.

Figure 6.3: The Ecocity Framework. Source (EB & IEAC 2011: 7).

The first condition – Ecocity Urban Design Features – is considered to be a primary attribute (IECA 2011: 5), and is explained as follows:

> *Various ecocity design features are entering into the mix as more and more cities begin exploring approaches to attain conditions of energy conservation, restored biodiversity, and pedestrian access to the offerings of the city. The existence of these helpful built precedents begins to form a guide that quickens the understanding and pace of change in ecocity directions. Such features include but are not limited to:*
>
> - **accessible rooftop and terrace gardens, shops and other facilities;**
> - **attached solar greenhouses and green walls,**
> - **car-free areas and streets,**
> - **features for high pedestrian permeability;**
> - **small blocks or mid-block pedestrian alleys,**
> - **sky-lit hallways and gallerias,**
> - **bridges linking buildings above ground level,**
> - **plazas with natural features like creeks or with views celebrating nature, [and or]**
> - **linkages of rail, bicycle and foot paths.**

Because all measures are equally important, the Ecocity Framework proposes that a city will only reach Ecocity status when it achieves an "Ecocity" or higher designation in all categories. Informed and guided by the Ecocity Framework, cities and citizens can move toward greater urban ecosystem health and sustainability by working at various levels from neighbourhood to region — developing ecocity zoning and redevelopment plans to reshape cities towards greater energy and land efficient mixed-use centres, designing neighbourhoods for improved form and function, creating specific action plans, or grappling with city, regional or country-wide programs that address broader policy and structural (i.e. educational, economic) impediments to creating Ecocities. The IEFS framework allows for assessment of ecocity performance that can be continually improved over time to give participating cities the opportunity to achieve an increasingly high status of ecocity recognition with the ultimate goal of being healthy, equitable and sustainable within 'one earth' ecological and resource limitations.

6.2.2 Ecocities and Biophilic Cities

> *"Biophilic urban design and biophilic urban planning represent one particular, albeit critical, element of green urbanism – the connection with and designing-in of nature in cities. In recognising the innate need for a connection to nature, biophilic cities tie the argument for green cities and green urbanism more directly to human well-being than to energy or environmental conservation."* (Beatley 2010:45)

The following table compiles extracts from Beatley's *Biophilic Cities: Integrating Nature into Urban Design and Planning* (2010) with numbering of the 'conditions' and 'activities', etc., instigated by the authors of this report for the convenience of reference.

BC1 Biophilic Conditions and Infrastructure	
"One key way to begin to describe what a biophilic city is (or could be) is to identify some of the various conditions or circumstances that exist or to which a city aspires. How much nature is there, and is it easily reached and enjoyed? To what extent has the city invested in the essential infrastructure to permit an urban life lived in close daily contact with the natural world" (Beatley 2010: 50).	
BC1a Biophilic Cities Are Places of Easily Accessible and Abundant Nature	A biophilic city is at once concerned about the ecological integrity of its network of nature and its accessibility and the ability of a resident to move from a neighbourhood to larger green realms (Beatley 2010: 50).
BC1b Biophilic Cities Are Rich, Textured, Multisensory Environments	A biophilic city is one that is full of varied sights, sounds, smells, and textures, many but not all of which are natural (Beatley 2010: 52).
BC1c Biophilic Cities Are Inspired by and Mimic Nature	Biophilic cities reflect a humility that understands the wisdom of nature and natural systems and the need to learn from them and mode design and planning after them (Beatley 2010: 53).
BC1d Biophilic Cities Exhibit and Celebrate the Shapes and Forms of Nature	Many advocates of biophilic design define it, in part, by the many visual connections and references made to the natural world – the symbols, pictures, shapes, and natural designs – that make their way into our cities and neighbourhoods. They appear on building façades, on street signs (and street names), or on sidewalks and pedestrian spaces and can even been seen in the shapes and forms taken by the buildings and architecture in cities (Beatley 2010: 58).

BC2 Biophilic Activities	
"A biophilic city is also about what it does – the more active ways in which its biophilic sensibilities are exercised and experienced and the many ways in which its citizens connect with and enjoy nature." (Beatley 2010: 62).	
BC2a Biophilic Cities Celebrate Their Unique Nature and Biodiversity	A biophilic city ought to be judged not only by the existence of nature and natural features but also in some way by its biophilic sensibilities – that is, how important is nature and how central is it to the lives and modus operandi of a city's leaders and its populace? (Beatley 2010: 62).
BC2b In Biophilic Cities Citizens Are Actively Involved in Enjoying, Watching, and Participating in the Nature around Them	... we are profoundly disconnected from the people around us and from the places and environments that nurture and sustain us. Biophilic cities aspire to change these conditions and shift priorities such that citizens recognize and care about the nature around them (Beatley 2010: 63).
BC2c Biophilic Cities Actively Encourage Us to Connect with Nature	In a biophilic city it should be easy and relatively effortless to enjoy nature and the outdoors, and there should be many opportunities to participate in the biophilic life of city and region (Beatley 2010: 65)
BC2d Biophilic Cities Connect Us to Our Climate	There are many reasons to encourage outdoor living and lifestyles, but at the end of the day it's about enhancing quality of life (Beatley 2010: 69-70).
BC3 Biophilic Attitudes and Knowledge	
"*A biophilic city can ... be described and characterized by the extent of the knowledge about local nature exhibited by its residents.*" (Beatley 2010: 71).	
BC3a In Biophilic Cities Citizens Are Knowledgeable about the Biodiversity and Nature around Them	Limited ability of an urban population to recognize local nature is one potential indicator of the extent of general disconnect from the natural world. In addition, then, to local nature knowledge and recognition are attitudes about the importance of contact with nature, the priority given to spending time outside, the value residents see in natural contact, and the general level of care for and commitment to nature. All are indicative of a city's biophilic credentials ... (Beatley 2010: 71).
BC3b In Biophilic Cities Citizens Have a Deep Sense of the Natural History of City and Region	In biophilic cities, residents and leaders alike not only understand the present ecological and social conditions but are able to situate that understanding in a deeper arc of history and time. Citizens of a biophilic city are knowledgeable about the geologic and natural history of the city and region, and educating and informing them about this history are key priorities of planning and public policy (Beatley 2010: 72).

BC3c In Biophilic Cities Priority Is Placed on Ecological Restoration and Repair	Cities might also be judged on their commitment to restoring and repairing damage done in the past and to actively bringing back nature to urban neighbourhoods and centers (Beatley 2010: 73).
BC4 Biophilic Institutions and Governance	
"*Biophilic cities can also be described by the ways in which they are governed ... How much of a voice is given to biodiversity protection and environmental education, for instance ... How equipped and capable is a city to advance a biophilic agenda?*" (Beatley 2010: 75).	
BC4a Biophilic Cities Invest in the Institutions and Infrastructure Necessary to Educate and Foster Connections to Nature, Near and Far	A biophilic city invests in a robust network of public and private institutions that will educate urbanists about nature, teach them to restore and protect it, and nudge them towards enjoying nature (Beatley 2010: 75).
BC4b Biophilic Cities Take Cues from the Larger Environment and Bioregion	A biophilic sensibility or spirit suggests that the city's policies and planning –environmental, housing, and economic development, among others – reflect a consciousness about the unique climate, environment, natural history, and topography, of the bioregion in which it sits (Beatley 2010: 78).
BC4c Biophilic Cities Work to Protect Nature beyond Their Borders	Large cities exert a tremendous pressure on global biodiversity through their material flows and consumption patterns, and one measure of a biophilic city is the extent to which it seeks to moderate or reduce those impacts (Beatley 2010: 79).

Figure 6.4: Biophilic Conditions and Activities, abridged from Beatley (2010).

Beatley notes that, at the simplest level, "*a biophilic city is a city that seeks to foster a closeness to nature – it protects and nurtures what it has (understands that abundant wild nature is important), actively restores and repairs the nature that exists, while finding new and creative ways to insert nature into the streets, buildings, and urban living environments*"

(Beatley 2010: 81).

Although the relationship of ecocities to biophilic design has not been explored explicitly to any great extent, by matching Beatley's widely cited description of what constitutes a biophilic city against the Ecocity Framework it can be seen that there are sufficient commonalities and linkages to conclude that functional relationships exist between ecocities and biophilia.

ECOCITY URBAN DESIGN FEATURE	
ACCESS BY PROXIMITY	**BC1a** Biophilic Cities Are Places of Easily Accessible and Abundant Nature **BC2b** In Biophilic Cities Citizens Are Actively Involved in Enjoying, Watching, and Participating in the Nature around Them **BC2c** Biophilic Cities Actively Encourage Us to Connect with Nature **BC2d** Biophilic Cities Connect Us to Our Climate
ECOCITY BIO-GEO-PHYSICAL CONDITIONS	
CLEAN AIR	**BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
HEALTHY SOIL	**BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
CLEAN AND SAFE WATER	**BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
RESPONSIBLE RESOURCES/MATERIALS	**BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
CLEAN AND RENEWABLE ENERGY	**BC2d** Biophilic Cities Connect Us to Our Climate

HEALTHY AND ACCESSIBLE FOOD	**BC1a** Biophilic Cities Are Places of Easily Accessible and Abundant Nature **BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
ECOLOGICAL IMPERATIVES	
HEALTHY BIODIVERSITY	**BC1a** Biophilic Cities Are Places of Easily Accessible and Abundant Nature **BC2a** Biophilic Cities Celebrate Their Unique Nature and Biodiversity
EARTH'S CARRYING CAPACITY	**BC4c** Biophilic Cities Work to Protect Nature beyond Their Borders
ECOLOGICAL INTEGRITY	**BC2d** Biophilic Cities Connect Us to Our Climate **BC3c** In Biophilic Cities Priority Is Placed on Ecological Restoration and Repair
EECOCITY SOCIO-CULTURAL FEATURES	
HEALTHY CULTURE	**BC2a** Biophilic Cities Celebrate Their Unique Nature and Biodiversity **BC2b** In Biophilic Cities Citizens Are Actively Involved in Enjoying, Watching, and Participating in the Nature around Them **BC2c** Biophilic Cities Actively Encourage Us to Connect with Nature **BC3b** In Biophilic Cities Citizens Have a Deep Sense of the Natural History of City and Region

COMMUNITY CAPACITY BUILDING	**BC1c** Biophilic Cities Are Inspired by and Mimic Nature **BC2c** Biophilic Cities Actively Encourage Us to Connect with Nature **BC2d** Biophilic Cities Connect Us to Our Climate
HEALTHY AND EQUITABLE ECONOMY	**BC4b** Biophilic Cities Take Cues from the Larger Environment and Bioregion
LIFELONG EDUCATION	**BC2b** In Biophilic Cities Citizens Are Actively Involved in Enjoying, Watching, and Participating in the Nature around Them **BC3a** In Biophilic Cities Citizens Are Knowledgeable about the Biodiversity and Nature around Them **BC4a** Biophilic Cities Invest in the Institutions and Infrastructure Necessary to Educate and Foster Connections to Nature, Near and Far
WELL BEING – QUALITY OF LIFE	**BC1b** Biophilic Cities Are Rich, Textured, Multisensory Environments **BC1d** Biophilic Cities Exhibit and Celebrate the Shapes and Forms of Nature **BC2b** In Biophilic Cities Citizens Are Actively Involved in Enjoying, Watching, and Participating in the Nature around Them **BC2d** Biophilic Cities Connect Us to Our Climate

Figure 6.5: The Ecocity Framework and Biophilic Cities

The following table considers the Ecocity Framework against the Biophilic Design Patterns in terms of applicability and relevance. Ideally, all the Biophilic Design Patterns would be developed within an overarching Narrative and that Narrative would relate to both Metro Stations and the concept of Melbourne as an Ecocity. The Narrative Types are described in described in Chapter 2, section 2.4.

Biophilic Design Pattern:		P1	P1+	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14
	Narrative Type	Visual Connection with Nature	Non-Visual Connection with Nature		Non-Rhythmic Sensory Stimuli	Thermal & Airflow Variability	Presence of Water	Dynamic & Diffuse Light	Connection with Natural Systems	Biomorphic Forms & Patterns	Material Connection with Nature	Complexity & Order	Prospect	Refuge	Mystery	Risk/Peril
Ecocity Urban Design Feature		O		O		O	O		O	O	O	O	O	O	O	O
Access By Proximity	1,4,8															
Bio-Geo-Physical Conditions				O	O	O		O	O							
Clean Air	5,6			O			O		O							
Healthy Soil	5,6,7	O		O	O		O		O							O
Clean And Safe Water	2,5,6	O							O	O	O	O		O		
Responsible Resources/Materials	6,8,9	O	O	O	O	O			O							O
Clean And Renewable Energy	2,4,6,7															
Ecological Imperatives		O		O			O		O							
Healthy And Accessible Food	1,2,5,9	O		O			O		O			O	O			
Healthy Biodiversity	2,5,9		O								O				O	
Earth's Carrying Capacity	1,5,9															
Ecological Integrity		O		O				O	O	O		O	O	O	O	O
Healthy Culture	1,2,3,9			O					O					O	O	
Community Capacity Building	1,8,9	O		O					O		O	O				
Healthy And Equitable Economy	1,2,3,6	O			O				O			O			O	O
Lifelong Education	1,2,3,5,7,9															

Figure 6.6: Ecocity Framework & Biophilic Design Patterns

6.3 EcoCities & the City of Melbourne's Council Plan (2013)

The City of Melbourne, in its Council Plan 2013-17 (2013), seeks to create "*a bold, inspirational and sustainable city.*"

Included in the Council Plan (2013) is 8 goals of which 1 specially addresses the long-term community goal and City management aspiration to craft the City into an 'ecocity'. The Plan (2013) envisages this goal – "[to] provide solid foundations for the sustainability of Melbourne's communities – [to] embrace the unfamiliar if it helps us achieve our ambitions [and to] continue to encourage our community to take positive actions and we lead by example locally, nationally and globally, as summarised in the following Table that sets forth the Goal, and measurable Outcomes for the life of the Plan:

Long-term community goals	The outcomes the City of Melbourne seeks to achieve in the next four years through this Council Plan	We'll track progress in terms of:
5. An eco-city As an eco-city, Melbourne is committed to reducing our ecological footprint and will work to ensure our people and organisations can adapt to climate change and build a sustainable future.		• Municipal emissions: tonnes of greenhouse pollution (CO^2) per resident and per worker in the municipality.
Ecological Metropolis	Our greenhouse gas emissions are reduced.	• The proportional change in greenhouse gas emissions generated by City of Melbourne activities, per year.
Eco-Region or Bio-Region	Less municipal waste-to-landfill with less negative impact on amenity from collecting waste.	• The proportional change in total tonnes of waste to landfill. • The volume of complaints per capita about waste removal the City of Melbourne receives, per year.
Ecocity Network	Sustainable water management.	• The proportional change in the capacity of infrastructure to capture and reuse storm-water, per year.
	Increased biodiversity and tree canopy cover in the municipality.	• The percentage of tree canopy cover of the municipality, annually.

Long-term community goals	The outcomes the City of Melbourne seeks to achieve in the next four years through this Council Plan	We'll track progress in terms of:
	Climate change impacts on the municipality are managed.	• The proportional change in the number of residents who are aware of climate change-related risks and the actions they should be taking, annually.

Figure 6.7: City of Melbourne goals and outcomes

The Council's four-year priorities, under this Goal, include:

- **Update and continue to implement our Zero Net Emissions Strategy.**
- **Provide services to enable residents and businesses to transition to zero net emissions through energy efficiency and renewable energy sources.**
- **Develop low-carbon and renewable-energy infrastructure through structure plans and planning approvals.**
- **Embed municipal-wide waste management practices to increase recycling, reduce waste generation and lessen amenity impacts.**
- **Improve sustainable water management by updating and implementing our Total Watermark Strategy.**
- **Develop integrated water management infrastructure through structure plans and planning approvals.**
- **Improve resilience to environmental impacts by implementing our Urban Forest and Open Space strategies, and also develop a Biodiversity Strategy.**
- **Update and continue to implement our Climate Change Adaptation Strategy and Action Plan.**
- **Embed a stronger focus on sustainability and climate change adaptation in our systems, governance, tools and knowledge and in our interactions with the community.**

6.4 Green star

Launched by the Green Building Council of Australia in 2003, Green Star is an internationally recognised sustainability rating system extensively used throughout Australia in for individual buildings to entire communities. Australia's only national, voluntary rating system for buildings and communities, it comprises a Green Star rating system ('Green Star Rating System') and a Green Star Rating Tools ('Rating Tools'). The latter are intended to be used by project teams, contractors and other interested parties to measure and validate sustainability initiatives in the design and construction phases of eligible projects.

The purpose of Green Star is to improve environmental efficiencies in our buildings, while also boosting productivity, creating jobs and improving the health and wellbeing of our communities. It's mission is to "*create sustainable places for everyone*" by encouraging practices that: reduce the impact of climate change; enhance the health and quality of life of inhabitants and the sustainability of the built environment; restore and protect the planet's biodiversity and ecosystems; ensure the ongoing optimum operational performance of buildings; and, contribute to market transformation and a sustainable economy.

Green Star is now an internationally recognised rating system that delivers independent verification of sustainable outcomes throughout the life cycle of the built environment. Composed of four distinct sustainability rating tools, each tool is relevant to distinct phases of the built environment: Communities (a holistic rating tool for communities and precincts); Design & As Built (a holistic rating tool for the design and construction of new buildings and major refurbishments); Interiors (a holistic rating tool for the design and construction of new interior fitouts; Performance (a holistic rating tool for sustainable building operations).

In particular the Design & As Built rating tool was developed to rate the design and construction of any building, and to assist clients and project teams to achieve and rate their sustainability goals for their project; encourage a new approach to designing and constructing buildings by rewarding sustainability best practice and excellence; and provide consistent and clear advice in an easy to use manner.

Green Star – Design & As Built assesses the sustainability attributes through nine categories: Management; Indoor Environment Quality; Energy; Transport; Water; Materials; Land Use and Ecology; Emissions; and Innovation. Each category groups a number of issues related to a certain sustainability impact; these are known as Credits. A Credit addresses an initiative that improves or has the potential to improve a project's sustainability performance; each of these initiatives is a criterion.

In terms of the MTP, an initial Green Star assessment has indicated that the Project can achieve a 5 Star Green Star Rating under the Design As Built MTP Rating Tool, and this is now a minimum requirement on the Project. A 5 star rating (60-70% available points) means an 'Australian Excellence' designation whereas a 75+% results in a 6 Star rating of 'World leadership'.

A scorecard is an interactive spreadsheet that is required to be used by anyone seeking a formal rating, provides a number of error checks to allow projects to determine why a rating can, or cannot, be achieved, and some credits require additional calculations in order to determine the number of points awarded

Credit	Calculator	Guide
16. Visual Comfort	No calculator.	Daylight and Views Hand Calculation Guide
19. Greenhouse Gas Emissions	Greenhouse Gas Emissions Calculator	Greenhouse Gas Emissions Calculator Guide
20. Peak Electricity Demand Reduction		Shared Services and Low-carbon Energy Supply Calculator Guide
22. Potable Water	Potable Water Calculator	Potable Water Calculator Guide
25. Sustainable Products	Sustainable Products Calculator	No guide.
27. Ecological Value	Ecological Value Calculator	No guide.
33. Refrigerant Impacts	Refrigerant Impacts Calculator	No guide.
34. Innovation	No calculator.	Innovation Category Guidance

Figure 6.8: MMRA (2015: 12), MMR-AJM- UGAA-RP-ZZ-000243 Green Star Design & As Built Melbourne Metro Rail Tool

The project is seeking a certified minimum 5 star rating and targeting a 6 star rating under the Green Star – Design & As Built MTP Rating Tool. This tool has been specifically developed and prepared for the Melbourne Metro Rail Authority, for use on both above ground and underground train stations. A number of potential opportunities have been identified to gain Green Star credits from biophilic design initiatives. They include Indoor Air Quality, Acoustic Comfort, Minimum Lighting Comfort, Daylight Glare Reduction, Daylight, Views, Indoor Pollutants and Land Use and Ecology. Biophilic Design for railway stations can also potentially achieve innovation points under the Innovation Credit. The requirements set by Green Star are precisely delineated. These notes do not go into detail and are only intended as an indication of where the credit gains might relate to, or be because of, biophilia.

In terms of performance requirements, generally, under the Green Star Rating Tool: Section 6.4 Modelling Daylight-Controlled Artificial Lighting Systems (2015: 142) sets out credit that can be claimed for the dimming control of artificial lighting in response to measured daylight in a space, except adjustment factors explained in Section 14.5.2 Automatic Lighting Controls, permitting consideration of

- Calculation of hourly internal daylight levels by the building energy performance simulation software from first principles; or
- Calculation of daylight compensation by the building energy performance simulation software based on user-defined daylight factors and solar radiation from the weather data file.

In addition, matters listed in the Section 10 Appendices may also be pertinent.

In terms of credits directly relevant to, or influenced by Biophilic design outcomes, the Indoor Environmental Quality, Land Use & Ecology, and Innovation sections are relevant.

The Indoor Environment Quality (MMRA 2015: 87-138) category "*aims to encourage and reward initiatives that enhance the comfort and well-being of occupants". The credits within this section address issues such as air quality, thermal comfort and acoustic comfort.*" This category "*rewards projects that achieve Increased Comfort and Well-Being [through] improvements to air quality through appropriate ventilation, [through] provision of high levels of thermal, visual and acoustic comfort, [and through] reductions to occupant stress, [in addition to] Reduced Exposure To Pollutants [via] the creation of low-toxicity environments through reductions to pollutants, [and] the removal of harmful materials from existing buildings*" (MMRA 2015: 87).

The Land Use & Ecology (MMRA 2015: 245-272) category "*aims to reduce the negative impacts on sites' ecological value as a result of urban development and reward projects that minimise harm and enhance the quality of local ecology*". This category "*rewards projects that achieve Site Sustainability [thereby] addressing the ecological conditional requirement, [by] selecting site[s] for development on 'previously developed land', [and] where required the site has been remediated in accordance with a best practice remediation strategy, [in addition to] Reducing Ecological Impacts From Occupied Sites [that deal] with stormwater at best practice levels, [reduce] the impact of heat island effects from hard surfaces, [and result in a] specified reduction in light pollution … achieved by the project*" (MMRA 2015: 245).

The Innovation (MMRA 2016: 299-304) category *"aims to recognise the implementation of innovative practices, processes and strategies that promote sustainability in the built environment"* but "*also rewards projects that can demonstrate that sustainability principles have been incorporated not at a project level, but also in a broader sense [including] collaboration between building owners and tenants, disclosure of the financial impacts of sustainability or delivering sustainable education content to site workers"*. Thus, the category provides credits for projects that achieve: meeting the aims of an existing credit using a technology or process that is considered Innovative; implementing a sustainability initiative that substantially contributes to the broader market transformation towards sustainable development; delivering a substantial improvement on the benchmark required to achieve full points; addressing an Innovation Challenge; and addressing a 'global sustainability' issue as covered by other international sustainability rating systems. Note, the inclusion of the WELL Building Standard® (2016) rating system or the SITES® system, discussed below, in the project's requirements can offer potential to increase the Green Star Innovation credits and thus the overall project's Green Star rating.

Also, the definitional scope of Visual Qualities offers potentials for enabling credits especially where:

- *"A high quality external view … extend[s] to the outside towards natural elements such as large bodies of vegetation, a body of water, frequent movement of (people, vehicles, or animals) or sky.*
- *"A high quality internal view [affords] a view towards an area that is landscaped or contains a water feature, or an atrium, or an area where frequent movement of people can be expected [recognising that a] landscaped area must contain high plant density and may be vertical. (WELL 2016)*

In addition to the above specific categories, indoor and outdoor vegetation could assist with the credits for:

- **Ecological Values** – in the provision of "*planted native vegetation (including native garden, indigenous native garden, green roof, native plantation forest), noting that for "vertical gardens and green roofs, only the amount of soil/substrate in which the plants are rooted is recognised, not the total area covered by the plants*" (MMRA 2015: 249);
- **Energy** – reduction in energy use due to more passive cooling due to vegetation; and
- **Pollution** – reduction in internal pollution and reduction of carbon due to vegetation.

Green Star Category	Biophilic Design Response	Green Star Credit Points Available
Indoor Air Quality	Biophilic design, wherever possible, incorporates living vegetation. Many species of plants selected for indoor use have the capability to improve indoor air quality through a proven ability to capture and/or extract pollutants.	4 points
Acoustic Comfort	Vegetation can assist in providing acoustic comfort, as can acoustic design that reduces stress and facilitates human capacity to enjoy positive acoustic experiences, e.g., natural soundscapes.	3 points
Minimum Lighting Comfort	Biophilia is about human comfort and wellbeing as a consequence of shaping the environment to reflect nature and the patterns of nature – which include the patterns of light.	1 point for best practice compliance 1 point where lighting and surfaces improve uniformity of lighting.
Daylight Glare Reduction	In the natural environment, glare rarely happens, or is congruent with expectations set by context. In an artificial environment, glare should be avoided. Biophilic design can assist in ensuring that it is.	0 credits for underground stations
Daylight	Biophilic design favours natural daylight as a powerful imperative. In seeking ways to ensure daylight in the below-ground levels of the stations, the needs of both Green Star and biophilia can be addressed.	2 points where high levels of daylight are available within an underground station area. 1 point for underground stations where the lighting system in all primary spaces promotes and maintains natural circadian rhythms.

Views	Biophilic design requires views into the distance.	1 point where at least 60% of the nominated area has clear line-of-sight to a high quality internal or external view.
Indoor Pollutants	Appropriate vegetation can absorb and filter pollutants. Manufactured timber products that might prompt biophilia must be zero-formaldehyde.	1 point under the IEQ credit, where the vegetation could assist in the improvement of indoor environmental quality of stations.
Land Use and Ecology	The ecological value of the project surface areas can be improved by the project.	3 points
Innovation	Biophilic design of the railway stations will provide the opportunity to consider a WELL Building Standard rating, and this can achieve additional innovation points	4 points for additional rating tool credits

Figure 6.9: Potential Green Star Points

There is scope for reinforcing the overall effect that biophilic design can have on the Green Star score with the requirement for 'Sustainable Cultures and Behaviours' which require:

- Raising awareness among stakeholders, and the provision of education and learning opportunities that enable more sustainable practices.
- The fostering of sustainable behaviour and systems that allow for continual improvement through environmental data monitoring and information sharing.

The biophilic city model promoted by Beatley, for instance, has a lot to say about this one way and it may be argued that by contributing to the biophilic city goals identified by Beatley and in this research, the project might gain some points, or at least reinforce its claim for points in other areas. (Beatley, 2010)

Credit 9 'Culture, Heritage and Identity' may have similar biophilic leverage potential. The link between indigenous history and occupation of the place (bioregion) can enhance understanding of the nature of the place, including knowledge of place derived from indigenous sources. This connects to biophilic design in its most comprehensive form, inclusive of nature and human culture through recognising their interdependence, and fits one of Beatley's requirements for a biophilic city, ie: in Biophilic Cities Citizens Have a Deep Sense of the Natural History of City and Region.

In terms of Biophilic design and the MTP, the possibilities to increase the Project's Green Star rating from 5 to 6 exist in strengthening the Indoor Environment Quality, the Land Use & Ecology and the Innovation categories of which the application of vegetation, vistas, ecological values, use additional rating tools, and educational/research engagements and training offers potentials.

6.5 WELL Building Standard®

The International WELL Building Institute PBC believes "*that buildings should be developed with people's health and wellness at the center of design*" (Delos Living LLC 2016: 2). Thus, the Institute's WELL Building Standard® (2016) uses a holistic approach to apply a performance-based system to measure and assess health in the built environment addressing human and building behaviour, operations and design.

Building upon an extensive body of medical research, the WELL Building Standard® (2016) considers the connectivity between buildings, where contemporary humans spend more than 90% of their time, and the health and wellness impacts of such environments upon these occupants. It is an evidence-based system used to measure, certify and monitor the performance of building features that impact upon health and well-being. The assumption is that built environment has a direct bearing upon and can influence (improve / deteriorate) human nutrition, fitness, mood, sleep patterns and performance of building occupants. Importantly, this is a human-centred holistic tool, and not a human + wildlife + biodiversity holistic tool.

The WELL Building Standard®(2016) is administered by the International WELL Building Institute™ (IWBI), a public benefit corporation whose mission is to improve human health and well-being through the built environment. WELL is third-party certified by Green Business Certification Inc. (GBCI), which administers LEED certification and LEED professional credentialing.

WELL measures attributes of buildings that impact occupant health by looking at seven factors, or Concepts:

Concepts:	Measurable attributes:
Air	Optimize and achieve indoor air quality. Strategies include removal of airborne contaminants, prevention and purification.
Water	Optimize water quality while promoting accessibility. Strategies include removal of contaminants through filtration and treatment, and strategic placement.
Nourishment	Encourage healthy eating habits by providing occupants with healthier food choices, behavioral cues, and knowledge about nutrient quality.
Light	Minimize disruption to the body's circadian rhythm. Requirements for window performance and design, light output and lighting controls, and task-appropriate illumination levels are included to improve energy, mood and productivity.
Fitness	Utilize building design technologies and knowledge-based strategies to encourage physical activity. Requirements are designed to provide numerous opportunities for activity and exertion, enabling occupants to accommodate fitness regimens within their daily schedule.
Comfort	Create an indoor environment that is distraction-free, productive, and soothing. Solutions include design standards and recommendations, thermal and acoustic controllability, and policy implementation covering acoustic and thermal parameters that are known sources of discomfort.
Mind	Support mental and emotional health, providing the occupant with regular feedback and knowledge about their environment through design elements, relaxation spaces, and state-of-the-art technology.

Figure 6.10: WELL Measurable Attributes

The WELL Building Standard® (2016) comprises of over 100 Features that are applied to each building project, and each Feature is designed to address issues that impact the health, comfort, or knowledge of occupants. Many Features intentionally aim to improve human health are supported by existing government legislation, standards or other policies. Some Features purposefully seeks to change human behaviour through knowledge acquisition or building / office policy changes or through cultural (social and cultural) modifications, as well as in the provision of information and support infrastructure to aid positive lifestyle choices.

The Features can be:

- Performance-based standards: allow flexibility in how a project meets acceptable quantified thresholds; or
- Descriptive standards: require that specific technology, design strategies, or protocols are implemented.

The WELL Building Standard® (2016) Features are categorized as either Preconditions—necessary for baseline WELL Certification, or Optimizations—optional enhancements, which together determine the level of certification above baseline certification.

The following colour-coded Table shows which features are Preconditions and Optimizations for the different typologies of the standard for commercial and institutional offices. For occupied spaces to obtain WELL Certification, all Preconditions are required for the Silver level and completion of Optimizations allow projects to receive higher award levels. For Core and Shell projects to achieve WELL Compliance, all Preconditions are required, as well as at least one Optimization from every concept.

COMPLIANCE		PRECONDITION	OPTIMIZATION	Core and Shell	New and Existing Interiors	New and Existing Buildings
CERTIFICATION		PRECONDITION	OPTIMIZATION			
Air						
01	Air quality standards			P	P	P
02	Smoking ban			P	P	P
03	Ventilation effectiveness			P	P	P
04	VOC reduction			P	P	P
05	Air filtration			P	P	P
06	Microbe and mold control			P	P	P
07	Construction pollution management			P	P	P
08	Healthy entrance			P	O	P
09	Cleaning protocol				P	P
10	Pesticide management			P		P
11	Fundamental material safety			P	P	P
12	Moisture management			P		P
13	Air flush				O	O
14	Air filtration management			O	O	O
15	Increased ventilation			O	O	O
16	Humidity control				O	O

COMPLIANCE		PRECONDITION	OPTIMIZATION	Core and Shell	New and Existing Interiors	New and Existing Buildings
CERTIFICATION		PRECONDITION	OPTIMIZATION			
17	Direct source ventilation			O	O	O
18	Air quality monitoring and feedback				O	O
19	Operable windows			O	O	O
20	Outdoor air systems			O	O	O
21	Displacement ventilation				O	O
21	Displacement ventilation				O	O
22	Pest control				O	O
23	Advanced air purification			O	O	O
24	Combustion minimization			O	O	O
25	Toxic material reduction				O	O
26	Enhanced material safety				O	O
27	Antimicrobial activity for surfaces				O	O
28	Cleanable environment				O	O
29	Cleaning equipment				O	O
Water						
30	Fundamental water quality			P	P	P
31	Inorganic contaminants			P	P	P
32	Organic contaminants			P	P	P
33	Agricultural contaminants			P	P	P
34	Public water additives			P	P	P
35	Periodic water quality testing				O	O
36	Water treatments			O	O	O
37	Drinking water promotion			O	O	O
Nourishment						
38	Fruits and vegetables				P	P
39	Processed foods			P	P	P
40	Food allergies			P	P	P
41	Hand washing				P	P
42	Food contamination				P	P
43	Artificial ingredients			O	P	P
44	Nutritional information			O	P	P
45	Food advertising			O	P	P
46	Safe food preparation materials				O	O
47	Serving sizes				O	O
48	Special diets				O	O
49	Responsible food production				O	O
50	Food storage				O	O

COMPLIANCE		PRECONDITION	OPTIMIZATION	Core and Shell	New and Existing Interiors	New and Existing Buildings
CERTIFICATION		PRECONDITION	OPTIMIZATION			
51	Food production			O	O	O
52	Mindful eating			O	O	O
Light						
53	Visual lighting design				P	P
54	Circadian lighting design				P	P
55	Electric light glare control			P	P	P
56	Solar glare control			O	P	P
57	Low-glare workstation design				O	O
58	Color quality				O	O
59	Surface design				O	O
60	Automated shading and dimming controls				O	O
61	Right to light			O	O	O
62	Daylight modelling			O	O	O
63	Daylighting fenestration			O	O	O
Fitness						
64	Interior fitness circulation			P		P
65	Activity incentive programs				P	P
66	Structured fitness opportunities				O	O
67	Exterior active design			O	O	O
68	Physical activity spaces			O	O	O
69	Active transportation support			O	O	O
70	Fitness equipment			O	O	O
71	Active furnishings				O	O
Comfort						
72	ADA accessible design standards			P	P	P
73	Ergonomics: virtual and physical				P	P
74	Exterior noise intrusion			P	O	P
75	Internally generated nose			O	P	P
76	Thermal comfort			P	P	P
77	Olfactory comfort				O	O
78	Reverberation time				O	O
79	Sound masking				O	O
80	Sound reducing surfaces				O	O
81	Sound barriers				O	O
82	Individual thermal comfort				O	O
83	Radiant thermal comfort			O	O	O

COMPLIANCE		PRECONDITION	OPTIMIZATION	Core and Shell	New and Existing Interiors	New and Existing Buildings
CERTIFICATION		PRECONDITION	OPTIMIZATION			
Mind						
84	Health and wellness awareness			P	P	P
85	Integrative design			P	P	P
86	Post-occupancy surveys				P	P
87	Beauty and design I			P	P	P
88	Biophilia I – qualitative			O	P	P
89	Adaptive spaces				O	O
90	Healthy sleep policy				O	O
91	Business travel				O	O
92	Building health policy				O	O
93	Workplace family support				O	O
94	Self-monitoring				O	O
95	Stress and additional treatment				O	O
96	Altruism				O	O
97	Material transparency				O	O
98	Organisational transparency			O	O	O
99	Beauty and design II				O	O
100	Biophilia II – quantitative			O	O	O
101	Innovation feature I			O	O	O
102	Innovation feature II			O	O	O

Figure 6.11: WELL Measurable Attribute categories.

While Biophilia is specifically mentioned under the Mind Feature category, in terms of qualitative and quantitative attributes, a larger number of the overall Features are also pertinent to any biophilic design pattern evaluation of a project. Under Mind, the WELL Building Standard® (Delos Living LLC 2016: 133) defines this realm as:

Mind

While mental and physical health are often conceptualized as separate domains, our minds and bodies are inextricably connected. For instance, exercise increases the release of serotonin, which can elevate mood and regulate the sleep cycle. The simple act of worrying, on the other hand, can trigger physiological responses similar to the way physical stress and injury can. While the body has a remarkable capacity for recovering from a single acute stressor, chronic, repeated activation of the stress response can be especially damaging both physiologically and psychologically. Because humans have the capacity to worry about abstract and often nonimmediately resolvable problems such as loss, career, finance issues and self-esteem, modern life can be wrought with stressors that lead to low mood, depression and a negative sense of self. The WELL Building Standard® recognizes the features of the built environment and identifies workplace policies that can be implemented to positively impact mood, sleep, stress levels and psychosocial status in order to promote and enable overall occupant health and well-being.

Biophilia, generally is included in the Mind category of Features. It recognises that until recently humans had regular engagements with nature, living things and their natural contexts. The WELL Building Standard® (2016) links biophilia, or the notion that humans have a direct relationship with nature, as being an emergent sub-discipline field of psychology that associates human psychology needs require a desire to have engagement with life and life-like processes. As demonstrated in medical research, exhibition of real and or artificial views and representations of nature can aid human healing and recovery time, as well as increase positive human feelings and reduce negative feelings. Therefore, interior environments that are cold, sterile and devoid of life, can therefore diminish human experiences, moods and happiness.

The **Biophilia I – Qualitative Feature** recognizes the importance of creating interior environments that nurtures innate human-nature connections. Drawing the Living Building Challenge, biophilia design requirements include undertaking historical, cultural, ecological and climatic research that informs biophilic design pattern actions together with appropriate biophilic frameworks that monitor Biophilia design pattern realisation at each design phase of a project.

The **Biophilia I – Qualitative Feature** recognizes three Parts:

PART 1: NATURE INCORPORATION: A biophilia plan is developed that includes a description of how the project incorporates nature through the following:

a. Environmental elements.

b. Lighting.

c. Space layout.

PART 2: PATTERN INCORPORATION: A biophilia plan is developed that includes a description of how the project incorporates the following:

a. Nature's patterns throughout the design.

PART 3: NATURE INTERACTION: A biophilia plan is developed that provides sufficient opportunities for human-nature interactions:

a. Within the building.

b. Within the project boundary, external to the building (Delos Living LLC 2016: 140).

The **Biophilia II – Quantitative Feature** perceives that humans have a personal affinity to nature. Medical research evidence about the emotional and psychological benefits of nature has demonstrated this correlation especially where linked the experience of nature or nature-derived patterns can improve experience, mood and happiness. Therefore, this Feature seeks the provision of indoor design elements reminiscent of the natural environment, including water features and plantings, as well as access to outdoor gardens and landscaped areas.

The **Biophilia II – Quantitative Feature** recognizes three Parts:

PART 1: OUTDOOR BIOPHILIA: At least 25% of the project site area meets the following requirements:

a. Features either landscaped grounds or rooftop gardens accessible to building occupants.

b. Consists of, at minimum, 70% plantings including tree canopies (within the 25%).

PART 2: INDOOR BIOPHILIA

Wall and potted plants are incorporated into the design of interior space according to the following:

a. Potted plants or planted beds cover at least 1% of floor area per floor.

b. A plant wall per floor, covering a wall area equal or greater than 2% of the floor area, or covering the largest of the available walls, whichever is greater.

PART 3: WATER FEATURE

At least one water feature for every 9,290 m^2 [100,000 ft^2] in projects larger than 9,290 m^2 [100,000 ft^2] which meets the following requirements:

a. At least 1.8 m [5.8 to 6 ft] in height or 4 m^2 [43 ft^2] in area.

b. Ultraviolet sanitation or other technology to address water safety (Delos Living LLC 2016: 154).

Buildings in Melbourne and Geelong that have publicly lodged their certifications through the www.wellcertified.com/certification include the following:

Address	Type	Name
80 Collins Street, Melbourne	**Core & Shell**	80 Collins Street Melbourne Tower 2 (New)
L12, 570 Bourke Street, Melbourne	**New and Existing Interiors**	Charter Hall Workplace - Melbourne
2-16 Northumberland Street, Melbourne	**Core & Shell**	Northumberland
447 Collins Street, Melbourne	**Core & Shell**	447 Collins Street
1-7 Malop St, Geelong	**Core & Shell**	1 Malop St

Figure 6.12: Buildings WELL certified in Melbourne and Geelong.

6.6 Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability (IS) Rating Tool

The Infrastructure Sustainability Council of Australia (ISCA) is the peak Australian industry body for advancing sustainability in Australia's infrastructure. It is an industry member-based, not-for-profit industry (public and private) council. The ISCA's mission is "*Improving the productivity & liveability of industry & communities through sustainability in infrastructure*" (*www.isca.org.au/is-rating-scheme/is-overview/is-rating-tool/item/68-is-rating-tool*).

Devised and administered by the ISCA, the Infrastructure Sustainability (IS) rating scheme evaluates sustainability across the design, construction and operation of infrastructure; including separate typologies for the transport, water, communication and energy sectors. The Tool evaluates sustainability initiatives and potential environmental, social and economic impacts of major infrastructure projects towards helping to improve project performance and alignment with the expertise of designers, project managers and decision makers in ways to positively transform the manner in which infrastructure is planned, designed, built and operated. It offers a common methodology for use to inform sustainable outcomes across a broad range of infrastructure projects enabling project recognition through a third party certification system.

Themes	Categories
Management and Governance	Management Systems Procurement and Purchasing Climate Change Adaptation
Using Resources	Water Materials
Emissions, Pollution and Waste	Discharges to Air, Land & Water Land Waste
Ecology	Ecology
People and Place	Community Health, Well-being and Safety Heritage Stakeholder Participation Urban & Landscape Design
Innovation	Innovation

Figure 6.13: Infrastructure Sustainability (IS) Rating Tool themes and categories

Biophilic design of the railway stations and precincts can potentially assist in achieving higher levels in the credits of the ISCA IS rating tool, these include:

Ecology

- Eco-2 Ecological Value - level 2, enhancement of the ecological value of the site
- Eco-3 Biodiversity - level 2, the existing degree of biodiversity values is enhanced by more than 20%
- Eco-4 Habitat Connectivity - level 2, the existing degree of habitat connectivity is enhanced

People and Place

- Hea-1 Community Health and Wellbeing - level 2, positively contribute to community health and wellbeing
- Urb-2 Site Planning - level 3, site planning that facilitates sustainable urbanism
- Urb-3 Urban Design - level 3, support the adoption of world class best practice urban design

Innovation

- Transformative - Biophilic Design of railway stations connecting underground and aboveground habitats can be seen as a first in Australia and could be transformative in setting new standards for the design of railway stations.

6.7 The MMRA Urban Design Strategy

The MTP's Urban Design Strategy (2017: vi) seeks to create:

> *A legacy of outstanding rail stations and associated public spaces that put people first, contribute to Melbourne's reputation for design excellence, and deliver an overall substantial benefit in terms of urban quality for Melbourne, for the transport network, and for local areas influenced by the project.*

Melbourne Metro Rail Authority states that the MTP is "*not just to run trains along the new alignment. It is foundation infrastructure that will open opportunities for more frequent services across the entire network and will change how people move around the city as a whole.*" (2016: vi)

Biophilic Design has particular relevance to Melbourne Metro Rail Authority's Urban Design Strategy (2017), particularly in regard to its goal 3.2 'To Make Great Public Spaces'.

Design Guidelines (selected)	Associated Biophilic Design Pattern
1. Ensure that all aspects of the design are of a high quality in concept, resolution and execution. Designs must be:	P10
• fit for purpose	P7 Connection with Natural Systems P10 Complexity & Order P12 Refuge
• responsive to all users' needs	P8 Biomorphic Forms & Patterns P10 Complexity & Order P14 Risk/Peril
• responsive to the site and associated cultural values	P1 Visual Connection with Nature P8 Biomorphic Forms & Patterns
• sustainable	P1 Visual Connection with Nature
2. Design spaces to be activated by public use:	P12 Refuge
• Provide seating and other infrastructure to encourage people to inhabit the space.	P1 Visual Connection with Nature P12 Refuge
• Support the programming of spaces for a range of event scales and types.	P2 Non-Visual Connection with Nature P12 Refuge P13 Mystery P14 Risk/Peril
• Accommodate opportunities for street trading activities as consistent with local authority policies and guidelines.	P10 Complexity & Order

Design Guidelines (selected)	Associated Biophilic Design Pattern
• Locate, design and manage activities in underground stations, including business opportunities, to contribute to activation of the wider precinct.	P10 Complexity & Order
3. Provide safe environments that promote safe behaviour and the feeling of safety:	P9 Material Connection with Nature P11 Prospect P12 Refuge
• Design spaces with consideration of Crime Prevention Through Environmental Design principles.	P10 Complexity & Order P11 Prospect P12 Refuge P14 Risk/Peril
• Support complementary mixes of activities, activation and passive surveillance that contribute to other users' interest and safety.	P7 Connection with Natural Systems P10 Complexity & Order P11 Prospect P12 Refuge
• Maximise visual connectivity between spaces to enable passive surveillance, and arrange uses to maximise passive surveillance.	P10 Complexity & Order P11 Prospect P12 Refuge
• Design and manage entries to underground stations and pedestrian subways to ensure safe conditions in surrounding spaces and approach routes, including when the stations are closed.	P6 Dynamic & Diffuse Light P10 Complexity & Order P11 Prospect P13 Mystery P14 Risk/Peril
4. Respect heritage and respond to local cultural and indigenous heritage issues:	P9 Material Connection with Nature P13 Mystery
• Retain and protect significant heritage elements including spaces, views, vegetation, natural and designed landforms, and built fabric.	P1 Visual Connection with Nature P10 Complexity & Order P11 Prospect P12 Refuge
• Design new works to complement heritage elements.	P8 Biomorphic Forms & Patterns P9 Material Connection with Nature

Design Guidelines (selected)	Associated Biophilic Design Pattern
• Integrate interpretative elements into designs to respect local cultural and indigenous heritage where appropriate.	P7 Connection with Natural Systems P10 Complexity & Order P12 Refuge P13 Mystery
5. Make provision for stormwater drainage and management:	P5 Presence of Water
• Incorporate pollution control measures to protect water quality.	P5 Presence of Water
• Integrate the provision of pits, covers and grates and discharges into drains with other aspects of the design.	P5 Presence of Water
• Incorporate stormwater capture and reuse as appropriate.	P5 Presence of Water
• Incorporate drainage swales, bio-filtration beds and soil drainage as appropriate.	P1 Visual Connection with Nature P5 Presence of Water
• Respond to existing and future local flood levels and overland flow paths.	P5 Presence of Water
6. Select and design paving and surface finishes to be fit for purpose, durable, sustainable and easy to maintain, and to enhance the character and use of the space.	P8 Biomorphic Forms & Patterns P10 Complexity & Order
7. Integrate street and park furniture into the overall design of public spaces as appropriate to support their use and to provide for the comfort, convenience and safety of patrons and users.	P8 Biomorphic Forms & Patterns P9 Material Connection with Nature P10 Complexity & Order P11 Prospect P12 Refuge
8. Provide lighting for amenity, wayfinding, visual comfort, road safety and personal security:	P6 Dynamic & Diffuse Light
• Provide a high quality of illumination with respect to supporting people's perception at night, including minimisation of glare and the use of white light to improve colour rendition and people's ability to recognise detail.	P6 Dynamic & Diffuse Light
• Contribute positively to and integrate with the character of the area.	
• Incorporate feature lighting as appropriate to express the hierarchy and functionality of spaces.	P6 Dynamic & Diffuse Light
• Minimise light spill to adjacent sensitive land uses.	P6 Dynamic & Diffuse Light

Design Guidelines (selected)	Associated Biophilic Design Pattern
9. Provide access to public amenities including public toilets.	P12 Refuge
10. Provide access to public transport facilities including passenger shelters, other forms of weather protection, ticket sales and validation machines, etc.	P12 Refuge
11. Incorporate public art in appropriate places:	P10 Complexity & Order
• Integrate site responsive art into the project design where appropriate.	P1 Visual Connection with Nature P2 Non-Visual Connection with Nature P8 Biomorphic Forms & Patterns P9 Material Connection with Nature P10 Complexity & Order P12 Refuge
• Design the settings of existing artworks, memorials and monuments to be retained to respect the works' cultural values and formal design qualities.	P8 Biomorphic Forms & Patterns P9 Material Connection with Nature P10 Complexity & Order P12 Refuge
12. Provide signage as appropriate and in accordance with Public Transport Victoria, VicRoads, land manager and authority standards and guidelines, including:	P10 Complexity & Order
13. Integrate any advertising elements with public infrastructure and ensure that they complement the character, functionality and amenity of the precinct:	P10 Complexity & Order
14. Incorporate plantings as an integral part of site designs:	P7 Connection with Natural Systems P8 Biomorphic Forms & Patterns
• Provide shade and shelter, screening, ornament and define a sense of place that relates to each site and its landscape context.	P1 Visual Connection with Nature P8 Biomorphic Forms & Patterns P9 Material Connection with Nature P10 Complexity & Order P11 Prospect P12 Refuge
• Create good soil conditions for new planting, including consideration of the use of permeable paving materials within trees' drip zones, extensive soil preparation, and high quality structural soils beneath pavements.	

Design Guidelines (selected)	Associated Biophilic Design Pattern
• Avoid containerised planting conditions and provide contiguous root zones where possible.	P8 Biomorphic Forms & Patterns
• Contribute to increased biodiversity and resilience of plant communities in accordance with urban forest strategies.	P1 Visual Connection with Nature
• Offset any vegetation loss.	P1 Visual Connection with Nature
• Ensure that plantings are designed to complement and protect the functionality of other infrastructure including public lighting, CCTV surveillance systems and underground utilities.	P1 Visual Connection with Nature
15. Address irrigation including passive irrigation and opportunities for rainwater infiltration into the soil, options for non-potable water supplies, irrigation zones and system types, control systems and equipment.	P5 Presence of Water

Figure 6.13: MMR Urban Design Strategy X Biophilic Design Patterns

6.8 The City of Melbourne's Draft Urban Ecology and Vegetation Strategy (2016)

The City of Melbourne's Draft Urban Ecology and Biodiversity Strategy (2016) sets out "*to reinforce and re-inject nature into the fabric of the city, making interaction with nature an unavoidable experience for people in the city. Whether it is exploring a network of small green spaces and laneways, or hearing the sounds of native birds, to experience Melbourne will be to experience nature*" (MCC 2016:19).

A strong biophilia vision for the Metro Tunnel Project would align well with this strategy and would contribute to its goal of "*supporting a diverse, resilient and healthy ecosystem that contributes to the health and wellbeing of our community and the foundation of a liveable city*" (MMC 2016: 6). The strategy observes that the latest research highlights that all biodiversity plays a role in contributing to healthy and resilient urban ecosystems and that there is a notable opportunity to deliver positive outcomes for both people and nature when considered together.

Principle 1 of the report 'Connect people to nature' has the potential to be well supported with Biophilic Design Pattern 1 that calls for a 'Visual Connection with Nature' with views to "*elements of nature, living systems and natural processes*". The biophilic design principles calling for the presence of water and connection with natural systems would, in the Metro Tunnel Project environment, greatly reinforce the visibility and sense of connection to nature that the strategy calls for.

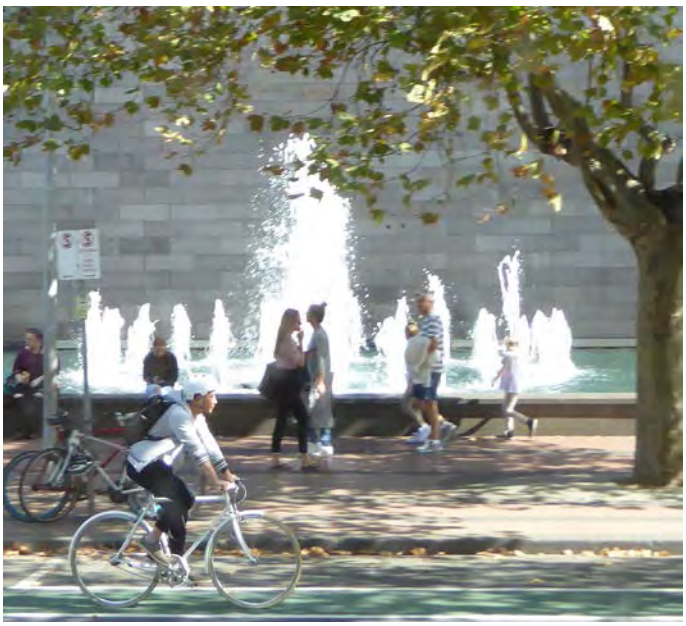


Figure 6.14: St Kilda Road lifestyle. Source: Downton.

Principle 2 seeks to 'Create a diverse, connected and resilient ecosystem' and a major part of the strategy is to create a connected habitat network. In this network it is recognised that 'Even small spaces are important' and that:

> *"Whilst large patches are often prioritised as more suitable habitat for biodiversity, some good research supports encouraging smaller patches, closely enough connected for species to pass from one to another. These parcels in close proximity to one another may provide good potential as habitat, for example, median strips and roadside verges can offer refuge for birds, insects and other species if suitable habitat structure is planted. Connectivity and patch size are both important for supporting biodiversity in urban landscapes. Gardens and green spaces in schools, city roads and laneways, businesses and residential homes can make a significant contribution to creating a habitat network. Particularly if advice on planting is provided so that it complements planting in local parks, green spaces and nearby corridors"* (MCC 2016:28).

Thus, even though the site available for biophilic design in MTP railway stations and their environs is not large in terms of area, it can provide areas of biodiversity and habitat that add to what promises to be a world-leading on-the-ground network of ecological intervention within the city.

To achieve Principle 3 and 'Demonstrate local and global leadership' the strategy proposes to "*Deliver a flagship biodiversity and urban ecology project that is recognised locally and internationally as an innovative and outstanding example of rewilding in a dense urban fabric.*"

A biophilic design strategy for the MTP has the potential to assist in this goal by making the city's active concern for nature visible in an environment where residents, commuters and visitors can be exposed to urban ecology innovation from up on the street to deep underground.

6.9 SITES®

Little known in Australia, to date, SITES® is a comprehensive rating tool system used to distinguish sustainable landscapes, measure their performance and elevate their value. SITES certification is for development projects located on sites with or without buildings—ranging from national parks to corporate campuses, streetscapes to homes, and more. SITES helps create ecologically resilient communities and benefits the environment, property owners, and local and regional communities and economies.

The core aspiration the SITES program is that any project—whether the site of a university campus, large subdivision, shopping mall, park, commercial centre, or a home—can protect, improve, and regenerate the benefits and services provided by healthy ecosystems.

While well-established architectural and building-centric range of performance tools already exist (e.g., BREEAM (UK), LEED, Living Building Challenge, Green Globes, WELL Building Standard (USA), Green Star, NABERS, BASIX, EER (Australia), CASBEE (Japan) and Estidama (Abu Dhabi)), assessment of landscape sustainability performance has been slower to emerge. Various attempts at creating landscape-centric performance and rating tools failed to establish as platforms for benchmarking and assessment until the development of the SITES tool. Some site planning tools (such as LEED Neighborhood, STAR and GBCA 'Communities') have, as a consequence of SITES' launch, have expanded their respective previously cursory consideration given to landscape dimensions.

SITES, or the Sustainable Sites Initiative (SITES™), administered by Green Business Certification Inc, was developed by American Society of Landscape Architects (ASLA) in partnership with the Lady Bird Johnson Wildflower Center at University of Texas at Austin, and the United States Botanic Garden, USA. Version 2 of SITES® was launched in June 2014. Administered by Green Business Certification Inc. (GBCI), SITES offers a comprehensive rating system designed. Originally modelled on the US Green Building Council's LEED rating system, SITES was developed through a peer-review appraisal and piloted upon 100 projects to finalise Version 2. Sections in SITES consider site context, pre-design assessment and planning, water, soil and vegetation, materials selection, human health and wellbeing, construction, operations and maintenance; education and performance modelling and innovation or exemplary performance, and this Biophilia concerns are included in its scope and star rating system. There are 18 required baseline prerequisites, such as conducting a site assessment prior to design, with points awarded from 1–6 for implementing initiatives. The prerequisites and 48 credits total 200 points resulting in four certification levels—one to four star, or 'certified' (70), 'silver' (80), 'gold' (100), and 'platinum' (135).

SITES Guiding Principles	
	Do no harm: Make no changes to the site that will degrade the surrounding environment. Promote sustainable design projects on sites where previous disturbance or development presents an opportunity to regenerate ecosystem services through sustainable design.
	Apply the precautionary principle: Be cautious in making decisions that could threaten human and environmental health. Some actions can cause irreversible damage. Examine a full range of alternatives (including no action), and be open to contributions from all potentially affected parties.
	Design with nature and culture: Create and implement designs that are responsive to economic, environmental, and cultural conditions and to the local, regional, and global context.
	Use a decision-making hierarchy of preservation, conservation, and regeneration: Maximize the benefit of ecosystem services by preserving existing environmental features, conserving resources in a sustainable manner, and regenerating lost or damaged ecosystem services.
	Provide regenerative systems as intergenerational equity: Provide future generations with a sustainable environment supported by regenerative systems and endowed with regenerative resources.
	Support a living process: Continuously re-evaluate assumptions and values, and adapt to demographic and environmental change.
	Use a systems thinking approach: Understand and value the relationships in an ecosystem. Use an approach that reflects and sustains ecosystem services and re-establishes the integral and essential relationship between natural processes and human activity.
	Use a collaborative and ethical approach: Encourage direct and open communication among colleagues, clients, manufacturers, and users to link long-term sustainability with ethical responsibility.
	Maintain integrity in leadership and research: Implement transparent and participatory leadership; develop research with technical rigor; and communicate new findings in a clear, consistent, and timely manner.
	Foster environmental stewardship: In all aspects of land development and management, foster an ethic of environmental stewardship—an understanding that responsible management of healthy ecosystems improves the quality of life for present and future generations.

Figure 6.15: Green Business Certification Inc. (2014: viii).

SITES is based on the concept of ecosystem services – the unobtrusive foundation of daily life services that are provided by healthy ecosystems. For example, trees mediate local climate conditions, plants moderate the climate of the world and provide a breathable atmosphere through evaporation, transpiration, and the uptake and storage of carbon, pollinator plant species aid and promote the growth of myriad plants and crops, and soils and vegetation purify en route to groundwater and underground aquifers. Such services occur at a variety of scales and in habitats ranging from rainforests to urban parks. These ecosystem services may be summarised as:

Ecosystem Services	**Global climate regulation:** Maintaining balance of atmospheric gases at historic levels; Maintaining healthy air quality; and, Sequestering carbon **Local climate regulation:** Regulating local temperature, precipitation, and humidity through shading, evapotranspiration, and windbreaks **Air and water cleansing:** Removing and reducing pollutants in air and water **Water supply retention:** Storing and conserving water within watersheds and aquifers **Erosion and sediment control:** Retaining soil within an ecosystem••Preventing damage from erosion and siltation **Hazard mitigation:** Reducing vulnerability to damage from flooding, storm surge, wildfire, and drought **Pollination:** Providing for the reproduction of crops and other plants **Habitat functions:** Providing refuge and reproduction habitat to plants and animals, contributing to the conservation of biological and genetic diversity and evolutionary processes **Waste decomposition and treatment:** Breaking down waste; and, Cycling nutrients **Human health and well-being:** Enhancing physical, mental, and social well-being as a result of interaction with nature **Food and renewable non-food products:** Producing food, fuel, energy, medicine, or other products for human use **Cultural benefits:** Enhancing cultural, educational, aesthetic, and spiritual experiences as a result of interaction with nature

Figure 6.16: Green Business Certification Inc. (2014: x).

Under SITES, a total of 200 potential points can be awarded amongst 48 credits for project. SITES reflects each credit's impact on improving site sustainability and protecting and restoring ecosystem services. Projects will receive SITES certification by achieving the minimum requirements (i.e. prerequisites) and a certain specified number of points for different levels of performance. The value assigned to each credit is based on its potential effectiveness in meeting the following four goals:

SITES Goals	
	Create Regenerative Systems and Foster Resiliency: Protect and restore natural resources such as soil, water, and vegetation; Encourage biodiversity; Enhance landscapes to provide multiple ecosystem services such as cleaning air and water, providing habitat, and storing carbon; and, Mitigate for evolving hazards and natural disasters; and, Plan for monitoring and adaptive management. **Ensure Future Resource Supply and Mitigate Climate Change:** Minimize energy consumption and encourage use of low carbon and renewable energy sources; Minimize or eliminate greenhouse gas emissions, heavy metals, chemicals, and other pollutants; Reduce, reuse, recycle, and upcycle materials and resources; Conserve water; and, Increase the capacity of carbon sinks through re-vegetation. **Transform the Market through Design, Development, and Maintenance Practices:** Foster leadership in industry and professional practice; Use a systems-thinking, integrative and collaborative design approach; Use lifecycle analyses to inform the design process; and, Support local economies and sustainability policies. **Enhance Human Well-Being and Strengthen Community:** Reconnect humans to nature; Improve human health (physical, mental, and spiritual); Foster stewardship by providing education that promotes the understanding of natural systems, and recognizes the value of landscapes; Encourage cultural integrity and promote regional identity; and, Provide opportunities for community involvement and advocacy.

Figure 6.17: Green Business Certification Inc. (2014: xii.)

While Biophilic design is not mentioned in the Tool, having regard to the MTP, the 1. Site Context, 3. Site Design – Water, 4. Site Design – Soil + Vegetation, 6. Site Design – Human Health + Well-being, 9. Education + Performance Monitoring, and Section 1. Innovation or Exemplary Performance, offer advantageous credits to the Project. For example, Section Site Context Credit 1.7 Connect to multi-modal transit networks seeks to “improve human health and reduce pollution by selecting a site that connects to pedestrian, bicycle, and mass-transit networks” and Credit 9.1: Promote sustainability awareness and education seeks to “promote understanding of sustainability in ways that positively influence user behavior by interpreting on-site features and processes.

In terms of Biophilic design and the MTP, the possibilities to increase the Project’s Green Star rating from 5 to 6 exist in strengthening the Indoor Environment Quality, the Land Use & Ecology and the Innovation categories of which the application of vegetation, vistas, ecological values, use additional rating tools, and educational/research engagements and training offers potentials.

6.10 Public Art

A key objective of the MMRA Urban Design Strategy is to Create Great Public Spaces, and creating public spaces that create places, buildings and art works that express Melbourne’s cultures and values is an important part of making great civic places. Alongside the Urban Design Strategy, MTP contractors will also be requires to respond to the MMRA Creative Strategy (via Environmental Performance Requirements) to ensure that creative content is embedded in the MTP.

6.11 Planting

While positive biophilic responses can be prompted by a range of cues, planting is one of the primary means of achieving biophilic outcomes. Planting benefits include mental health improvement, pollutant reduction, sound cushioning and temperature regulation (resulting in reduced energy consumption for climate controlled environments). All of these factors would be beneficial outcomes in the context of MMRA Project.

Four main scenarios exist for MMRA project planting – two for the horizontal plane and two for the vertical plane. The horizontal scenarios apply to streetscapes and surrounds, plazas/squares or deck/platform conditions. Vertical plane scenarios are particularly relevant to the subterranean station conditions, walls and building facades.

Horizontal scenarios:

1. Horizontal planting at grade with in-ground soil depth (eg deep soil or tree pits - Figure 6.18);

2. Horizontal planting on slab (such as a carpark or train station below, essentially creating a green roof scenario that requires raised planting areas - Figure 6.19. Note that green roofs are known as intensive = >200mm soil depth, and extensive = <200mm soil depth. This relates to the structural requirements from additional weight of soil, water, plants

Figure 6.18: Showing scenario 1: at grade (WSUD) road median, Victoria Park Sydney.

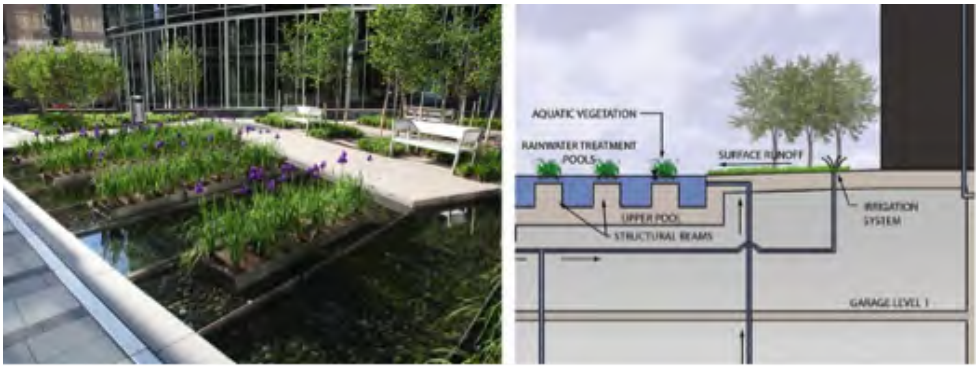


Figure 6.19: Showing scenario 2, horizontal planting and parking garage (includes water recycling system). Sasaki Associates (image: Eric Taylor), The Avenue, USA.

and access.

Vertical scenarios:

3. Climbing plants used for vertical façades and walls (self-supporting - Figure 6.20) or requiring wire/mesh/trellis systems - Figure 6.21. See recommended plant list (Figure 6.25) for Melbourne and MTP conditions.

4. Vertical green walls (planting modules/units/structures attached to vertical surfaces that contain soil, irrigation, nutrient and possibly

Figure 6.20: Succulents have very low water, nutrient and maintenance needs, but require high light levels, and are more vulnerable to wind and hail damage (not issues if indoors in sealed environment).

Figure 6.21: Showing scenario 3: Boston Ivy, a deciduous self supporting climber on a building facade.

Figure 6.22: Showing scenario 3: climbing plants on stainless wire support system. MFO Park, Switzerland.

Figure 6.23: Showing scenario 4: vertical green wall system at Triptych Apartments, Southbank Melbourne.

Figure 6.24: Showing scenario 4, example of green wall unit system.

Figure 6.24 and 6.25 are provided to outline possible plant species for vertical scenarios three and four, as these are the key opportunities and focus for biophilic planting in the MMRA project. Figure 6.24 provides possible species for scenario 3 (climbing plants) and 6.25 provides possible species for scenario 4 (vertical green walls). These tables provide indicative species that are both likely to be suitable to both Melbourne's climate as well as the modified climatic conditions in the stations (further detail and modelling of these conditions is required to better determine final plant suitability). These Figures are intended as a guide, however, detailed plant selection needs to occur specific to design propositions and conditions.

Possible plant species depend on several key factors as identified in the tables:

- **Light needs** (high, medium, low): note that natural and artificial lighting require separate analysis, modelling and measurement. A range of plants are included, although most plants struggle in low lighting levels;
- **Growth rate** (high, medium, low): depends on plants receiving their light needs, with lower light levels resulting in slower growth rates. Note that invasive species prone to weedy growth (and high growth rates) have been avoided (except where noted);
- **Water needs** (high, medium, low): in addition to individual species requirements, this will depend on orientation, season and wind and requires detailed, site specific modelling;
- **Maintenance** (high, medium, low): All living things need maintenance as do all infrastructures including grey and green infrastructures. High maintenance is more likely to result from improper design, specification and installation, as high maintenance plants have attempted to be excluded/avoided in the tables. Planting dependent on irrigation system function (and artificial lighting) are more prone to failure than those that receive runoff and natural light;
- **Other** (includes specific notes on species characteristics).

In addition to these core factors, public domain and vertical plant selection is complex and needs to be determined by suitable experts who possess detailed knowledge of the specific context and conditions of the project. Some of the relevant considerations, questions and factors for the MTP project include:

- Height and Spread;
- Plant life cycle (annual, biennial, perennial, years, decades);
- Self seeding? Wind dispersed seeds? Weed/invasive? Will plant develop roots from lateral stems?;
- Mild frost tolerance? (If outdoors);
- Drought tolerant? (e.g. grey or silver foliage, hairy leaves or thick leaf cuticle?);
- Resilience of plant stems? (Wind exposure and velocities, heavy rain and/or hail);
- Dry biomass accumulation? (e.g. dead leaves could pose a fire hazard);
- Are any parts poisonous to humans? (Potentially unsuitable if within reach/public access);
- Do any parts have thorns/spikes? (Potentially unsuitable if within reach/public access).

Figures 6.25: Climbing plant species potentially suited to Melbourne and MTP conditions.

Plant		Plant Type	Self supporting or Needs Support	Light needs	Maintenance needs	Growth rate	Water needs	Other
Botanic name	Common Name	Climbers: twining or self-attaching	Self attaching = climbing plants, either directly on wall and façades OR Needs wires/ trellis/mesh for vertical growth.	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	
								Note: annuals have been excluded
Actinidia chinensis	Kiwi fruit, chinese gooseberry	Deciduous climber, twining	Needs wires/ trellis/mesh	High	Medium	High-medium	Medium	Edible/productive. Fruit needs harvesting. Requires pruning. 3-5m height.
Akebia quinata	Chocolate vine	Semi-deciduous climber, twining	Needs wires/ trellis/mesh	Medium	Medium	High	Medium	Grows to 10+ m height. Chocolate aromatic sausage-shaped pods which contain edible pulp. Can be invasive - plant in contained area.
Aphanopetalum resinosum	Gum Vine	Evergreen climber, twining/scrambling	Needs wires/ trellis/mesh	Medium-low	Low-medium	Medium	Medium	Smaller climber. Responds to pruning if woody.
Billardiera species	Apple berry, Apple Dumpling.	Small shrub or twining plant	Needs wires/ trellis/mesh					Around 30 mostly climbing species. *Scandens* produces edible fruit of oblong berries up to 30 mm long, Formerly included in the genera Sollya. *Heterophylla* is the most common species.
Bouganvillea trailii	Bouganvillea	Climber, woody vine.	Needs wires/ trellis/mesh	Medium to High	Low-medium	High	Medium	Will lose up to 3/4 of leaves in cold winter, none in mild winter in Melbourne. Needs good drainage. Responds to hard pruning.
Cissus antarctica	Kangaroo vine	Evergreen climber, tendril/vine	Needs wires/ trellis/mesh	Low	Medium	High	Moist, well drained	Can also be used as a groundcover and indoor plant.

Plant		Plant Type	Self supporting or Needs Support	Light needs	Maintenance needs	Growth rate	Water needs	Other
Botanic name	Common Name	Climbers: twining or self-attaching	Self attaching = climbing plants, either directly on wall and façades OR Needs wires/ trellis/mesh for vertical growth.	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	
Cissus rhombifolia	Grape ivy	Evergreen climber, tendril/vine	Needs wires/ trellis/mesh	Low	Medium	High	Medium, well-drained	Prefers moist shade but will tolerate dry shade. Can be used as an indoor plant.
Clematis glycinoides	Forest Clematis, headache vine	Climbing shrub	Needs wires/ trellis/mesh	Low-medium		Medium-high	Moist	
Epipremnum species	Golden pothos, hunter's robe, ivy arum, money plant, silver vine, Solomon Islands ivy, taro vine, devil's vine, devil's ivy	Herbaceous ground cover and evergreen perennial vines	Aerial roots	Low-medium	Medium	Medium	Medium	Well drained. Some species can be invasive. Common indoor genus.
Epipremnum aureum ' Marble Queen'	Golden pothos, Marble Queen	Climber, trailing	Aerial roots	Medium	Low-medium	Medium	Low-medium	Prefers moist shade but will tolerate dry shade. Common indoor species. Syn *Scindapsus aureus.* Pruning encourages bushy growth. Useful at cleansing air pollution. Allow to dry out between watering.
Ficus pumila	Creeping Fig	Woody evergreen vine/climber, creeping	Self-attaching	High	Low-medium	High	Medium	Requires pruning to ensure juvenile foliage is maintained.
Hardenbergia violacea	Native Sarsaparilla, Purple Coral Pea, False Sarsaparilla	Evergreen climber, twining	Needs wires/ trellis/mesh	Medium to High	Medium	Low-medium	Low-medium	Prune after flowering. Well drained soil.

Plant		Plant Type	Self supporting or Needs Support	Light needs	Maintenance needs	Growth rate	Water needs	Other
Botanic name	Common Name	Climbers: twining or self-attaching	Self attaching = climbing plants, either directly on wall and façades OR Needs wires/ trellis/mesh for vertical growth.	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	
Hedera species								Genus of 12–15 species of evergreen climbing or ground-creeping woody plants.
Hedera helix	Ivy	Evergreen creeping climber	Self-attaching	Medium	Low-medium	High	Low-medium	Can be invasive if not pruned/managed. Spreading habit needs control/pruning, e.g. twice per year. Low cost, provides wall coverage with no extra structure needed. Prefers moist shade but will tolerate dry shade.
Hydrangea petiolaris	Climbing Hydrangea	Decidous woody climbing vine	Self-attaching aerial roots	Low-high	Low-medium	High	Moist, well drained	Spreading habit needs control/pruning, e.g. twice per year.
Mandevilla 'White Fantasy'	White dipladenia	Evergreen climber	Needs wires/ trellis/mesh	Medium		Medium-high	Well drained	Frost prone. Cultivar of *Mandevilla boliviensis.*
Muellenbeckia species		Perennial shrubs or climbers						Genus of around 20 species.
Pandorea jasminoides cultivars 'Alba' Aloe 'Always Red', 'Lady Di'	Bower Vine, Bower of Beauty, wonga wonga vine	Evergreen climber, woody vine	Needs wires/ trellis/mesh	Medium	Low-medium	Medium	Moist, well drained	Cultivars are less vigorous.
Parthenocissus quinqefolia	Virginia Creeper	Decidous climber	Self-attaching	Medium-high	Low-medium	High	Medium	Spreading habit needs control/pruning, e.g. twice per year. Can grow very high. Spectacular autumn colour.

Plant		Plant Type	Self supporting or Needs Support	Light needs	Maintenance needs	Growth rate	Water needs	Other
Botanic name	Common Name	Climbers: twining or self-attaching	Self attaching = climbing plants, either directly on wall and façades OR Needs wires/ trellis/mesh for vertical growth.	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	
Parthenocissus tricuspidata	Boston ivy	Decidous climber	Self-attaching	Medium-high	Low-medium	High	Medium	Spreading habit needs control/pruning, e.g. twice per year. Can grow very high. Spectacular autumn colour.
Passiflora edulis	Passionfruit	Climber, twining, evergreen	Needs wires/ trellis/mesh	High	Medium	High-medium	Medium-high	Edible/productive. Beautiful flowers. Fruit needs harvesting. To 3m. Various varieties available.
Philodendron scandens	Heartleaf philodendron, Heart-leaf Ivy, Sweetheart Plant	Hemiepiphyte vine	Needs wires/ trellis/mesh	Medium	Low-medium	Medium-low	Medium	Prefers moist shade but will tolerate dry shade.
Spathiphyllum cultivars	Boston Ivy	Climber, self-attaching	Self-attaching	Medium	Low-medium	High	Medium	Spreading habit needs control/pruning, e.g. twice per year. Decidious = leaf drop. Spectacular colour. Low cost, provides wall coverage with no extra structure needed.
Syngonium podophyllum	Arrowhead vine	Evergreen	Needs wires/ trellis/mesh	Low-medium	Low-medium	Low	Low-medium	Common house plant but is poisonous. Prefers moist shade but will tolerate dry shade. Compact shrub when young, later developing climbing stems with aerial roots. Sometimes confused with unrelated *Nephthytis* species. Good for air pollution. Tolerates neglect.

Plant		Plant Type	Self supporting or Needs Support	Light needs	Maintenance needs	Growth rate	Water needs	Other
Botanic name	Common Name	Climbers: twining or self-attaching	Self attaching = climbing plants, either directly on wall and façades OR Needs wires/ trellis/mesh for vertical growth.	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	High/ Medium/ Low	
Trachelospermum jasminoides	Star jasmine, confederate jasmine	Woody climber, evergreen, twining	Needs wires/ trellis/mesh	Medium-high	Low-medium	Low-medium	Medium	Fragrant
Vitis vinifera	Common Grape Vine	Climber, tendril, decidious	Needs wires/ trellis/mesh	High	Medium	Medium-high	Medium	Woody, maintenance may increase over time, as stems grow larger and thicker. Fruiting and non-fruit varities. Deciduous. Deep root system.
Wisteria sinensis	Wisteria	Woody, deciduous, perennial climbing vine	Needs wires/ trellis/mesh	High	Medium	High	Medium, well drained	Woody, maintenance may increase over time, as stems grow larger and thicker.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
							Note: annuals have been excluded to reduce maintenance intensity.
Acorus gramineus cultivars	e.g. Green Acorus	Sedge, spreading aquatic perennial	High	Medium	Wet		
Aeonium species	Tree houseleek	Succulent	High		Dry	Low	Possible wind or hail damage.
Adiantum pubescens	A member of Maidenhair Fern	Fern	Low		Moist		Prefers moist shade
Ajuga species, e.g. 'Caitlins Giant', ' Jungle Beauty'	Bugle flower, Bugleweed	Herbaceous perennial groundcover	Medium	High	Moist	Low	Blue flowers. Is around twice the size of other ajuga cultivars
Arthropodium species and cultivar, e.g. cirrhatum 'Te Puna' and 'Parnel'	NZ Rock Lily	herbaceous perennial / Lilies/Irises	Low		Dry	Low	White flowers
Aristea ecklonii	African blue star iris	Lilies/Irises, evergreen perennial	Low	High			Self spreading, rhizomatous. Can be invasive. **B**lue flowers.
Asplenium species	Spleenwort	Fern	Low		Moist	Medium	Genus of about 700 species of ferns. Prefers moist shade and some humidity. Can be frost tender.
Asplenium astralasicum	Birdnest Fern, crow's nest fern	Epiphytic fern	Low	Medium	Moist	Medium	Prefers moist shade. Young fronds edible.
Asplenium bulbiferum	Mother Spleenwort, hen and chicken fern	Fern	Low	Low	Medium	Medium	Prefers moist shade
Asplenium nidus	Birdnest Fern	Epiphytic fern	Low	Medium	Moist	Medium	Prefers moist shade. Young fronds edible.
Aspidistra elatior	Cast-iron-plant or bar room plant	Evergreen rhizomatous perennial	Low	Medium	Low-medium	Low	Prefers moist shade. Clumping. Resilient.

Table 6.26: Vertical Wall plant species potentially suited to Melbourne and MTP conditions.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Billardiera species	Apple berry, Apple Dumpling.	Small shrubs, groundcovers or twining plants	Low-medium		Low		Around 40 mostly climbing species.
Blechnum species	Hard fern	Mainly herbaceous ferns	Low		Moist.	Low-medium	Genus of 150–220 species of ferns . Prefers moist shade
Blechnum gibbon	Silver Lady, dwarf tree fern	Fern	Low	Low	Medium/ Moist	Medium	Prefers moist shade, humidity, free draining acid soil. Frost intolerant.
Bulbine species e.g. bulbosa, crassa, frutescens, vagans	Bulbine Lily, Grass Lily , Wild Onion, Golden Lily, Leek Lily, Yellow Onion Weed, Native Leek	Herbaceous perennial	Medium-high		Moist		Good coverage. Can be short lived. Yellow flowers. Frost hardy.
Bromeliad species, e.g Silver King		Herbaceous perennial, evergreen, can be ephiphytic	Varying		Moist		51 genera and around 3475 known species.
Campanula poscharskyana	Serbian Bellflower	Perennial ground cover	Medium	Low-medium	Moist	Low	Blue flowers, pinch off spent flowers to encourage continual blooming. Moist but well drained soil.
Cerastium tomentosum	Snow-in-summer	Groundcover perennial	High	Medium-high	Dry	Low	Spreading habit, resilient species.
Chlorophytum comosum& variegatum	Spider Plant	Herbaceous rhizomatous perennial, evergreen	Low	Low-Medium	Dry	Low	
Clivia miniata	Bush lily	Clumping grass	Low	Medium	Low	Low	Orange flowers. May require division.
Correa cultivars 'Canberra Bells', 'Dusky Bells', 'Mini Marian'		Cultivars: Compact spreading shrubs	Medium		Low	Low-medium	Flowers. Pruning can be beneficial.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Cyrtomium falcatum	Holly Fern	Fern	Low		Moist	Low-medium	Prefers moist shade, well drained soil. Hardier than most ferns.
Davallia solida var. pyxidata	Hare's foot fern	Fern, epiphytic	Low		Moist	Low-medium	Prefers moist shade. Brown rhizomous stems.
Davalia tyermanii	Bear's Paw Fern, Silver Hare's Foot Fern, White Rabbit's Foot Fern	Fern	Low	Medium-high	Moist	Low-medium	Prefers moist shade, well drained soil. Easily propagated from rootball divisions. Rurry rhizomes.
Dianella species and cultivars	Flax Lily	Grass	High	Medium	Low	Low	
Dianella caerulea 'Goddess'	Blue flax-lily, blueberry lily, paroo lily	Grass/clumping perennial	High-medium	Medium	Moist	Low	Larger form, hardy and long-lived once established. Prefers moist well drained soil. Starry blue flowers followed by blue berries.
Dianella cultivars 'Little Jess', 'Emerald Arch', 'Breeze', 'Silverado', 'Lucia'	Flax Lily	Grass, clumping	High-medium	Medium	Low	Low	
Dianella tasmanica & 'Emerald Arch'	Tasman Flax Lily, Native Flax	Grass, clumping perennial	High	Medium	Low	Low	Blue flowers followed by blue berries. Well drained soil.
Dietes species	Wild iris, wood iris, Fortnight lily, African iris, Japanese iris, Butterfly iris	Grass/iris, rhizomatous, spreading	High-medium	Medium	Low	Low	Cream or yellow flowers.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Echeveria glauca	Blue Hens and Chicks	Succulent	High-medium	High	Low	Low	Powder blue foliage with yellow / orange flowers. Possible wind or hail damage.
Epipremnum species	Golden pothos, hunter's robe, ivy arum, money plant, silver vine, Solomon Islands ivy, taro vine, devil's vine, devil's ivy	Herbaceous ground cover and evergreen perennial vines	Low-medium	Medium	Medium	Medium	Well drained.
Erigeron karvinskianus	Seaside Daisy, Mexican fleabane, Latin American fleabane, Santa Barbara daisy, Spanish daisy, Karwinsky's fleabane, Bony-tip Fleabane	Herbaceous perennial spreading groundcover, evergreen	Medium-high	High-medium	Low	Low	Speading flowering groundcover with white and/or pink flowers.
Escallonia cultivars, eg 'Newport Dwarf'		Evergreen shrub	Medium-high	Medium-high		Low-medium	Genus of 40 to 50 species of flowering plants and hedging shrubs, compact cultivars available. Well drained soil.
Euphorbia dulcis 'Chameleon' & 'Blackbird'	Spurge, Swamp Spurge	Perennial	High-medium	High	Dry	Low	Well drained. Blackbird has burgundy foliage, compact, tidy habit with a prolific display of flowers of lime yellow.
Ficinia nodosa	Knobby Club Rush	Grass, rhizomatous perennial	High	High	Low	Low	Formerly know as Isolepis nodosa. Tolerates damp.
Ficus species, eg elastica, lyrata, benjamina	Burgundy rubber plant, fiddleleaf fig, weeping fig	Shrub/tree	Medium	High	Moist	Medium-high	Use carefully due to vigour and invasive roots.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Humata tyermanii	Rabbit's foot fern	Fern	Low		Moist	Low-medium	Well drained.
Liriope species and cultivars		Herbaceous perennial, evergreen					Some species are spreading.
Liriope muscari	'Evergreen Giant'	Herbaceous perennial, evergreen groundcover	Medium-high	Medium	Low-medium	Low	Flowers. Clumping.
Liriope spicata	Lilyturf, creeping lilyturf, creeping liriope	Grass/lily, evergreen groundcover	Medium-high	High	Low-medium	Low-medium	Spreading but can be aggressive.
Lomandra species and cultivars	Lomandra, mat-rush	Grass/perennial herbs	High	Medium	Low	Low	51 species native to Australia
Lomandra 'Tropic Belle', 'Katie Belles', 'Tanika', 'Wingarra'	Lomandra	Grass	High	Medium	Low	Low	
Metrosideros excelsa 'Nana'	Dwarf NZ Christmas Tree	Shrub/tree	High	Medium	Low-medium	Low-medium	Large shrub
Monstera species, eg deliciosa	Fruit Salad Plant	Herbaceous perennial, evergreen	Medium	Medium	Medium	Medium	Edible fruit. Epiphyte with aerial roots.
Neomarica gracilis	Blue walking iris, apostle plant	Lilies/Irises, clumping perennials	Medium		Moist	Low-medium	Fragrant flowers, spreading, well drained.
Nephrolepis species		Fern	Low		Moist	Medium	Genus of around 30 species of ferns.
Nephrolepsis codifolia " Lemon Button"	Lemon button fern, tuberous sword	Fern	Low	Low-medium	Moist	Medium	Can be invasive.
Nephrolepsis exaltata	Sword Fern	Fern	Low	Medium	Moist	Medium	Prefers humid conditions. More drought hardy than most ferns.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Nephrolepis obliterata	Kimberley queen fern, sworf fern	Fern	Low	Medium-high	Moist	Low-medium	Tolerates lower humidity and dry soil between watering, one of the easiest ferns to grow.
Ophiopogon japonicus	Mondo grass, dwarf lilyturf, fountainplant, monkeygrass	Lily/grass, evergreen, sod-forming groundcover	High-medium	Medium	Low	Low	Tolerates periodic innundation. Spreading.
Orchid species		Lilies/Irises					
Orthrosanthus multiflorus	K.I. Morning Iris	Grass-like clumping perennial	High-medium		Low	Low	
Orthophytum gurkenii		Bromeliad	Medium		Low	Medium	
Patersonia occidentalis	Native Iris	Herbaceous tufted perennial, evergreen, rhizomatous	High-medium		Low-medium		Well drained soil.
Peperomia species, eg caperata, marmorata, obstusifolia		Evergreen perennials and epiphytes	Medium-low		Medium	Low	Some varities cold sensitive, better grown semi-indoors.
Philodendron species, eg 'Xanadu', oxycardiu, pertusum	Heart Leaf Philodendron						Some are cold sensitive and better grown semi-indoors.
Plectranthus species	Spurflower	Herbaceous ground cover					
Plectranthus argentatus	Silver spurflower	Spreading semi-deciduous ground cover/shrub	Medium-low		Low-medium	Medium	Prune in winter.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Plectranthus ciliatus	Silver Plectranthus, speckled spur-flower, eyelash spur-flower, white wild sage	Herbaceous ground cover	Low-medium		Moist		Slow growth rate?
Plectranthus parviflorus	Cockspur Flower, little spurflower	Spreading semi-deciduous ground cover/shrub	Medium-low		Moist		Good coverage.
Ricinocarpos pinifolius	Wedding Bush	Herbaceous perennial, evergreen shrub	Medium		Medium		Showy fragrant white flowers.
Rhipsalis species	Mistletoe cacti	Epiphytic and lithophytic cacti					Genus of over 50 species native to South America.
Rosmarinus officinalis prostratus	Prostrate Rosemary	Herbaceous perennial, evergreen, spreading	Medium-high	Medium	Low	Low	Edible.
Rumohra adiantiformis	Leatherleaf Fern, leathery shieldfern, iron fern, 7-weeks-fern, climbing shield fern	Fern	Medium		Medium	Medium	
Ruscus hypoglossum	Spineless butcher's-broom, mouse thorn, horse tongue lily	Small evergreen shrub	Medium		Low		
Sarcococca confusa	Sweet Box	Herbaceous perennial, evergreen bushy shrub	Low-high	Low-medium	Moist	Low	Well drained soil. Scented creamy-white flowers, followed by glossy black berries.

Plant		Plant Type	Light needs	Growth rate	Water/ Moisture needs	Maintenance needs	Other
Botanic name	Common Name	Shrub/ Fern/Grass / Lilies & Irises/ Evergreen herbaceous perennial/ Herbaceous ground cover/ Epiphyte & lithophyte/ Bromeliad	High/ Medium/ Low	Hig0	High/ Medium/ Low Wet / Moist / Dry	High/ Medium/ Low	
Schleffera species, eg arboricola	Dwarf Umbrella Tree	Evergreen herbaceous perennial shrub	Medium		Moist		Genus of flowering trees, shrubs or lianas.
Spathiphyllum cultivars	Peace lily, spathe flower, white sails	Herbaceous perennial, evergreen	Low	Low-medium	Moist	Low	
Strobilanthes anisophyllus	Goldfussia, Persian Shield	Evergreen bushy shrub	High	High	Moist	Medium	Mauve flowers. Prefers humidity and sheltered location.
Viola species	Violets, pansies						Genus containing between 525 and 600 species.
Viola hederacea	Native Violet	Herbaceous perennial, evergreen creeping	Low	Medium	Moist	Low	
Viola odorata	Sweet Violet, wood violet, English violet,common violet, florist's violet, garden violet	Herbaceous rhizomatous perennial	Low-medium	Medium-high		Low	Aromatic flowers.
Zamioculcas zamifolia	Aroid Palm, ZZ Palm, Zanzibar Gem	Sub-erect herb	Medium		Moist	Low	

7

Resilience & Climate Change

Resilience in a world of change

Credit: P Downton

7.1 Resilience Implications

Resilience is about having the capacity to understand change and to use that understanding to deal with the impacts generated by that change. This can be done in positive or negative ways but the issue of whether there will be change is non-negotiable; what resilience does is foster the ability to act in the interest of long-term stability. It is also commonly used in context of "natural" systems ability to respond to change. Thus, resilience is based on social cohesion as much as, if not more so, than appropriate infrastructure and planning. Social cohesion depends on wellbeing and that is enhanced by biophilic design.

There is a good deal of overlap and interchange between 'green/eco', 'biophilic' and 'resilient' cities networks.

7.2 Resilient Melbourne

The City of Melbourne is part of the 100 Resilient Cities Challenge, an initiative funded by the Rockefeller Foundation. Melbourne's first resilience strategy was endorsed by the City of Melbourne's Future Melbourne Committee on 17 May 2016. The strategy sets out "*a series of distinct, yet connected, actions that will help make Melbourne a viable, sustainable, liveable and prosperous city, today and long into the future.*"

In the chapter on "*A Healthier Environment*" in the 2016 Resilient Melbourne strategy document, it states (MCC 2014: 51) that a resilient Melbourne should "*Enable strong natural assets and ecosystems alongside a growing population*". As one of the means of achieving this it proposes that the city should "*explore imaginative ways to put nature back into communities*". Although the scope of that proposition was intended mostly to be about local communities working together to understand and improve their communities and their place, there is a role to play for biophilia in the MTP and that is as an educational agent and means of advocacy.

Beatley and Newman (2013) argue forcefully that "*Biophilic cities are sustainable, resilient cities*", asserting that *"Achieving the conditions of a biophilic city will go far in helping to foster social and landscape resilience, in the face of climate change, natural disasters and economic uncertainty and various other shocks that cities will face in the future.*"

Beatley and Newman (2013) note that "*It is important to recognize that biophilic cities are not simply green cities. The presence of abundant nature is a necessary, but not sufficient condition, and the 'philic' is as important as the bio.*" They go on to explain that "*In biophilic cities, residents are directly and actively engaged in learning about, enjoying and caring for the nature around them and have developed important emotional connections with this nature.*"

The role of MTP in this equation is to repeatedly expose citizens to recurrent biophilic experiences and to educate them about the ecosystem of the region in which they and their city reside. This is a crucial aspect of building an understanding of ecological resilience into the city's general population.

As a key piece of infrastructure with a design life of 100 years and regular exposure to people from all over the city, the MTP has a vital role to play in shaping the perception of millions of citizens and it can play a significant part in providing evidence of resilience strategies to the city's population.

7.2 Climate Change Implications

However accurate the predictions may or may not be, the one certainty about climate change is that it will bring greater variability and extremes in the weather. The experiences of those who reside in cities are already considerably conditioned by the urban environment. The MTP offers another controlled environment that, to some extent, mediates users from direct climate change impacts.

The near-future environment being delivered by climate change in the context of MTP is drier and hotter than present conditions (AJM 2016:220,222). Roof gardens, green walls and the locations of most urban vegetation tend to be warmer and drier environments with micro-climates that exhibit characteristics not dissimilar to the warmer, more desiccating climates predicted by climate change. Vegetation on green walls and roofs not only serve a powerful biophilic function, but according to botanists Farrell et al (2015: 597), at the University of Melbourne, are "*valuable resources for understanding 'urban plant physiology*" ... and "*are 'living laboratories' for understanding plant responses to climate change*".

The effective biophilic design displayed by these urban plantings might be able to reflect changing climatic conditions and provide a kind of litmus paper to help scientists, citizens and decision-makers assess the state of the climate and come to terms with its changes.

Such can include:

- Biophilic Design being as a tool to mitigate climate impacts, eg vegetation etc.;
- indirect benefits of Biophilic Design, eg., the stations can be seen as 'refuges' for commuters when extreme heat days occur; thus, vegetation can provide an effect of relief, etc.; and
- reduction of urban heat island effect for the aboveground areas

Figure 7.1: Key biophilic design elements, green roofs cool the air, provide retention for stormwater run-off, add to biodiversity – and offer potential as living laboratories for researching climate change response. Source: Downton

A key aspect in Biophilic Design is its important capacity in how vegetation can assist in the reduction of the urban heat island effect.

Green roofs and WSUD initiatives such as tree pits have proven ability to capture rainfall and act as retention devices to slow the flood of water into city stormwater systems, again, providing measurable practical infrastructure services as well as biophilic effects.

This aspect reinforces the idea of incorporating biophilic design patterns in the design of the MTP railway stations and their environs, addressing 'Nature of Space' Pattern 12: Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

7.3 Maintenance Implications

The environment in which biophilic design interventions will take place in the MTP is a relatively controlled and predictable environment. On the other hand, the areas in which the living plants may be located are more exposed to the fluctuations of the anthropogenically impacted climatic environment. A high level of maintenance is required for items such as green walls and roofs and this must be taken into account in the overall planning of any facilities.

Notwithstanding some relatively high maintenance demands for specific biophilic design elements, it should be recognised that these are not outside the envelope of expectations that accompany any urban planting regimes. Importantly, most of the biophilic design options described by the 'Patterns' are design approaches (such as 'Dynamic and Diffuse Light') that can have low to no maintenance requirements.

8

Recommendations

Credit: P Downton

8.1 Biophilic Design Principles for the MTP - Overall

The underground stations are the 'signature doorways' into and out of the city, and the Biophilic inspired station landscapes could result in an inspirational journey, arrival and departure experiences, supporting patronage wellbeing as well as improving the indoor environmental quality of these spaces. (MMRA 2017b)

This report agrees with the proposition that "*the Biophilic design of railway stations will support and assist in the realisation of the Vision statement of the MTP Urban Design Strategy*", namely, that it is possible to achieve:

"A legacy of outstanding rail stations and associated public spaces that contribute to Melbourne's reputation for design excellence, and that delivers an overall substantial benefit in terms of urban quality for Melbourne, for the rail network, and for local areas influenced by the Project." (MMRA 2017b)

The following recommendations indicate practical biophilic design strategies and techniques by which this may be achieved in line with the following Urban Design Principles in the MTP Urban Design Strategy:

- Safe, legible, understandable, safe and secure feeling, and provided with good visual links and strong passive surveillance. The built form must be clear and way finding carefully considered as part of the Project
- Socially responsive, supporting community land aspirations for the place, connecting nearby facilities, and incorporating shops, art, and recreation spaces.
- Site responsive, responding to specific local conditions inclusive of built form, landscape, topography and orientation.
- Valuing of heritage, responding to history, memory, understanding of and continuity with the past.
- Delightful, authentic, sensitive and intelligent in design of form, space, proportion, craft and detail.

(MMRA 2017b)

Melbourne Metro Rail Authority Sustainability Policy

To achieve this Sustainability Vision, Melbourne Metro Rail Authority is committed to:	To give effect to this Policy, our people will:	Alignment of this Policy to Biophilic Design Patterns and Principles
Optimising the projects' design to ensure it is delivered to operate sustainably;	Demonstrate leadership in the commitment to a prosperous and integrated economic, social and environmental sustainable future	**MEDIUM**
Managing resources efficiently through embedding energy, water and material saving initiatives into the design, construction and operation of the Project;	Demonstrate commitment to sustainable procurement	**HIGH**
Avoiding minimising and offsetting harm to the environment and the loss of biodiversity;	Protect and maintain vegetation, the functioning of ecosystems and biological diversity	**HIGH**
Protecting and conserving the natural environment; and	Facilitate economic prosperity and development and provide a resilient local workforce;	**MEDIUM**
Preparing for the challenges presented by climate change.	Support and enhance social, cultural and community wellbeing;	**MEDIUM**
	Encourage environmental and sustainability outcomes by establishing robust sustainability objectives and targets, and	**HIGH**
	Report on sustainability performance and be accountable for meeting environmental and social responsibilities	**MEDIUM**

Figure 8.1. Source: MMRA Sustainability Policy (2016:10).

Figures 8.2: Design for the Future: Design Guidelines and Principles

Design for the Future		
	Urban Design Strategy	**Biophilic Design Principles**
Aims	The Metro Tunnel will be designed to: Accommodate population growth and changing community and transport needs. Ensure resilience to predicted climate change and associated weather events. Create manageable infrastructure and places. Support a wide range of sustainability targets throughout the project lifecycle.	Maintain a connection with nature by ensuring views to elements of nature that are appropriate to a rapidly changing environment and climate. In addition, take account of the numerous means by which nature can be experienced in non-visual ways and the sensory stimuli that might be built into the Metro Stations and infrastructure.
Objectives	1.Ensure that infrastructure and spaces are durable, hard wearing and easy to maintain.	Make material connections with nature and natural systems that contribute to the longevity of infrastructure materials.
	2. Ensure that infrastructure and spaces are resilient to climate change and associated sea level rise and extreme weather events.	Articulate and facilitate awareness of natural processes so that the context and challenges of environmental changes are understood.
	3. Improve the quality of the urban environment, including tree planting to mitigate the urban heat island effect.	The goal of visual and non-visual connections with nature need to be integral to improving the quality of the urban environment.
	4. Contribute to habitat and biodiversity values.	Improving opportunites for biophilic experiences should be intrinsic to improving the value of habitat and biodiversity.
	5. Minimise long-term constraints on the use, layout and character of spaces above the Metro Tunnel due to potential conflicts with underground structures.	Use the constraints of the situation to enhance the complexity and order of the environment and minimise risk and peril.
	6. Minimise risks of damage to the Metro Tunnel infrastructure due to heavy vehicle loadings, possible future works and maintenance activities.	Use the constraints of the situation to enhance the complexity and order of the environment and minimise risk and peril.
	7. Embed sustainable initiatives, use energy and resources efficiently and incorporate renewable technologies.	'Love of nature' implies working with its natural flux of energies in the environment, particularly those of the wind and sun.

Design for the Future

	Urban Design Strategy	Biophilic Design Principles
Design Guidelines	1. Anticipate growth of Melbourne's population and future changes in activity patterns and development in response to the new Metro Tunnel services: Reinstate or redesign open spaces and infrastructure to a standard that responds to heavier pedestrian traffic, heightened public profile and other changes that will be generated by the Metro Tunnel, e.g. through the use of higher standards of materials and finishes, more robust surfaces, widened footpaths, etc. Design to maximise long term flexibility in the management of, and options for improvement, of nearby spaces and infrastructure.	Use all opportunities in the design/ redesign of open space and infrastructure to enhance the presence of nature and make it visible and readily experienced by the growing population.
	2. Although MMRA will take possession of various areas to enable construction of the Metro Tunnel, many of these will revert to other owners or managers after construction is completed. Management requirements after this handover must be supported by the design: Streets, spaces and assets that will be managed and maintained by a particular agency must be designed to the satisfaction of that agency. Boundaries between areas and assets included in the project area and scope of works, but which are ultimately to be managed by other agencies, must be delineated and the implications of that long-term management responsibility must be reflected in the design. Facilities that are managed through separate contractual processes (e.g. the City of Melbourne's self-cleaning public toilets) should, where possible, be maintained as discrete elements enabling clear demarcation of responsibilities.	Inculcate biophilic design awareness through appropriate caveats and descriptors in management, sales and leasing arrangements.

Design for the Future		
	Urban Design Strategy	**Biophilic Design Principles**
	3. Allow for long-term flexibility in the uses of public spaces and in the provision of facilities and services: Notwithstanding the requirement for an integrated design approach, take a cautious approach in the creation of any multifunction structures — e.g. co-locating public toilets and emergency access shafts, or recreational structures and vents —in situations where demands in relation to one function are likely to vary over time but adaptive redesign may be constrained by requirements of the other function. Design underground structures at any location in road reserves, parkland and other public spaces to withstand vehicular loadings as appropriate to a trafficable roadway, regardless of current carriageway layouts.	Be careful not to abandon clear biophilia goals in the process of assessing the various requirements for integrated design.
	4. Support the healthy growth of canopy trees throughout parks, streets and other open spaces, and allow for the potential to plant and replant over the long-term with minimal constraints: Locate underground structures at sufficient depth below the finished ground level to support healthy root systems of large canopy trees over the long-term, including provision of reserves of soil moisture to sustain trees in periods of drought and extreme heat. Where underground structures must be at relatively shallow depths below the existing surface, give consideration to wholesale elevation of the finished surface to help achieve satisfactory depth of cover (within constraints relating to issues such as provision for accessibility and drainage, and protection of landscape character and heritage fabric).	Trees offer some of the strongest biophilia triggers in the built environment and their care and management are vital to both the urban design and biophlic agendas.

Design for the Future		
	Urban Design Strategy	**Biophilic Design Principles**
	(Continue) Areas over structures where soil volumes are unavoidably too shallow to ensure long-term tree health should be designed to be successful without trees, making other provisions for shade, shelter and greening. Any new or relocated underground services should, if possible, be clustered into compact corridors and away from likely areas of planting. Overhead power or telecommunication lines should be placed underground where possible to avoid interference with tree canopies.	
	5. Create robust and durable landscapes: Select plants with consideration of climate, microclimate and likely climate change. Design to ensure resistance to wear due to intensive use of urban spaces and potential vandalism. Minimise requirements for irrigation while ensuring appropriate landscape qualities and amenity of public spaces. Design to suit relatively low-level maintenance regimes without reliance on a high level of horticultural skill.	Visual connection with nature requires that plantings are visible and effective. They may also generate scents, condition airflow, cool the air, affect light levels and variability, suggest refuge, add mystery, and contribute to complexity and order in the environment.
	6. Respond to changing climate and microclimate conditions to improve thermal comfort and create enjoyable places for use throughout the year: Incorporate climate change adaptation measures. Use trees and awnings to provide shade and shelter and to mitigate the urban heat island effect. Minimise tree loss as a result of construction.	Trees offer some of the strongest biophilia triggers in the built environment and their care and management are vital to both the urban design and biophlic agendas. Visual connection with nature requires that plantings are visible and effective. They may also generate scents, condition airflow, cool the air, affect light levels and variability, suggest refuge, add mystery, and contribute to complexity and order in the environment.

Design for the Future		
	Urban Design Strategy	**Biophilic Design Principles**
	(Continue) Replace trees removed as a result of the project to improve existing landscape character and biodiversity and contribute to increased tree canopy coverage and species diversity.	
	7. Integrate water-sensitive urban design initiatives: Incorporate rainwater collection, treatment, storage and re-use systems. Maximise the proportion of stormwater from within the project area that is treated, evaporated or retained within the project footprint. Use permeable surfaces where possible to allow rainwater infiltration and passive irrigation.	The presence of water is a powerful biophilic design tool and water-sensitive design initiatives should consider potential biophilic value in addition to their utilitarian value.
	8. Practice sustainable use of materials and resources: Use durable, high performance materials and finishes that are designed for the long-term and align with land managers' requirements. Use sustainable materials with low embodied energy or lifecycle impacts. Avoid and minimise waste and recycle were possible. Use rainwater harvesting and passive irrigation to support plantings. Apply energy efficient and renewable technologies in the design.	The choice of materials also affects biophilia possibilities. The opportunity exists for material choices that not only address the pragmatics of the urban design requirements but also create biophilic effects. Texture and pattern can contribute to material functionality and also add biophilia appeal with biomorphic forms and patterns and materials that reference the local ecology or geology and contribute to a sense of place.

8.2 Biophilic Design Principles – Recommendations

In the following table, general principles of biophilic design are matched against a design narrative generated by the 14+1 Patterns described in Chapter 2 Biophilia.

Design Narrative	Biophilic Design General Principles	General Principles Station Priority
0. Design Narration Clarity and coherence of an experience	Construct an individual narrative story and sequence, from portal-to-platform, that celebrates place and people though the strengths and characteristics of biophilic design patterns.	**General HIGH** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station HIGH**
1. Visual Connection with Nature A view to elements of nature, living systems and natural processes.	Ensure visual access to real presentations of nature throughout the station complexes in preference to simulated nature and non-nature representations.	**General MEDIUM** **Domain Station HIGH** **CBD South Station MEDIUM** **CBD North Station MEDIUM** **Parkville Station HIGH** **Arden Station MEDIUM**
2. Non-Visual Connection with Nature Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.	Enhance opportunities for sensory connections (audible, smell, texture, temperature) to nature throughout the station complexes, in preference to urban simulated or constructed representations.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station MEDIUM** **Arden Station MEDIUM**
3. Non-Rhythmic Sensory Stimuli Stochastic and ephemeral connections with nature that may be analysed statistically but may not be predicted precisely.	Instil patterns of nature's movements and seasonality throughout the station complexes, using real or artistic representations where necessary	**General MEDIUM** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville MEDIUM** **Arden Station MEDIUM**
4. Thermal & Airflow Variability Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.	Consider sequential changes in thermal and airflow variability to refresh spaces and to enable comfortability throughout the station complexes.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station MEDIUM**

Design Narrative	Biophilic Design General Principles	General Principles Station Priority
5. Presence of Water A condition that enhances the experience of a place through the seeing, hearing or touching of water.	Use water as a static, dynamic and or variable design element to achieve multi-sensory experiences throughout the station complexes	**General MEDIUM** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station MEDIUM** **Arden Station HIGH**
6. Dynamic & Diffuse Light Leveraging varying intensities of light and shadow that change over time to create conditions that occur in nature.	Use mixtures of dynamic, diffuse and changeable lighting arrangements and patterns (including illuminance and colour) to evoke movement, time, seasonality, while maximizing solar access throughout the station complexes.	**General MEDIUM** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station MEDIUM** **Arden Station MEDIUM**
7. Connection with Natural Systems Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem.	Use natural systems (weather, hydrology, geology, terrestrial and aquatic wildlife, diurnal and seasonal patterns) as design inspirations throughout the station complexes.	**General MEDIUM** **Domain Station HIGH** **CBD South Station MEDIUM** **CBD North Station MEDIUM** **Parkville Station HIGH** **Arden Station HIGH**
8. Biomorphic Forms & Patterns Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature.	Ensure biomorphic patterns legibility and interest in floor/ ceiling/roof/wall places and furniture detail throughout the station complexes.	**General HIGH** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station HIGH**
9. Material Connection with Nature Material and elements from nature that, through minimal processing, reflect the local ecology or geology to create a distinct sense of place.	Consider the richness of material colour, warmth, authenticity and tactility throughout the station complex.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station MEDIUM** **CBD North Station MEDIUM** **Parkville Station MEDIUM** **Arden Station MEDIUM**
10. Complexity & Order Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature.	Prioritise pattern compositional and order use enabling stimulation, interest and legibility, including artwork throughout the station complexes.	**General MEDIUM** **Domain Station HIGH** **CBD South Station MEDIUM** **CBD North Station MEDIUM** **Parkville Station MEDIUM** **Arden Station HIGH**

Design Narrative	Biophilic Design General Principles	General Principles Station Priority
11. Prospect An unimpeded view over a distance for surveillance and planning.	Provide a sense of arrival, prospect, for each portal 'gate', concourse level and platform level for the station complexes.	**General HIGH** **Domain Station HIGH** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station HIGH**
12. Refuge A place for withdrawal, from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.	Provide opportunities for retreat, contemplation, waiting, meeting, refuge, for each portal 'gate', concourse level and platform level of the station complexes.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station MEDIUM**
13. Mystery The promise of more information achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.	Provide a sense of journey in pedestrian environments that ensures sightlines, permeability, and variability in edges and planes.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station MEDIUM** **Arden Station MEDIUM**
14. Risk/Peril An identifiable threat coupled with a reliable safeguard.	Lessen personal risk in preference to safety but do not let safety considerations override biophilic design opportunities and principle execution.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station HIGH** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station HIGH**
+ Virtual Connection with Nature A view to a simulacrum of natural elements, living systems and natural processes	Ensure visual access to virtual or simulated representations of nature throughout the station complexes in the case of it not being otherwise possible to elicit biophilia responses.	**General MEDIUM** **Domain Station MEDIUM** **CBD South Station MEDIUM** **CBD North Station HIGH** **Parkville Station HIGH** **Arden Station HIGH**

Figure 8.3: Biophilic Design Principles - Recommendations

'THE BIOPHILIC DESIGN TOOLKIT' SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
1	**Adopt a Biophilia Design Program**	**Designs must be sustainable** Site responsive, responding to specific local conditions inclusive of built form, landscape, topography and orientation.	**1.2 Objectives:** **Principle 1** Connect people to nature **Principle 2** Create a diverse, connected and resilient ecosystem **Principle 3** Demonstrate local and global leadership	**All**	Dingpu Metro Station, Taiwan. Atocha Railway Station, Spain. Low Line Lab, New York City. Stockholm Metro, Stockholm. MetroNapoli, Naples. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth. MFO Park, Switzerland. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
2	**Make Judicious Use of Planting, Green Roofs and Walls**		**Principle 1** Connect people to nature **Principle 2** Create a diverse, connected and resilient ecosystem	**1, 2,**	Atocha Railway Station, Spain. Low Line Lab, New York City. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Central Wharf Plaza, Boston. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth. MFO Park, Switzerland. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.

'THE BIOPHILIC DESIGN TOOLKIT' SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
3	**Optimise use of Natural Light**			**1, 6, 7, 10**	Dingpu Metro Station, Taiwan. Atocha Railway Station, Spain. Low Line Lab, New York City. Stuttgart Airport Terminal 3, Stuttgart. Gare do Oriente Train Station, Lisbon. The Eden Project, England. Park Güell, Barcelona. Madrid Rio, Madrid. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
4	**Apply Controlled Air Movement**			**4, 10**	The Eden Project, England. Park Güell, Barcelona
5	**Make Creative Use of Water**			**5, 10**	Atocha Railway Station, Spain. The Eden Project, England. Park Güell, Barcelona. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Perth Cultural Centre Urban Wetland, Perth. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
6	**Manipulate the Soundscape & Olfactory Landscape to Reinforce Biophilic Effects**			**+1, 2, 5, 12, 13**	Atocha Railway Station, Spain. The Eden Project, England. Paris Metro, Paris. Park Güell, Barcelona. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.

'THE BIOPHILIC DESIGN TOOLKIT' SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
7	**Incorporate Biomorphic Forms & Images**			**7, 8, 10, 13**	Low Line Lab, New York City. Stockholm Metro, Stockholm. MetroNapoli, Naples. Stuttgart Airport Terminal 3, Stuttgart. Gare do Oriente Train Station, Lisbon. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Dubai Mall, Dubai. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
8	**Use Materials as Natural Analogues**			**8, 9, 10**	Stockholm Metro, Stockholm. The Eden Project, England. Monash University, Sundial Concept and Turtle Bay Sundial Bridge. Paris Metro, Paris. Park Güell, Barcelona. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Perth Cultural Centre Urban Wetland, Perth. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.

‘THE BIOPHILIC DESIGN TOOLKIT’ SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
9	**Create Distinct Spatial Environments**	**Designs must be enjoyable**, creating a desire to experience the journey rather than just pass through.		**3, 11, 12, 13,14**	Atocha Railway Station, Spain. Low Line Lab, New York City. Stockholm Metro, Stockholm. MetroNapoli, Naples. Stuttgart Airport Terminal 3, Stuttgart. Gare do Oriente Train Station, Lisbon. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Dubai Mall, Dubai. Central Wharf Plaza, Boston. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth. MFO Park, Switzerland. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.

'THE BIOPHILIC DESIGN TOOLKIT' SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
10	**Layer Texture & Modelling over Undifferentiated Planar Surfaces**			**+1, 2, 8, 9**	Stockholm Metro, Stockholm. MetroNapoli, Naples. The Eden Project, England Gardens by the Bay, Singapore. Monash University, Sundial Concept and Turtle Bay Sundial Bridge. Paris Metro, Paris. Dubai Mall, Dubai. Central Wharf Plaza, Boston. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth. MFO Park, Switzerland. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
11	**Explore Transitioning of Biophilia Effects**			**All**	Low Line Lab, New York City. Stockholm Metro, Stockholm. The Eden Project, England. Gardens by the Bay, Singapore. Monash University, Sundial Concept and Turtle Bay Sundial Bridge. Park Güell, Barcelona. Promenade Plantée, Paris. The High Line, New York City.
12	**Use Signage and Wayfinding to Raise Public Awareness of Local Nature**	**Designs must be functional** Safe, legible, understandable, safe and secure feeling, and provided with good visual links and strong passive surveillance. The built form must be clear and way finding carefully considered as part of the Project.	**Principle 1** Connect people to nature	**+1, 7, 8, (15)**	Low Line Lab, New York City. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore.

‘THE BIOPHILIC DESIGN TOOLKIT’ SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
13	**Apply Fractal Design Techniques**			**+1, 7, 8, 10**	Low Line Lab, New York City. Stockholm Metro, Stockholm. MetroNapoli, Naples. Stuttgart Airport Terminal 3, Stuttgart. Gare do Oriente Train Station, Lisbon. The Eden Project, England. Gardens by the Bay, Singapore. Park Güell, Barcelona.
14	**Use Public Art to Achieve Biophilic Effects**			**+1, 1, 10, 15**	Stockholm Metro, Stockholm. MetroNapoli, Naples. The Eden Project, England. Gardens by the Bay, Singapore. Paris Metro, Paris. Park Güell, Barcelona. Dubai Mall, Dubai. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth.
15	**Avoid Abstraction**			**8, 9, 10**	Stockholm Metro, Stockholm. The Eden Project, England. Gardens by the Bay, Singapore. Monash University, Sundial Concept and Turtle Bay Sundial Bridge. Paris Metro, Paris. Park Güell, Barcelona. Promenade Plantée, Paris. The High Line, New York City.

‘THE BIOPHILIC DESIGN TOOLKIT’ SUMMARY OF RECOMMENDATIONS					
Design Tool		**Urban Design Strategy**	**Urban Ecology Strategy**	**14+1 Patterns** (see Chpt 2.3)	**Exemplars** (see Chapter 5)
16	**Make Visible & Incorporate the Skyline**			**1, 11, 13**	Dingpu Metro Station, Taiwan. Atocha Railway Station, Spain. Stuttgart Airport Terminal 3, Stuttgart. Gare do Oriente Train Station, Lisbon. The Eden Project, England. Gardens by the Bay, Singapore. Monash University, Sundial Concept and Turtle Bay Sundial Bridge. Paris Metro, Paris. Park Güell, Barcelona. Central Wharf Plaza, Boston. Cheonggyecheon Stream, Seoul. Promenade Plantée, Paris. The High Line, New York City. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth. MFO Park, Switzerland. Le Mur Vegetal, Paris. Edgeware Road Tube Station, London. One Central Park, Sydney.
17	**Make Visible & Incorporate the Local Pre-European/ Pre-Industrial Environment**	**Designs must be sustainable** Valuing of heritage, responding to history, memory, understanding of and continuity with the past.	**Principle 1** Connect people to nature – Caring for Country	**+1,7, 9, 13**	The Eden Project, England. Park Güell, Barcelona. Central Wharf Plaza, Boston. Cheonggyecheon Stream, Seoul. Khoo Teck Puat Hospital, Singapore. Madrid Rio, Madrid. Lurie Garden, Chicago. Perth Cultural Centre Urban Wetland, Perth.

Figure 8.4: Biophilic Design Toolkit

A Biophilic Design Program aligns well with the City of Melbourne’s Draft Urban Ecology and Biodiversity Strategy, in particular:

3.10 Connecting people to nature

This strategy sets out to reinforce and re-inject nature into the fabric of the city, making interaction with nature an unavoidable experience for people in the city. Whether it is exploring a network of small green spaces and laneways, or hearing the sounds of native birds, to experience Melbourne will be to experience nature.

All the Biophilic Design Toolkit recommendations fit and support the overall Urban Ecology Strategy of connecting people to nature.

4.7 Strategy 4 – Support habitat creation within the private realm and other public land to maximize diversity and connectivity

Enhance ecological connectivity through stepping stones and corridors along streets and bio- links between larger green spaces.

5.1 Strategy 5 – Demonstrate local and global leadership in urban ecology and biodiversity

The City of Melbourne will demonstrate local and global leadership through its approach and commitment to delivering positive outcomes related to biodiversity and urban ecology.

The Proposed Actions in the Draft Urban Ecology and Biodiversity Strategy include an emphasis on advocacy and education to increase awareness of bioodiversity, which can be strongly supported and reinforced by the Metro biophilia program, and specifically includes the Biophilic Cities Network as part of developing international networks.

5.2 Proposed Actions

- Undertake ongoing advocacy and education to increase awareness of biodiversity.
- Undertake a community-wide survey to select an emblematic species to represent the City of Melbourne and further promote awareness of biodiversity in the city.
- Partner with researchers to position Melbourne internationally as a hub for urban ecology and biodiversity research.
- Support and partner with local volunteer groups to enhance biodiversity management.
- Develop local and international networks on biodiversity (C40, ICELI, Biophilic Cities Network)
- Deliver a flagship biodiversity and urban ecology project that is recognised locally and internationally as an innovative and outstanding example of rewilding in a dense urban fabric.

8.2.1 Adopt a Biophilic Design Program

Patterns – All

It is recommended that the MMRA adopt a specific Biophilia Design Program that is incorporated in all design briefs and relevant tender documents, emphasising the idea of biophilia as an constant theme in all design and art works and that the works are considered in an integrated manner to reinforce 'biophilia in the city'.

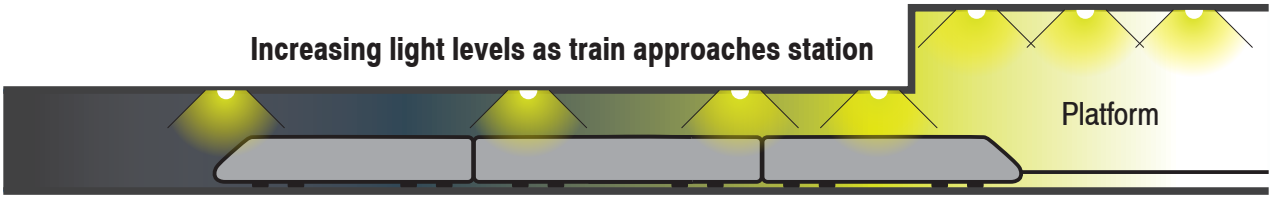


Figure 8.5: A Biophilic Design Program implies careful consideration of all the potential ways that biophilia might be evinced in the metro environment to improve well-being. For instance, as a consequence of considering how to reduce the shock of glare as trains emerge into well–lit areas it might be suggested that a gradation of light levels are introduced into the metro design.

8.2.2 Make Judicious Use of Green Roofs and Walls

P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.

P2 Non-Visual Connection with Nature: Auditory, haptic & olfactory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

Figure 8.6: Internal green wall incorporating a controlled environment display case containing a veiled chameleon with a running water feature running the length of the wall. Source: Downton

The green roof and walls industry has been maturing rapidly in recent years and it is possible to specify and build green roofs and walls for Australian conditions with considerable confidence. Green walls can be designed to incorporate additional elements, including pockets of controlled habitat to display living fauna as well as flora.

Similar green walls to the one shown here, even if dependant on artificial light, might be included in appropriate locations in the stations and include, potentially, examples of local fauna and flora that were indigenous to the station site prior to European settlement.

Green roofs and walls can provide the most direct and effective biophilic design impacts but they are relatively expensive and difficult to incorporate in metro stations because the opportunities to use them are limited by restricted site conditions and the requirements of vegetation for certain levels of light.

For these reasons, the use of green roofs and walls needs to be judicious, carefully chosen to make the best use (ie., have the most biophilic impact) of the living greenery they provide.

8.2.3 Maximise Use of Natural Light

P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.

P6 Dynamic & Diffuse Light: Leverages varying intensities of light and shadow that change

over time to create conditions that occur in nature.

P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

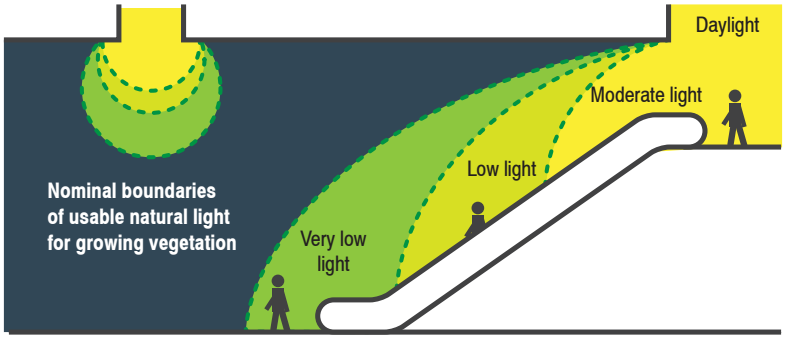


Figure 8.7: Understanding the range of light levels available for biophilic design purposes is essential.

Figure 8.8: Detail of the effect of light through coloured glass windows falling on formed concrete in the Sagrada Familia. Source: Downton

Natural light is one of the most powerful 'tools' available for biophilic design. As well as being a primary asset in the biophilic design toolkit, the use of natural light saves energy.

The availability of natural light is limited and is at a premium in the case of metro stations. It is difficult to incorporate effectively in subterranean environments. Nevertheless, its use should be optimised because it provides a direct link to extant natural conditions and can provide travellers with experiential evidence of nature during their transit of the station environment.

Natural light has a strong biophilic effect but because it is not physically possible to flood all station spaces with natural light it should be manipulated in diverse ways to optimise its impact. Potential techniques range from simple skylighting to the use of reflected light and channelled light, to spots of light enlivening various surfaces and spaces, delivered by fibre optics.

Natural light can be employed in a number of subtle and effective ways, e.g., the use of coloured glass can add vibrancy and interest, and wash changing hues across monochrome surfaces.

The introduction of natural light, even in small areas, can provide travellers with evidence of the diurnal cycles that underpin all nature.

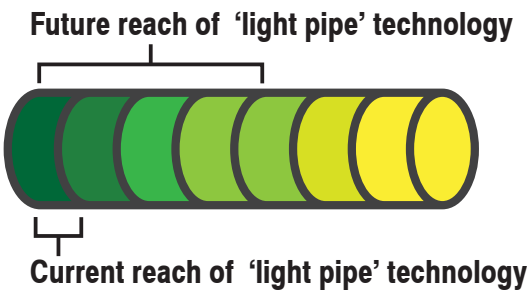


Figure 8.9: Advances in 'light pipe' technology are likely to extend the scope for its use as the Metro Stations project progresses

Light pipes and similar technology (REF) are being tested and developed for channelling natural daylight (with all its variation and changes) from above ground to underground. The Lowline experiment in New York (see Chapter 5) gives an indication of how the technology is evolving. Right now, this technology is experimental but, given the rate of technological progress in recent decades (for instance in lighting, as LEDs have quickly usurped compact fluorescent fittings which had quickly overtaken incandescent lighting in efficiency and ubiquitousness of use in a few short years), it is not unreasonable to presume that the advances in 'light-pipe' technology may make its use relatively cost-effective and non-disruptive by the time the building of the metro stations begins to roll out.

8.2.4 Apply Controlled Air Movement

> P4 Thermal & Airflow Variability: Subtle changes in air temperature, relative humidity, airflow across the skin, and surface temperatures that mimic natural environments.
>
> P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

There are few opportunties for introduced air movement in a metro environment but still air should be avoided, as should high velocity air movement.

Air speeds of XYZ metres/second contribute to comfort and well-being and should ideally be obtained in major public spaces as part of the air-conditioning.

8.2.5 Make Creative Use of Water

> P5 Presence of Water: A condition that enhances the experience of a place through seeing, hearing or touching water.
>
> P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

Water, especially flowing water, is a powerful biophilic design 'tool'. It is also difficult to incorporate in the constrained metro station environment. Nevertheless, because it is such a powerful element in biophilic design its use should be considered wherever possible.

Its use may range from waterfall features (where practical of allowable) to small trickles of water that can movement and sound to otherwise sterile spaces.

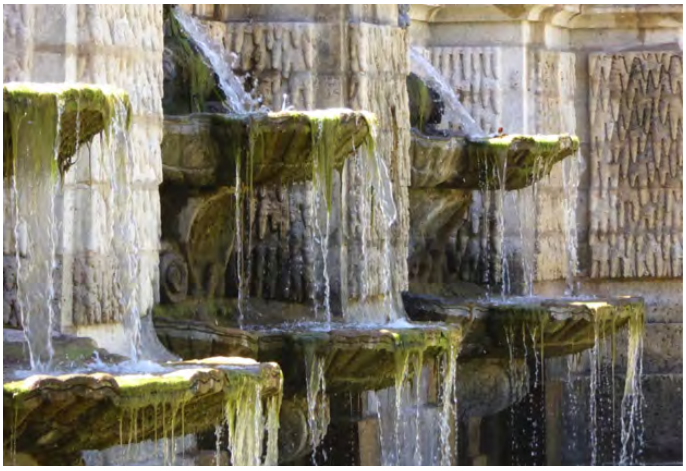


Figure 8.10: Detail of fountain, Domain de Chantilly. Source: Downton

8.2.6 Manipulate the Soundscape and Olfactory Landscape to Reinforce Biophilic Effects

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

P5 Presence of Water: A condition that enhances the experience of a place through seeing, hearing or touching water.

P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

*"With the internal combustion engine on its way out... the acoustic fog created by cars, buses and trucks will finally lift and other sounds of the city will emerge. Will we like what we hear? All those annoying sounds currently masked by traffic noise, such as humming ventilation systems and music escaping from pubs, restaurants and cars, will become more audible. It's time to work out how we want our cities of the future to sound" (*Cox 2010:1).

Biophilic design is less likely to be effective if the total environment does not support the biophilia goal. The total, integrated environment includes the auditory and olfactory landscapes. The collective sound made by non-human animals in a given environment is know as 'biophony' and "*the interrelationship of disciplines informed by natural soundscapes is called 'soundscape ecology*'". Natural soundscapes can benefit human wellbeing. They may help generate, or help define, a sense of place that connects people to the environment and provides unique aesthetic experiences. Preservation of natural soundscapes is becoming a recognized conservation goal.

According to Pijanowski et al (2011) soundscapes can influence well-being, noting that "*natural and unique soundscapes have many associated human ideals, such as cultural, sense of place, recreational, therapeutic, educational, research, artistic, and aesthetic values.*" (p.205). Referencing Wilson and Schafer, Pijjanowski et al maintain that whereas "the natural world is the most information-rich environment that humans can experience", urban soundscapes contain little acoustic information and reinforce a growing disconnect between humans and nature (p.205).

Sound can be a critical component of biophilic design. Quieter spaces (relative to the general background noise) can reinforce biophilic experiences such as observing images of birds. In an environment of intense noise, especially sharp, metallic or 'industrial' noises, images of, for instance, soaring Grey Goshawks would be less able to override the impact of that environment and achieve biophilic effects. Careful attention to the auditory environment has to be integrated into the Biophilic Design Program to maximise the investment in biophilia and its outcomes. Thus, images of Grey Goshawks might unfold or be presented just as the station user reaches a point along their journey where acoustic design has been used to strongly reduce the immediate decibel level. Relative to the overall background noise of the station experience, that area would seem suddenly quiet – and suited for receiving images of wild nature.

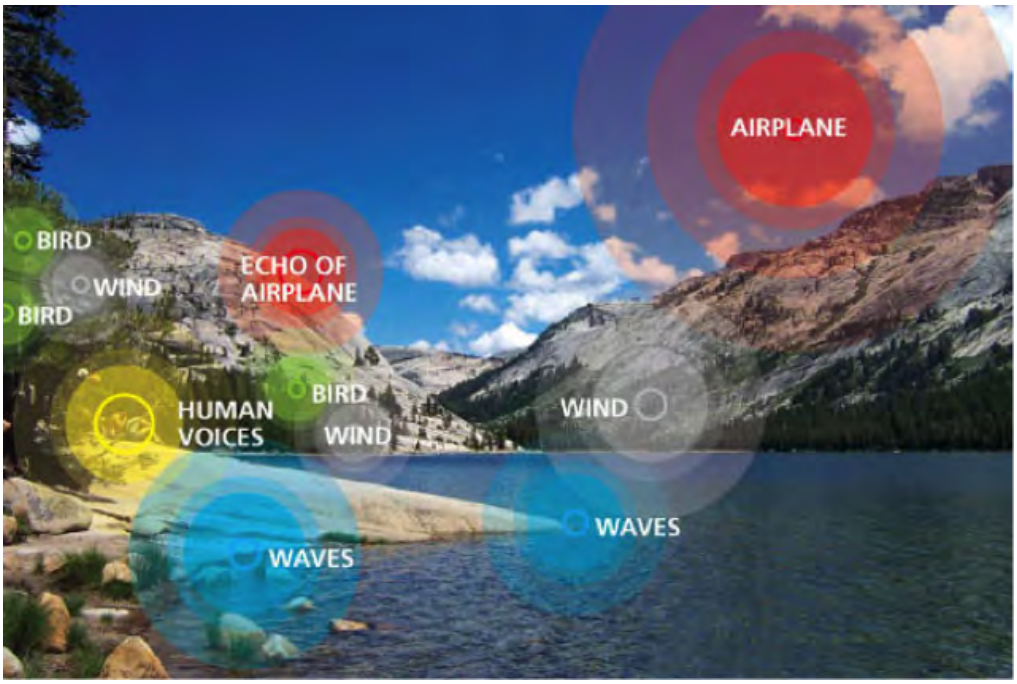


Figure 8.11. Source: https://www.nps.gov/yose/learn/nature/soundscape.htm

The texture and disposition of different surfaces greatly affect the acoustic environment and their use should be considered in relation to that environment. For instance, anechoic tiling patterns could contribute considerably to the acoustics but also add striking changes and visual wayfinding elements to the station experience.

A further refinement of this soundscaping approach would be to embed audio art installations which created 'sound sculptures' that reflect, in 3-D, the sounds of wild natural habitat. The natural soundscape can be modelled (recorded) and projected. This offers another potential dimension for evoking biophilia even in such a highly artificial urban environment as a metro station.

Densely planted green walls (see 8.2.2) have the potential to provide some acoustic deadening and water features can add an aural layer with positive biophilic associations (see 8.2.5).

Movement through different spaces can be mapped and expressed in acoustic terms. Appropriately quieter and noisier spaces might reflect or reinforce a traveller's journey and assist in way-finding..

The olfactory experience a traveller enjoys in metro stations is rarely pleasant. The air quality is difficult to control where potentially polluting machinery and active human bodies exuding warmth, sweat, cutaneous detritus and various perfumes mix in contained spaces.

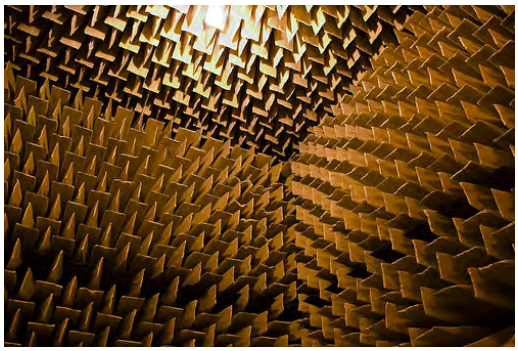


Figure 8.12: Anechoic chamber. Source: http://24.media.tumblr.com/tumblr_m4jmvu4cxm1qafy5xo1_500.jpg

Consequently, apart from the necessary effort required to control air quality by limiting the impact of unwanted particulates, a biophilic design approach might suggest subtle additions to the olfactory mix, although this might only be achievable with the use of flowering plants and the potential for locating them in the metro will be severely limited (see 8.2.2).

8.2.7 Incorporate Biomorphic Forms & Images

P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

Figure 8.13: Red human figure and wallaby, date -4000 - -2000. "A squatting human figure above a wallaby partly overlays a hand stencil". Djulirri, Western Arnhem Land.

Figure 8.14: Gaudi's La Pedrera, Barcelona.

Biophilia can be evoked by non-natural images and forms that have biomorphic qualities. Caves, branching and vegetation-related forms have proven biophilic effect. Biomorphic forms and images appeal directly to the biophilia that animates human beings. Architecture has incorporated biophilic form and imagery since its beginning. If caves were the earliest shelters, then the evidence of cave paintings shows that, regardless of the utilitarian purpose of the paintings, humans were using their most advanced technologies to produce biophilic effects.

The most formal and constrained architectural styles, including Classicism and Neo-Classicism, invariably incorporated biomorphic forms and images.

Figure 8.15: Formalised biomorphic design details on the 18th century Great Stables at Domaine de Chantilly.

Whether architecture was vernacular or 'high art', like Gothic or traditional Chinese architecture, it has consistently reflected a biophilic sensibility that has only been absent since the advent of formalist modernism. This has, arguably, been the result of ideological positioning rather than anything intrinsic to being functionally 'modern'. It is interesting to note that the aesthetic of early industrialism embraced forms and patterns that were clearly fractal/biophilic and it is instructive to recognise the strong organic inspiration and biophilic tendencies of the architectural movements and sensibilities that jostled against the straitening effects of Bauhaus modernism in the early part of the 20th century.

Figure 8.16: The pioneering Art Nouveau Metropolitain stations of Paris used naturalistic/ biomorphic forms and imagery to create artefacts in the urban landscape that can be readily recognised as having a biophilic effect (Downton 2016a).

Figure 8.17: Strong biomorphic forms and are integral to the Art Nouveau design of the Modernista Complex of the Hospital de la Santa Creu di Sant Pau, Barcelona. Source: Downton

8.2.8 Use Materials as Natural Analogues

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

The use of natural materials and textures has proven biophilic effects.

Timber handrails and similar surfaces should be considered as biophilic design elements. A default to the hard, shiny surfaces and textures associated with the mechanistic environment of the Metro should be avoided where possible and practicable. The visual texture of wood can be effective even when the timber cannot be physically touched, so materials can provide evocative experiences despite being appreciated in different ways.

8.2.9 Create Distinct Spatial Environments

P11 Prospect: An unimpeded view over a distance, for surveillance and planning.

P12 Refuge: A place for withdrawal from environmental conditions or the main flow of activity, in which the individual is protected from behind and overhead.

P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

P14 Risk/Peril: An identifiable threat coupled with a reliable safeguard.

Different parts of the Metro Station environment should be given distinctive characters that reinforce way-finding and a sense of place so that a traveller ‘knows’ where they are without having to resort to reading conventional signs.

8.2.10 Layer Texture & Modelling over Undifferentiated Planar Surfaces

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P2 Non-Visual Connection with Nature: Auditory, haptic, olfactory, or gustatory stimuli that engender a deliberate and positive reference to nature, living systems or natural processes.

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

The necessary, but somewhat insistent, rectilinear forms of the stations are not intrinsically congruent to the aesthetic language of biophilic design. However, there are ways to retain the underlying forms whilst adding a layer, or layers, of strong design elements that can elicit biophilia responses from users and observers of the stations.

Figure 8.18: A striking example of how biophilia can inspire the reimagining of otherwise predictable architectural expression can be seen in Gaudi's work for Casa Batlló in Barcelona, where biomorphic and zoomorphic forms are layered over an otherwise conventional structure. These models on display in the Casa Batlló show the original building on the left and Gaudi's reworking of the façade on the right. Source: Downton

8.2.11 Explore Transitioning of Biophilia Effects

Patterns – All

The gradation from the 'full' biophilia of outdoor or near-outdoor biology-dominated environments to indoor environments where artificial imagery is used for biophilic effect offers the opportunity for art and design that makes use of the gradient to draw out the connection between real nature and its emulation in artefact. Melbourne's now-iconic tessellated building surfaces has potential for providing the nominal matrix for biophilic transformative connections.

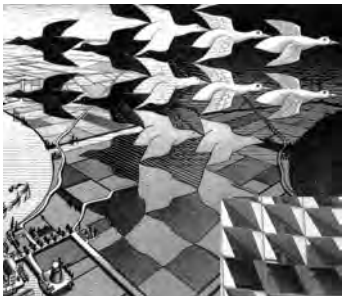


Figure 8.19: Transitioning to biophilia? Detail of an Escher drawing overlaid with a photograph showing part of an RMIT building façade. Source: http://britton.disted.camosun.bc.ca/escher/day_and_night.jpg and Downton

8.2.12 Use Signage and Wayfinding to Raise Public Awareness of Local Nature

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

Figure 8.20: http://www.abc.net.au/news/2015-12-31/powerful-owl-found-tangled-in-rope-rescued/7061056

The biophilic design responses should enhance public awareness of the flora and fauna and ecological character of the region. Thus Powerful Owl imagery may be linked to the Domain precinct and used a graphic theme in signage and way-finding, and the Grey Goshawk might similarly inform art and design works for the eastern portal precinct.

The creek critter project of Urban Ecology back in the late 1980s used images of indigenous wildlife to identify different buried creeks within the city of Berkeley, California to draw attention to the fact that creeks had been turned into drains but they were still part of the local hydrology and ecosystem.

Signage can have a pivotal role to play in maintaining links and continuity in any narrative adopted for the overall MTP railway stations design program.

Figure 8.21: Creek stencil. Source: Richard Register

8.2.13 Apply Fractal Design Techniques

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

Figure 8.22: Fractal branching inspires the form of Singapore's 'Super Trees'. Source: Downton

Human beings are predisposed "*to prefer an environment that has the self-similar properties of a fractal*" and as a consequence "*fractal art and architecture reduce physiological stress*" (Salingaros, 2012).

Fractals are mathematically described and their attributes can be predicted. Research indicates that the fractal qualities of an image are at least as important as its otherwise superficial aesthetic qualities in eliciting biophilic preferences. Salingaros argues that our biophilic responses are triggered more by fractal properties than by the literal 'accuracy' of an image, and that this demonstrates the physiological response involved 'relies squarely upon their mathematical content, and not in some intrinsic or mysterious vitalistic qualities of the natural scenes themselves,' thus making possible 'a remarkable simplification of what is at first a very puzzling effect.' (Salingaros, 2012)

An interesting corollary of this proposition is that the 'non-natural' examples in the 14+ Patterns may have at least as much pyschological and physiological effect as the 'natural' ones. From this it might even be the case that virtual connections with nature (e.g., the images of the sky used in MRI rooms) can be as powerful as 'actual' connections (e.g., looking directly at the sky), drawing into question suppositions about a correlation between 'virtuality' and the weakness or otherwise of the biophilic effect. Whereas this suggests a potentially disruptive or disturbing disconnect between the biophilic effects of 'authentic' nature and its simulacrum (and reinforces the need for targetted research in this area), it also supports the view that significant biophilic effects in the subterranean depths of the MMRA project may be achievable despite the difficulties of its constrained environments.

8.2.14 Use Public Art to Achieve Biophilic Effects

P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

The Landscape and Visual chapter of the Environment and Effects Statement for the Metro Tunnel states that the vision for the stations includes:

Integration of public art to enrich the experience for people using the spaces and contribute to the cultural richness of the urban environment (MMRA 2016:16-17).

The opportunity to achieve biophilia outcomes from the public art program is high. It is recommended that the brief for all and any public art created for the project requires a biophilia-focussed approach to the design of the works and that every attempt should be made by the artist(s) to coordinate and integrate with the biophilic design program adopted by the MMRA.

Figure 8.23: Abor sole' by Ulan Murray. Many artworks inspired by nature have an inherent fractal structure and elicit a biophilia response. This example is crafted from recycled copper and steel. Photographed at The Waterhouse Natural Science Art Prize exhibition, Adelaide. Source: Lily Zhou.

Graffiti and street art are gaining increasing social, cultural and political significance. There is an ongoing debate about whether they can, or should be, assimilated as legitimate public art, but the pendulum appears to be swinging towards legitimacy (Downton, 2014, 2016a, Maddox, 2016). Meanwhile, graffiti has achieved a remarkable kind of cultural prominence in Melbourne and have given it something of an international reputation for its street art. As an aspect of public art, this might be coopted or given a place in the public space associated with the stations to reinforce a biophilia/nature theme.

The Metro Tunnel Urban Design Strategy (2017) includes the following Design Guidelines for the incorporation of public art in appropriate places:

- Integrate site responsive art into the project design where appropriate;
- Design the settings of existing artworks, memorials and monuments to be retained to respect the works' cultural values and formal design qualities;
- Integrate site responsive art into the project design(e.g. facilitating playful interaction and seating opportunities) and located to optimise the legibility of the surrounding area (MMRA 2017).

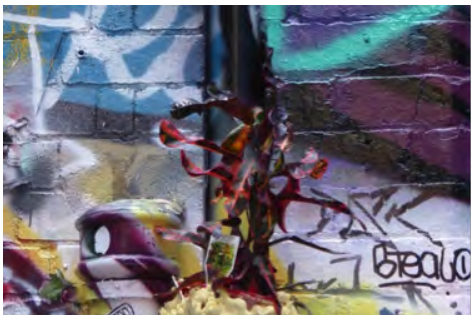


Figure 8.24: Graffiti with a biophilic twist, Hosier Lane, Melbourne CBD. Source: Downton

Figure 8.25: Portland Mausoleum Mural. North America's largest mural at 55,000 square feet,overlooking Oaks Bottom Preserve in Portland, Oregon. Commissioned and photographed by Mike Houck. http://www.thenatureofcities.com/2016/01/20/creative-place-making-this-is-the-nature-of-graffiti/

8.2.15 Avoiding Non-fractal Abstraction

P8 Biomorphic Forms & Patterns: Symbolic references to contoured, patterned, textured or numerical arrangements that persist in nature. (Fractal self-similarity and hierarchical characteristics)

P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

P10 Complexity & Order: Rich sensory information that adheres to a spatial hierarchy similar to those encountered in nature. (Fractal self-similarity and hierarchical characteristics)

There are different kinds of 'abstract'; one kind contains information that links it to biophilia, the other kind lacks that information and can have what amounts to an 'anti-biophilic' effect. If images lose their fractal properties as they become more abstract, they are less likely to retain their biophilia affect.

A 1986 NASA study has shown that simplified or stylised imagery that is based on fractals can have a positive physiological effect as strong as, or even stronger than, images of natural scenes, whereas non-fractal images can increase stress levels (as measured by skin conductance) (Salingaros 2012). Thus abstractions of natural scenes and objects can be as effective as pictures of the real thing provided they maintain fractal properties, but abstract images without fractal properties are more likely to be experienced as stressful.

Fractals are measurable. There is a proven formula for establishing the dimension of a fractal Joye suggests that abstraction is limited by ensuring that the fractal dimension of an image is between 1.3 and 1.5 (Joye 2007). A fractal dimension ranges from D=1 for a smooth line to D=2 which, in two dimensions, is a totally filled-in area. Thus, an object halfway between the smooth line and the filled area has a 'mid-range' fractal dimension of about D=1.5. Taylor et al reported that the increasing visual complexity of an object is related to its positive physiological response in humans such that objects that are regarded as most restorative and relaxing have a dimension of around D=1.3 (Salingaros 2012). This is the same fractal dimension as clouds and waves (Taylor et al 2011).

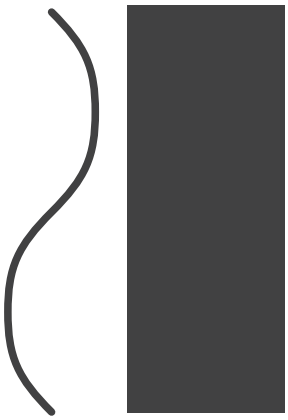


Figure 8.26: Research shows that simplified images of nature can have an even stronger biophilic effect that photographic representations, but purely abstract images can be unsettling.

Designers should be advised that images intended to provide biophilic experiences to people using the metro should not be so abstract that they lose their fractal properties as they are then unlikely to be appreciated in a positive, i.e., biophilic way by the users. As a preference for natural images does not depend on photo-realistic depiction, the fractal content of images should be considered as integral to their biophilic function (Joye 2007). To reiterate the point, this does not mean that abstract images should not be used, but that non-fractal abstraction should be avoided, bearing in mind that the abstract work of Jackson Pollock has been analysed and established as having a distinctly fractal structure (Taylor et al 2011).

The concept of biophilia is tied to fractals by analysis of the shapes and forms of nature which show them to have measurable fractal dimensions.

8.2.16 Make Visible and Incorporate the Skyline

P1 Visual Connection with Nature: A view to elements of nature, living systems and natural processes.

P11 Prospect: An unimpeded view over a distance, for surveillance and planning.

P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

Being able to see the stars from city streets should be a biophilic objective. Beatley suggests that recapturing and connecting with some of the urban wildness represented by the night sky should be a goal for every city. *<http://biophiliccities.org/wildness-in-the-night-sky/>*

From the point of view of the railway stations this suggests looking up in some way, perhaps using mirrored surfaces, kaleidoscopes pointing at the skyline and viewed at station level, or live electronic projection of the night sky/skyline.

8.2.17 Make Visible and Incorporate the Local Pre European/ Pre-Industrial Environment

P1+ Virtual Connection with Nature: A view to a simulacrum of natural elements, living systems and natural processes.

P7 Connection with Natural Systems: Awareness of natural processes, especially seasonal and temporal changes characteristic of a healthy ecosystem. (Fractal natural patterns or processes)

P9 Material Connection with Nature: Materials and elements from nature that, through minimal processing, reflect the local ecology or geology and create a distinct sense of place.

P13 Mystery: The promise of more information, achieved through partially obscured views or other sensory devices that entice the individual to travel deeper into the environment.

Figure 8.27: Berlin Reichstag. Source: http://photos1.blogger.com/blogger/5328/605/1600/Berlin%20Reichstag%20141.jpg

Figure 8.28: Tokyo Yurakucho Marion escalator. Source: https://www.flickr.com/photos/130700920@N08/26261228631

Biophilia is 'the inherent human inclination to affiliate with nature' and indigenous and pre-industrial era peoples had and have a proven and necessary close association with nature. The wealth of 'nature affiliations' enjoyed by pre-European inhabitants of the landscape since obliterated by urban development can be reflected and celebrated in a biophilic design approach.

This might be realised through artefacts, artwork, informative displays and more imaginative means that evoke the history of pre-European cultures and their early biophilic relationship with nature.

It is here that the 15th Pattern might be usefullly realised. Virtual recreations and presentations of aboriginal occupation of the landscape have the potential to provide sensitive and powerful vignettes of the narrative arc that stretches across the several thousand years of the human relationship with the nature of the places where the Metro Stations are now planned.

Figure 8.29: Me, 200 Years Ago Megan Cadd, 2010, in The Yalukit willam, The First People of Hobsons Bay

9

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Street Art
& Graffiti
can support
Biophilia
Credit: P Downton

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10

Appendices

10.1 Definitions of Biophilic Cities

Biophilic Cities: What are they? by Timothy Beatley

Source: http://biophiliccities.org/what-are-biophilic-cities/. Accessed 12 July 2016.

Biophilia is a term popularized by Harvard University myrmecologist and conservationist E.O. Wilson to describe the extent to which humans are hard-wired to need connection with nature and other forms of life.

More specifically, Wilson describes it this way: "*Biophilia…is the innately emotional affiliation of human beings to other living organisms. Innate means hereditary and hence part of ultimate human nature*" (Wilson, "Biophilia and the Conservation Ethic," in The Biophilia Hypothesis, 1993, p.31).

To Wilson biophilia is really a "*complex of learning rules*" developed over thousands of years of evolution and human-environment interaction.

Evidence of the emotional and psychological benefits of nature is mounting and impressive: research shows its ability to reduce stress, to aid recovery from illness, to enhance cognitive skills and academic performance, and to aid in moderating the effects of ADHD, autism and other childhood illnesses. Recent research suggests even that we are more generous in the presence of nature; all these values are in addition to the immense economic value of the ecological services provided by natural systems.

Support for the practice of biophilic design has been growing and there are now many exemplary examples of buildings that seek to integrate natural features and qualities. We recognize the need for biophilic workplaces, for healing gardens and spaces in hospitals, and for homes and apartments that provide abundant daylight, natural ventilation, plants and greenery. Less attention, however, has been focused on the city or urban scale, despite the fact that the planet continues an inexorable trend in the direction of urbanization. Urban residents need nature more than ever, and much work is needed to find creative and effective means for incorporating it into urban environments.

It is likely that the benefits of close contact with nature are deeper and even more profound than we realize, and the potential to make a difference by integrating nature directly into our lives, even greater. Nature ought not to be an afterthought, and ought not to only be viewed in terms of the (considerable to be sure) functional benefits typically provided (benefits of trees, green rooftops, wetlands for managing stormwater, for mediating air and water pollutants, for addressing urban heat island effects, and so on). The elements of a deeper concept of integrating nature into everyday living include recognition of some of the following:

Important Ties to Place. There are considerable place-strengthening benefits and place-commitments that derive from knowledge of local nature, including: direct personal contact, enhanced knowledge, deeper connections, greater stewardship, and willingness to take personal actions on behalf of place and home;

Connections and Connectedness. Caring for place and environment, essential for human wellbeing and in turn an essential ingredient in caring for each other;

A Need for Wonder and Awe in Our Lives. Nature has the potential to amaze us, stimulate us, and propel us to want to learn more and understand our world more fully; nature adds a kind of "wonder value" to our lives unlike almost anything else;

Meaningful Lives Require Nature. The qualities of wonder and fascination, the ability to nurture deep personal connection and involvement, and visceral engagement in something larger than and outside oneself, offer the potential for meaning in life few other things can provide.

Urbanists and city planners have special opportunities and unique obligations to advance biophilic city design, utilizing a variety of strategies and tools, applied on a number of geographical and governmental scales. The agenda is one that must extend beyond conventional urban parks, and beyond building-centric green design. It is about redefining the very essence of cities as places of wild and restorative nature, from rooftops to roadways to riverfronts. It is about understanding cities as places that already harbor much nature and places that can become, through bold vision and persistent practice, even greener and richer in the nature they contain.

What a biophilic city is or could be is an open question, and it is hoped that this website will help to stimulate discussion of this. As a tentative starting point I offer some of the following as key qualities of biophilic cities:

- Biophilic cities are cities of abundant nature in close proximity to large numbers of urbanites; biophilic cities are biodiverse cities, that value, protect and actively restore this biodiversity; biophilic cities are green and growing cities, organic and natureful;
- In biophilic cities, residents feel a deep affinity with the unique flora, fauna and fungi found there, and with the climate, topography, and other special qualities of place and environment that serve to define the urban home; in biophilic cities citizens can easily recognize common species of trees, flowers, insects and birds (and in turn care deeply about them);
- Biophilic cities are cities that provide abundant opportunities to be outside and to enjoy nature through strolling, hiking, bicycling, exploring; biophilic cities nudge us to spend more time amongst the trees, birds and sunlight.
- Biophilic cities are rich multisensory environments, where the sounds of nature (and other sensory experiences) are appreciated as much as the visual or ocular experience; biophilic cities celebrate natural forms, shapes, and materials;
- Biophilic cities place importance on education about nature and biodiversity, and on providing many and varied opportunities to learn about and directly experience nature; in biophilic cities there are many opportunities to join with others in learning about, enjoying, deeply connecting with, and helping to steward nature, whether though a nature club, organized hikes, camping in city parks, or volunteering for nature restoration projects;
- Biophilic cities invest in the social and physical infrastructure that helps to bring urbanites to closer connection and understanding of nature, whether through natural history museums, wildlife centers, school-based nature initiatives, or parks and recreation programs and projects, among many others;
- Biophilic cities are globally responsible cities that recognize the importance of actions to limit the impact of resource use on nature and biodiversity beyond their urban borders; biophilic cities take steps to actively support the conservation of global nature.

These are but a few of the ways a city might be seen as biophilic. What do you think? Are there other ways, and other important qualities or dimensions not listed above?

10.1.1 Metro Tunnel Project

This detailed review of contextual information only pertains to the MTP railway station complexes, and not to the overall project sites and associated sites.

The purpose of this detailed review is to contextually analyse instruments and documents that are relevant to Biophilic Design as may be applicable for the MTP proposed railway stations.

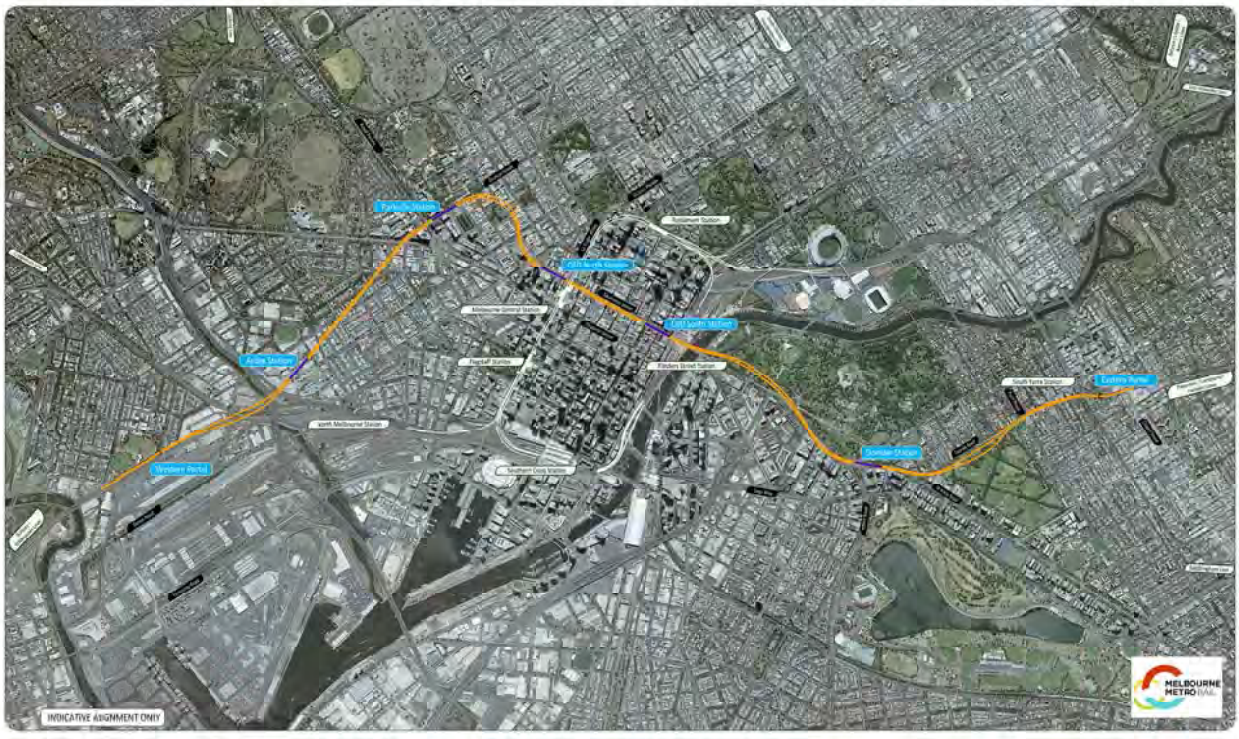

Figure 10.1 Source: http://metrotunnel.vic.gov.au/resources/maps

10.1.2 Australia

The following documents are relevant under this sub-section:

United Nations Conference on Environment and Development (UNCED)

10.1.2.1 United Nations Conference on Environment and Development

Thus, the aspects of efficiency in public transportation systems, use of alternative sources of energy, reducing congestion in cities" are integral to the MTP project.

The Earth Summit resulted in three key documents -- Rio Declaration on Environment and Development; Agenda 21; and Forest Principles -- of which the former two are applicable to the MTP project.

In terms of the Rio Declaration, more than 130 nations (including Australia) signed a Convention on Climate Change and a Convention on Biodiversity, whereby:

The ultimate objective of this convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant position provisions of

the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

Framework Convention on Climate Change, United Nations, A/AC.237/18 (PartII)/Add.1, 15 May 1992.

The delegates also reached agreement on Agenda 21, an action plan for developing the planet sustainably through the twenty-first century, and on a broad statement of principles for protecting forests. All nations present accepted without change the Rio Declaration, a non-binding statement of broad principles for environmental policy. New international networks, both formal and informal, were set up to carry out and oversee implementation of the agreements.

Agenda 21 is a 300-page document divided into 40 chapters that have been grouped into 4 sections:

Section I: Social and Economic Dimensions is directed toward combating poverty, especially in developing countries, changing consumption patterns, promoting health, achieving a more sustainable population, and sustainable settlement in decision making.

Section II: Conservation and Management of Resources for Development Includes atmospheric protection, combating deforestation, protecting fragile environments, conservation of biological diversity (biodiversity), control of pollution and the management of biotechnology, and radioactive wastes.

Section III: Strengthening the Role of Major Groups includes the roles of children and youth, women, NGOs, local authorities, business and industry, and workers; and strengthening the role of indigenous peoples, their communities, and farmers.

Section IV: Means of Implementation: implementation includes science, technology transfer, education, international institutions and financial mechanisms.

In terms of Biophilic Design, the intent of both the Rio Declaration and Agenda 21 are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

10.2 Victoria

The following documents are relevant under this sub-section:

Planning & Environment Act 1987

Heritage Victoria (2016), Assessment of Cultural Heritage Significance and Executive Director Recommendation To The Heritage Council: St Kilda Road

Heritage Victoria (2016), Assessment of Cultural Heritage Significance and Executive Director Recommendation To The Heritage Council: Fawkner Park

Heritage Victoria (2013), Decision of Council: Domain Parklands

1.3.1 Planning & Environment Act 1987

The objectives of planning in Victoria are articulated in Section 4(1) of the Planning & Environment Act 1987.

These objectives are:

To provide for the fair, orderly, economic and sustainable use and development of land.

To provide for the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity.

To secure a pleasant, efficient and safe working, living and recreational environment for all Victorians and visitors to Victoria.

To conserve and enhance those buildings, areas or other places which are of scientific, aesthetic, architectural or historical interest, or otherwise of special cultural value.

To protect public utilities and other assets and enable the orderly provision and coordination of public utilities and other facilities for the benefit of the community.

To facilitate development in accordance with the objectives set out in the points above.

To balance the present and future interests of all Victorians.

In terms of Biophilic Design, the objectives of "*the protection of natural and man-made resources and the maintenance of ecological processes and genetic diversity*" and to "*secure a pleasant, efficient and safe working, living and recreational environment"* are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

1.3.2 Heritage Victoria

Heritage Victoria has recently gazetted two inclusions to the Victorian Heritage Register under the Heritage Act 1995 [Section 32 (1)(a)], pertaining to St Kilda Road and Fawkner Park, that are pertinent to the Domain Station precinct.

The St Kilda Road gazettal includes:

The whole of the road known as St Kilda Road, being the road reserve extending from Princes Bridge, Melbourne in the north, to the intersection with Henry Street, Melbourne in the south. It includes the roadway, medians, garden beds, kerbing, plane trees (Platanus ×acerifolia) and elm trees (Ulmus procera), and footpaths. The Edmund Fitzgibbon Memorial, located in the south-eastern median at the intersection of St Kilda Road and Linlithgow Avenue is nominated as a feature. The nominated area abuts the Princes Bridge VHR extent (H1447), but does not include it. The nomination does not include properties abutting the road reserve.

The conclusion of Heritage Victoria for its inclusion is based upon a judgement that "St Kilda Road is of historical and aesthetic significance to the State of Victoria. It satisfies the following criterion for inclusion in the Victorian Heritage Register:

Criterion A: Importance to the course, or pattern, of Victoria's cultural history.

Criterion D: Importance in demonstrating the principal characteristics of a class of cultural places and objects.

Criterion E: Importance in exhibiting particular aesthetic characteristics.

Resulting in a recommendation that St Kilda Road be included as a Heritage Place in the Victorian Heritage Register under the Heritage Act 1995 [Section 32 (1)(a)].

The Fawkner Park gazettal includes:

The whole of the place known as Fawkner Park, being Crown Allotment 16B and Crown Allotment 2B at South Yarra, Parish of Melbourne South (Crown Land).

The conclusion of Heritage Victoria for its inclusion is based upon a judgement that "Fawkner Park is of historical, archaeological aesthetic significance to the State of Victoria. It satisfies the following criterion for inclusion in the Victorian Heritage Register:

Criterion A: Importance to the course, or pattern, of Victoria's cultural history.

Criterion C: Potential to yield information that will contribute to an understanding of Victoria's cultural history.

Criterion E: Importance in exhibiting particular aesthetic characteristics.

Resulting in a recommendation that Fawkner Park be included as a Heritage Place and Archaeological Place in the Victorian Heritage Register under the Heritage Act 1995 [Section 32 (1)(a)].

The Domain Parklands gazettal includes:

The Domain Parklands, Melbourne includes a number of reserves in the area bounded by St Kilda Road to the west, the Yarra River to the north, Anderson Street to the east and Domain Road to the south. These reserves include Alexandra Gardens, Alexandra Park, Queen Victoria Gardens, King's Domain North and King's Domain South.

On 18 May 2012, the Executive Director recommended that the place be included in the Register having regard to the following criterion:

Criterion A - Importance to the course, or pattern of Victoria's cultural history

Criterion B - Possession of uncommon, rare or endangered aspects of Victoria's cultural history

Criterion C - Potential to yield information that will contribute to an understanding of Victoria's cultural history

Criterion E - Importance in exhibiting particular aesthetic characteristics

Criterion G - Strong or special association with a particular community or cultural group for social, cultural or spiritual reasons. This includes the significance of a place to Indigenous peoples as part of their continuing and developing cultural traditions

Criterion H - Special association with the life or works of a person, or group of persons, of importance in Victoria's history

In terms of Biophilic Design, there is little substance in these registrations linked to Biophilic Design less in terms of memorial familiarisation of places and thus mental wayfinding.

10.3 Melbourne Metropolitan Region

The following documents are relevant under this sub-section:

- **Victoria (2002), Melbourne 2030 - Planning for sustainable growth. Melbourne: Government of Victoria.**
- **Melbourne City Council (2016), Resilient Melbourne: Viable Sustainable Liveable Prosperous Strategy. Melbourne: City of Melbourne Council.**

1.4.1 Melbourne 2030 - Planning for sustainable growth

Melbourne 2030 - Planning for sustainable growth (2002) was released by the State of Victoria in October 2002 as a 30 year plan to manage urban growth and development across metropolitan Melbourne.

The Vision of this plan articulates that

"in the next 30 years, Melbourne will grow by up to one million people and will consolidate its reputation as one of the most liveable, attractive and prosperous areas in the world for residents, business and visitors. Melbourne 2030 – planning for sustainable growth is a 30-year plan to manage growth and change across metropolitan Melbourne and the surrounding region. It emphasises the city's interdependence with regional Victoria, to provide maximum benefit to the whole State. The main thrust is to continue to protect the liveability of the established areas and to increasingly concentrate major change in strategic redevelopment sites."

Melbourne 2030 (2002) expresses this Vision through a set of Principles and nine Key Directions, Melbourne 2030 provides a framework for governments at all levels to respond to the diverse needs of those who live and work in and near to Melbourne, and those who visit. "The main thrust is to continue to protect the liveability of the established areas and to increasingly concentrate major change in strategic redevelopment sites." These Directions include:

1 A more compact city
2 Better management of metropolitan growth
3 Networks with the regional cities
4 A more prosperous city
5 A great place to be
6 A fairer city
7 A greener city
8 Better transport links
9 Better planning decisions, careful management

In terms of Directions 7 and 8, the following are the Policies:

	Policies
Direction 7: **A greener city**	• Ensure that water resources are managed in a sustainable way (Policy 7.1) • Reduce the amount of waste generated and encourage increased reuse and recycling of waste materials (Policy 7.2) • Contribute to national and international efforts to reduce energy usage and greenhouse gas emissions (Policy 7.3) • Reduce the impact of stormwater on bays and catchments (Policy 7.4) • Protect ground water and land resources (Policy 7.5) • Ensure that land-use and transport planning and infrastructure provision contribute to improved air quality (Policy 7.6) • Protect native habitat and areas of important biodiversity through appropriate land-use planning (Policy 7.7) • Promote the concept of sustainability and develop benchmarks to measure progress (Policy 7.8) • Lead by example in environmental management (Policy 7.9)
Direction 8: **Better transport links**	• Upgrade and develop the Principal Public Transport Network and local public transport • services to connect activity centres and link Melbourne to the regional cities (Policy 8.1) • Improve the operation of the existing public transport network with faster, more reliable and efficient on-road and rail public transport (Policy 8.2) • Plan urban development to make jobs and community services more accessible (Policy 8.3) • Coordinate development of all transport modes to provide a comprehensive transport system (Policy 8.4) • Manage the road system to achieve integration, choice and balance by developing an efficient and safe network and making the most of existing infrastructure (Policy 8.5) • Review transport practices, including design, construction and management, to reduce environmental impacts (Policy 8.6) • Give more priority to cycling and walking in planning urban development and in managing our road system and neighbourhoods (Policy 8.7) • Promote the use of sustainable personal transport options (Policy 8.8)

Figure 10.2

In terms of Biophilic Design, the Directions 7 and 8 of "*a greener city*" and "*better transport links*" are directly aligned and applicable to the execution of successful Biophilic Design outcomes.

1.4.2 Resilient Melbourne: Viable Sustainable Liveable Prosperous Strategy (2016)

In May 2016 the City of Melbourne Council released the Resilient Melbourne: Viable Sustainable Liveable Prosperous (2016) strategy is joint project of 32 metropolitan Melbourne councils, Melbourne's academic, business and community sectors, and the Victorian Government. The Vision of the strategy is to "In a resilient Melbourne, our diverse communities are viable, sustainable, liveable and prosperous" with the objectives of:

Stronger Together: Empower communities to take active responsibility for their own and each other's wellbeing, safety and health;

A Dynamic Economy: Provide diverse local employment opportunities that support an adaptable workforce that is ready for the jobs of the future.

Our Share Places: Create and sustain buildings, infrastructure and activities that promote social cohesion, equality of opportunity and health, and

A Healthier Environment: Enable strong natural assets and ecosystems alongside a growing population.

Key Actions are scaffolded around areas of Adapt, Survive, Thrive and Embed, of which the following are most pertinent to the MMRA Railway Stations:

Adapt: Flagship Action: Metropolitan urban forest strategy

Thrive: Local Aligned Action: Metro Tunnel Project

The Metropolitan urban forest strategy action seeks to "*Extend and link existing urban greening, reforestation and nature initiatives across Melbourne, to improve wellbeing and reduce our exposure to hazards such as heatwaves and flooding.*"

Primary Resilience Objective	Enable strong natural assets and ecosystems alongside a growing population
Related Objectives	Create and sustain buildings, infrastructure and activities that promote social cohesion, equality of opportunity, and health
Stresses	• Climate change • Development pressures on ecosystem services • Higher rates of chronic illness • Ageing population • Increasing pressure on healthcare services • Decreasing social equality • Lower rates of community participation
Shocks	• Flood • Heatwave • Drought • Marine pollution

Figure 10.3

Within the body of the Resilient Melbourne (2016) is a specific 'Aligned Local Action' that states:

Metro Tunnel Project

The Metro Tunnel will reduce the rail network's vulnerability to failure by providing entirely separate end-to-end lines from Sunbury in the west to Cranbourne-Pakenham in the south-east. Additionally, 39,000 more passengers will be able to reach and leave the central city during the morning and afternoon travel peaks. Greater capacity on the public transport network will reduce congestion across all modes of transport. The project will be equivalent to removing 18,000 cars from the city's roads during the busiest hours of the day, and will provide public transport users with an alternative to taking trams along Swanston Street, currently the city's busiest tram and pedestrian corridor.

In terms of Biophilic Design, the Objective of "*Our Share Places: Create and sustain buildings, infrastructure and activities that promote social cohesion, equality of opportunity and health links*" is directly aligned and applicable to the execution of successful Biophilic Design outcomes.

1.5 Melbourne Metro Rail Authority Assessments

The following documents are relevant under this sub-section:

AJM (2016), Aboriginal Cultural Heritage Impact Assessment.

AJM (2015), Adoption of Climate Change Scenarios and Projections Report.

AJM (2016), Aquatic Ecology and River Health Impact Assessment.

AJM (2016), Climate Change Adaptation Plan.

AJM (2016), Climate Change Adaptation Plan Reference Design Report.

AJM (2016), Climate Change Risk Assessment Report.

AJM (2016), Design for Climate Change Framework.

AJM (2016), Drainage and Flooding Reference Design Report.

AJM (2016), Public Realm Reference Design Report. Melbourne: AJM.

AJM (2016), Terrestrial Ecology Impact Assessment.

Aurecon (2016), Melbourne Metro Rail Project: Daylight Modelling Report.

Golder Associates (2016), Contaminated Land Assessment – EES Summary Report.

Golder Associates (2016), Regional Groundwater Numerical Modelling – EES Summary Report.

John Patrick Pty Ltd (2016), Arboricultural Impact Assessment Report: Melbourne Metro Rail Authority

Lovell Chen (2016), Predictive Archaeological Assessment: Prepared for AJM Joint Venture.

Lovell Chen (2016), Melbourne Metro Rail Project: Historical Heritage Impact Assessment.

MMRA (2016), EES Chapter 16 Landscape and Visual Technical Report.

Urbis (2016) Melbourne Metro Rail Project: Landscape and Visual Impact Assessment.

MMRA (2017), Metro Tunnel: Urban Design Strategy.

The above reports, summarised in the below discussion, have been mapped against the Biophilic Design patterns in terms of relevance, as follows:

	Narrative	Visual Connection with Nature	Non-Visual Connection with Nature	Non-Rhythmic Sensory Stimuli	Thermal & Airflow Variability	Presence of Water	Dynamic & Diffuse Light	Connection with Natural Systems	Biomorphic Forms & Patterns	Material Connection with Nature	Complexity & Order	Prospect	Refuge	Mystery	Risk/Peril	Virtual Connection with Nature
AJM (2016), Aboriginal Cultural Heritage Impact Assessment.	L							L								
AJM (2015), Adoption of Climate Change Scenarios and Projections Report.		L	L		L			L							M	M
AJM (2016), Aquatic Ecology and River Health Impact Assessment.						M										
AJM (2016), Climate Change Adaptation Plan		L	L		L			L							M	M
AJM (2016), Climate Change Adaptation Plan Reference Design Report.		L	L		L			L							M	M
AJM (2016), Climate Change Risk Assessment Report		L	L		L			L							M	M
AJM (2016), Design for Climate Change Framework.		L	L		L			L							M	M
AJM (2016), Drainage and Flooding Reference Design Report.						M									M	
AJM (2016), Public Realm Reference Design Report. Melbourne: AJM	L	L	L			L		L	L	L	L					
AJM (2016), Terrestrial Ecology Impact Assessment		L						L								
Aurecon (2016), Daylight Modelling Report.							M									
Golder Associates (2016), Contaminated Land Assessment				M				M								
Golder Associates (2016), Regional Groundwater Numerical Modelling						L									M	
John Patrick Pty Ltd (2016), Arboricultural Impact Assessment Report		M						M		M						
Lovell Chen (2016), Predictive Archaeological Assessment.	L															
Lovell Chen (2016), Historical Heritage Impact Assessment.	L							L								
MMRA (2016), EES Chapter 16 Landscape and Visual.																
Urbis (2016) Landscape and Visual Impact Assessment		H										M	M	M		
MMRA (2017), Metro Tunnel: Urban Design Strategy.	H										M	M	M	M	L	

Figure 10.4

These reports and assessments are considered in the following subsections.

1.5.1 Climate Change Assessments

Various climate change risk assessment evaluations, cited above, have been undertaken by the MMRA. The MMRA's Sustainability Policy (MMRA, 2015) specifies several requirements for the project in relation to climate change adaptation and resilience, including:

> Adaptation: identify and respond to climate change impacts by: undertaking a climate risk assessment considering direct and indirect risks; and identifying and implementing adaptation measures to address priority risks;
>
> Resilience: future-proofing of infrastructure against projected climate change impacts by providing resilient design and as-built outcomes.
>
> In addition several time periods have also been used to broadly consider the life cycle of different components of the MTP system:
>
> 2030: assets and systems with short operating lives, such as communications and other electronic systems and landscaping;
>
> 2050: assets and systems with long operating lives, such as rail tracks, power supply systems and flood pumps; and,
>
> 2090: "permanent" assets, which are fixed and on-going features of MMR for as long as it operates, such as: the rail tunnel, portals, station "boxes" and storm water drainage systems which are modified during the early works phase.

The Intergovernmental Panel on Climate Change (IPCC) concluded in its Fifth Assessment Report (2013) that evidence of climate change was unequivocal whereby the global climate system would continue to warm through the 21st Century in response to emissions of greenhouse gases resulting from human activity. Their conclusions are that:

> since the industrial revolution, atmospheric concentrations of greenhouse gases have risen from about 280 ppm to over 400 ppm;
>
> that the radiative forcing (warming) effect of greenhouse gases is considered to have almost certainly contributed to the observed increase in global mean temperature of 0.7°C from 1880; and
>
> that models of the global climate system project that this warming will accelerate through the 21st Century in response to anticipated increases in the atmospheric concentration of greenhouse gases,

and, as a consequence, this warming will affect atmospheric circulation patterns, hydrological cycles and sea levels (IPCC, 2013).

In terms of Melbourne, climate modelling has concluded that the climate of south-eastern Australia is likely to become:

Warmer: with increased average and extreme high temperatures, but fewer extreme cold temperatures;

Drier: rainfall is projected to decline, particularly during winter and spring. Reduced annual rainfall and increased evaporation is anticipated to result in drier soil conditions, less run-off in water supply catchments and reduced average river flows and groundwater recharge;

Subject to more extreme weather conditions: hydrological cycles are projected to intensify, leading to more intense extreme rainfall events and river flooding. Heatwaves will become more frequent, intense and prolonged.

Sea levels are also projected to continue to rise in response to warming of the oceans and the melting of continental ice sheets.

The MTP *"is exposed to risks arising from extreme weather and climatic variability. Drought conditions, fluctuations in groundwater levels, extreme rainfall events, river and storm water flooding, heatwaves and other extreme high temperature events all have potential to disrupt MTP operations, damage components, endanger users and staff, as well as detract from passenger experience. Climate change is anticipated to worsen risks posed by extreme weather and climate variability. The impact of events may be exacerbated and their likelihood may increase.*"

A summative evaluation of the Climate Change risks as it pertains to the Stations is drawn from a Table that summarises the "Highest Overall Risk Ratings for Risks to MTP Resulting from Climate Change":

Area	Climate Risk Cause	Risk / Hazard Description	Life of Asset	Likeli-hood	Max Con-sequence	Risk	Residual Risk
All stations	Cycles of drought and rain leading to changes in groundwater levels.	Soil and ground instability due to cycles of elevated and lowering groundwater.	>50	3	4	H	L
CBD South Station	Storm water flood events in vicinity of station.	Egress from station unsafe due to flooding.	>50	4	3	H	M
All stations	Increased atmospheric concentrations of CO2.	Carbonation induced corrosion of concrete.	>50	3	4	H	L
All stations	Heatwave event leads to poor cooling system performance.	Temperatures in concourse area and on platforms are	>50	4	3	H	M

Figure 10.5. MMRA (2016), Climate Change Risk Assessment Report, from Table 3-2, pages 9-10.

In terms of Biophilic Design, there are evident warnings in these conclusions to better insulate and mediate the impacts of heat, drought, erratic weather patterns, and variable water tables upon the station areas, their designs and the spaces created to

accommodate humans and biodiversity.

1.5.2 Aboriginal Cultural Heritage Impact Assessment

The Aboriginal Cultural Heritage Impact Assessment sought to provide an understanding of the Aboriginal cultural heritage present within the Metro Tunnel study area and to identify potential risk, as it relates to Aboriginal cultural heritage.

The appraisal included a desktop assessment and of the Victorian Aboriginal Heritage Register (VAHR), contextual review of the bio- geography of the region, a documentation review, use of a predictive model to identify Aboriginal Place types within the geographic region, and consultation with a range of stakeholders, including Bunurong Land and Sea Association, Bunurong Land Council, Boon Wurrung Foundation, Office of Aboriginal Affairs Victoria and Wurundjeri Tribe Land and Compensation Cultural Heritage Council Incorporated.

Aboriginal cultural heritage risk appraisals of the station sites can be summarised as follows:

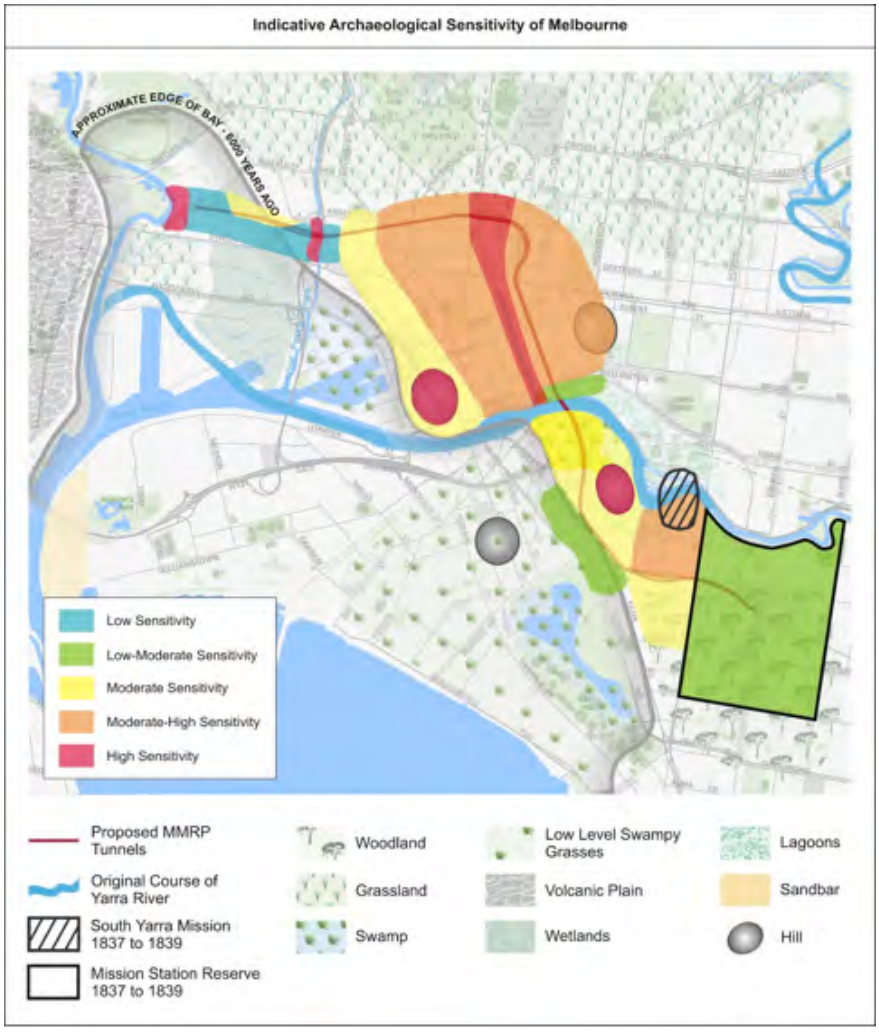

Figure 10.6. MMRA (2016), Aboriginal Cultural Heritage Impact Assessment, page 24, comprising "Figure 5 2 Indicative map of archaeological zones of sensitivity across the study area

(Note: this map does not account for SGD, which is to be reviewed during the CHMP)."

Station area:	Risk Assessment Summation
Domain Station	As the Domain TBM launch site has been previously subject to earth moving works, this area has been assessed as being of very low Aboriginal archaeological potential and no further assessment is required. Works would have the potential to adversely impact on unknown Aboriginal cultural heritage values within the construction work site located at Edmund Herring Oval, if excavation works occur within natural soil deposits. The presence of Aboriginal cultural material is largely dependent upon the extent of disturbance from past construction activities, such as the tramway along St Kilda Road. The CHMP would provide management measures and contingences in the event that previously unknown items of Aboriginal cultural heritage are uncovered during project works within this precinct.
CBD South Station	As the City Square has been previously assessed as having no historical archaeological potential (due to a car park being located below), this area is evaluated as having a very low Aboriginal archaeological potential. Federation Square is located above railway lines and is not within a natural ground surface. As such, no further investigations for these areas are required. Works would have the potential to adversely impact on unknown Aboriginal cultural heritage values within the Swanston Street construction work site, should excavation works within natural soil deposits occur. Should historical archaeological excavations occur within this precinct, contingency plans within the CHMP would be developed for the discovery of Aboriginal cultural heritage material.
CBD North Station	As Franklin and A'Beckett Streets have been previously assessed as having no historical archaeological potential, this area is evaluated as having low Aboriginal archaeological potential. Therefore no further investigation into this area is required. Works would have the potential to adversely impact on unknown Aboriginal cultural heritage values within the construction work sites located on the corner of Swanston Street and La Trobe Street, and at A'Beckett Street, if excavation works take place within natural soil deposits. Should historical archaeological excavations occur within this precinct, contingency plans within the CHMP would be developed for the discovery of Aboriginal cultural heritage material.
Parkville Station	As University Square is the site of an underground car park, this area is assessed as having no Aboriginal archaeological potential. Grattan Street, Barry Street and Royal Parade have been previously subject to earth moving works, and these areas have been assessed as having very low Aboriginal archaeological sensitivity. There is potential for works to impact upon Aboriginal cultural heritage values within the City Ford car yard, if natural soil deposits occur, as this area has not undergone extensive redevelopment. However, no ground surface disturbance is expected at this site. Should historical archaeological excavations occur within this precinct, contingency plans within the CHMP would be developed for the discovery of Aboriginal cultural heritage material.
Arden Station	The Arden station precinct traverses areas of moderate-high Aboriginal archaeological sensitivity. However, the archaeological potential is low due to the previous ground disturbing activities that have taken place at the precinct. In addition, the Arden station precinct is located within former swamplands. The proposed substation locations are considered to be in areas of low archaeological potential due to the land use alterations that have taken place since non-Aboriginal occupation and no further assessment is required.

Figure 10.7. MMRA (2016), Aboriginal Cultural Heritage Impact Assessment, pages 41, 43, 47, 50, 53.

The Aboriginal Cultural Heritage Impact Assessment (2016: 62) concludes that "*based on the information collected in this report, the residual risk to Aboriginal cultural heritage values is considered to be low after following implementation of the recommended Environmental Performance Requirement.*"

In terms of Biophilic Design, there is little pertinence in the appraisals and recommendations, less clues that the bio-geography of the landscape pre-contact offers ecological and ethnobotanical resources and properties that could be scaffolded into the patterns.

1.5.3 Predictive Archaeological Assessment

The Predictive Archaeological Assessment (2016) sought to review archaeological sites included on the Victorian Heritage Inventory (VHI) and to assess the potential for additional previously unmapped post-settlement (ie, non-Indigenous) sites at these locations.

The focus of this investigation was on areas within each precinct where there is the potential for archaeology which will be affected by the proposed works. The areas investigated included identified archaeological sites on the VHI, and sites which have not previously been identified. Areas were removed from consideration for archaeological potential where significant ground disturbance had previously taken place, including in the form of building basements or below ground car parks. No additional research was undertaken on HI sites where works are proposed to be at such a depth that impact on archaeological sites is unlikely.

A summary of the conclusions and recommendations of this predictive risk assessment include:

Station areas	Abstracted conclusions and recommendations:
Domain Station	There are two VHI sites within the Domain station precinct – Former St Kilda Road Tram Engine House Track Precinct (H7822-2220) and the associated Engine House (H7822-2246). Additionally consideration is made of areas within the Domain station precinct for the physical potential for archaeological remains – the corner of St Kilda Road and Domain Road (within the Shrine of Remembrance Reserve) and the St Kilda Road road reserve. There is no archaeological potential at the Grange site, therefore no further recommendations for further assessment or management. The St Kilda Road road reserve archaeological area was recommended for inclusion and subsequently included in the VHI for its archaeological values (H7822-2341). As such the site must be managed and protected during construction (Figure 35). The St Kilda Road road reserve is potentially subject to impacts from the proposed works, therefore the preparation of an archaeological management plan is required to manage and mitigate impacts. Likewise, an archaeological management plan is required for the St Kilda Road Tram Engine House and Track Precinct.

Station areas	Abstracted conclusions and recommendations:
CBD South Station	Previous predictive archaeological investigations of the central city in the Melbourne Central Activities District: Archaeological Management Plan (Fels et al., 1992) are reflected in the VHI sites in this location and show the CBD South station precinct to be an area of very high potential for historical archaeology. There are 34 VHI sites within the CBD South station precinct. In addition to the identified sites, the Fels archaeological management plan references the potential presence of early service infrastructure in the central city and recommended further work be completed on the identification of related structures and features. Extensive services infrastructure is known to exist below Swanston Street including a telecommunications tunnel, and this will require investigation. Of relevance it is noted that recent tramways works in Collins Street uncovered a late nineteenth/early twentieth century brick sewer pit. As all eight VHI sites are subject to impacts from the proposed works, the preparation of an archaeological management plan is required to manage and mitigate impacts. The archaeological management plans will be prepared in accordance with Guidelines for Investigating Historical Archaeological Artefacts and Sites (Heritage Victoria 2014) and in consultation with Heritage Victoria.
CBD North Station	Previous predictive archaeological investigations of the central city in the Melbourne Central Activities District: Archaeological Management Plan (Fels et al., 1992) are reflected in the VHI sites in this location and show the CBD North Station precinct to be an area of very high potential for historical archaeology. There are 29 VHI sites within the CBD North station precinct. Of these, only four will be subject to project works as they are situated within the construction site on the corner of Swanston Street and La Trobe Street, and the alternative construction site option at 22-44 A'Beckett Street. The four sites are identified for their archaeological potential in Fels et al. (1992), and their history from various documentary sources (presented in Table 2). As all four VHI sites are potentially subject to impacts from the proposed works, the preparation of an archaeological management plan is required to manage and mitigate impacts. The archaeological management plans will be prepared in accordance with Guidelines for Investigating Historical Archaeological Artefacts and Sites (Heritage Victoria 2014) and in consultation with Heritage Victoria.
Parkville Station	While there are no VHI sites located within the Parkville station precinct, consideration has been given to the potential for archaeological sites that are not included in the VHI and have not been previously identified to be affected by works within the Parkville station precinct. The City Ford archaeological area was recommended for inclusion and subsequently included in the VHI for its archaeological values (H7822-2340). As such the site must be managed and protected during construction. City Ford archaeological area is potentially subject to impacts from the proposed works, therefore the preparation of an archaeological management plan is required to manage and mitigate impacts.
Arden Station	While there are no VHI sites within the Arden station precinct, consideration has been given to the potential for archaeological sites that are not included in the VHI and have not been previously identified to be affected by works within the Tunnel precinct. The brick stormwater drain was recommended for inclusion in the VHI. It was found not to merit inclusion on the VHI, as such no further management or mitigation of archaeological impacts is required.

Figure 10.8. Lovell Chen (2016) pages 12, 17, 18, 25, 26, 28-29, 31, 39, 40, 45.

In terms of Biophilic Design, there is little pertinence in the appraisals and recommendations, less clues that excavations may identify archaeological evidence of old underground service infrastructure.

1.5.3 Historical Heritage Impact Assessment

This report provides an assessment of the historical cultural heritage issues and impacts of the Metro Tunnel Project (MTP). These include potential physical and visual impacts on heritage places or objects from the construction works and permanent infrastructure associated with Metro Tunnel.

The approach of the study was to identify all heritage places that are subject to statutory heritage controls under Australian or Victorian legislation as follows: Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth), Heritage Act 1995 (Victoria), and Planning and Environment Act 1987 (Victoria), consider all relevant heritage conservation studies and assessments and management plans, review the documentation on site, and undertaken a consultation with relevant stakeholders.

The following is a summation of the post-contact cultural heritage risks:

Station Areas	Risk Assessment
Arden Station	At the Arden station precinct there would be some impacts on industrial/ infrastructure sites that are proposed for local HO controls under a proposed planning scheme amendment. There would be an adverse impact associated with the demolition of the railways workshops buildings at 173-189 Laurens Street, North Melbourne. A small brick pumping station in Langford Street in North Melbourne, which forms part of a proposed HO precinct, could also be demolished for the proposed new substation, though retention of this structure may be possible. Recording requirements would apply in the case of the buildings to be demolished and it is recommended that an interpretation plan be developed for the railways workshops site in Laurens Street
Parkville Station	The Parkville station site abuts several VHR registered places including Royal Parade and three University of Melbourne sites; the Vice-Chancellor's House, Main Entrance Gates, Pillar and Fence and Gatekeeper's Cottage, all located on the north side of Grattan Street. Impacts on all three University sites would be limited and relate to the proximity of the structures to works. These could be managed or mitigated. There would be no significant impacts in the VHR registered Royal Parade associated with the construction of the station itself, which would be within Grattan Street, but there would be tree losses associated with the proposed new tram stop in Royal Parade and consequent changes to road functional layouts. Mitigation measures include the re-establishment of the boulevard character through tree replanting
CBD North Station	There would be few direct impacts on heritage places associated with works in this precinct. There would be a visual impact associated with new above ground structures in proximity to the City Baths, however this could be mitigated through care in detailed design. While a project-wide issue, it is noted that works are proposed in close proximity to numerous heritage buildings in this precinct and risks associated with construction vibration and ground settlement would need to be addressed. The management of historical archaeology is also a key issue in the central city and the development of archaeological management plans would be required, specifying activities such as testing, excavation and monitoring
CBD South Station	
Victorian Heritage Register- registered places	This area is highly sensitive in heritage terms and has a concentration of heritage sites and buildings, many of State significance and included in the VHR. Of these, the only one that would be directly affected by the works is Flinders Street Station where a direct connection from the CBD South station is proposed. This connection would require the removal of some significant fabric but with care in detailed design the adverse impact on heritage values would be a modest one.

Station Areas	Risk Assessment
Heritage Overlay precincts	The works include the demolition of some relatively low graded buildings in the Flinders Gate Precinct (HO505). Of these, the Port Phillip Arcade (224-226 Flinders Street) is of some individual heritage significance in its own right and recommendations are made for its interpretation as part of the redevelopment of the site for the new station. The retention of the facade to one building (65 Swanston Street) is recommended however the other buildings proposed for demolition make a minor contribution to the HO precinct. While not mitigating the loss, all would be recorded prior to demolition.
Historical archaeology	As noted above, the management of historical archaeology is a key issue in the central city and this is particularly so in the case of CBD South Station precinct, where evidence of Melbourne's earliest post-contact history may be uncovered. As for CBD North station the management of historical archaeology is also a key issue in the central city and the development of archaeological management plans would be required, specifying activities such as testing, excavation and monitoring
Domain Station	Located in St Kilda Road, Domain station is located at the edge of the VHR-registered Shrine of Remembrance and also intersects with the VHR-registered South African Soldiers Memorial on the triangular reserve at St Kilda and Albert roads. New entries are proposed on both these sites. In the case of the Shrine, as part of mitigation, a low- key design approach would be required to minimise the physical impacts and visual presence of the entry and ensure no adverse impact on the place as a whole. The co-location of the station entry with the South African Soldiers Memorial presents a more significant challenge in terms of the establishment of an appropriate setting for the memorial if located on this site. An improved outcome may be achieved through reconfiguration and enlargement of the reserve to accommodate the relocated memorial. There would also be significant construction impacts in this location and these would include tree removal and other works. These impacts are concentrated within the St Kilda Road road reserve and on the South African Soldier's Memorial site at St Kilda and Albert Road road reserves and on the South African Soldier's Memorial site at St Kilda and Albert roads, with little adverse impact in the Shrine Reserve or the VHR-registered Domain Parklands (where a construction site is proposed on the Edmund Herring Oval). St Kilda Road is not currently subject to statutory heritage controls but even in the absence of these, is considered to be on state historical and aesthetic significance. Mitigation measures for St Kilda Road would include the reinstatement for boulevard treatment and provision for replanting trees.

Figure 10.9: Heritage Impact Assessments.

In terms of Biophilic Design, there is strong pertinence in the appraisals and recommendations as it relates to the appearance, character, physical and mental engagement with the station users and care should be taken to delimit loss of built form and natural form elements, visual attributes, landscape and built form characteristics and qualities.

1.5.5 Arboricultural Impact Assessment

The Arboricultural Impact Assessment (2016) provides an evaluation of potential impacts to trees associated with the construction and operation of the MTP including trees managed by the City of Melbourne and the City of Port Phillip, the University of Melbourne as well as other trees located within publicly owned (VicTrack) land at Arden. The Metro Tunnel alignment and associated infrastructure potentially interacts with trees at locations where works at, or close to, ground level would occur,

including proposed stations, emergency access shafts and construction work sites.

The report identified:

Station Area	Risk Assessment:
Arden Station	some 5 trees will require removal from the public realm with an additional 116 individual specimens or tree groups requiring removal from the publicly owned (VicTrack) land, that are predominantly groups of naturalised desert ash (Fraxinus angustifolia);
Parkville Station	construction of the station box and associated entries would require the removal of 22 trees in the immediate station site, and removal of 10 elms (Ulmus ssp) in Royal Parade. In addition, 39 trees would be removed from the southern boundary of the University of Melbourne and an additional 73 medium and long-term viability trees would be removed from the northern end of University Square above the underground car park and in the Barry Street road reserve recognising that the plantings within University Square are modestly scaled and many have generally performed poorly;
CBD North Station	up to 6 medium and long-term viability trees may require removal for access and an additional 40 trees will require removal for the construction areas, including 18 medium and long-term viability trees;
CBD South Station	all trees within the City Square, 19 in total with 16 medium and long-term viability trees, would require removal for the construction area, with a limited number of plane (Platanus ssp.) trees from Swanston Street requiring a total of 24 trees to be removed from this site;
Domain Station	a total of 223 trees would potentially require removal, with 134 identified as medium and long-term viability trees, along St Kilda Road as well as associated removals from the Albert Road Reserve resulting in a significant impact on this section of St Kilda Road, creating a large, albeit temporary gap, in a prominent Melbourne boulevard.

Figure 10.10: Arboricultural Risk Assessment. John Patrick (2016: vi-vii).

The report concluded that given that the "*majority of the project is proposed to be located underground*", this would limit the number of trees that would need to be removed. Therefore the "*primary opportunities in these and other areas where trees would be removed to facilitate work would be to replant in accordance with the City of Melbourne's Urban Forest Strategy (2013), the City of Port Phillip Greening Port Phillip and the requirements of any relevant cultural heritage conservation management plan*" (John Patrick 2016: ix).

In terms of Biophilic Design, the assessment offers an insight as to the extent of tree vegetation removal only that will occur as a consequence of the railway station construction and allied works.

1.5.3 Drainage and Flooding

The Drainage and Flooding Reference Design Report (2016) investigated drainage Infrastructure for, inter alia, for the tunnels and stations, and flooding impact to the tunnels. The engineering design, accordingly, assumes that tunnel drainage "*is designed primarily to remove flows from the tunnel and stations caused by operation of the fire hydrants, with a secondary function of removing any ground water seepage that may occur*". Such is predicated on the assumptions that:

> "The flow rate of firewater being collected by the drainage sumps is assumed to be true for a controlled fire event only"; and
>
> "The drainage system is only concerned with the collection and pumping of groundwater and firewater before discharging to the drainage system, [and accordingly] there is no provision for the collection and handling of wastewater from toilets or other station services.

In addition, a preliminary flood assessment was undertaken to determine the likelihood of floodwaters entering tunnels through the tunnel portal locations, stations portals and egress shafts as a result of either local catchment hydrology flood events or from backwater inundation from mainstream flooding of nearby watercourses. The following table summarises the results of this assessment:

Station Area:	Local Catchment Hydrology	Likelihood Of Flooding
Arden Station	At low point in catchment, extremely prone to flooding	Certain for existing conditions. Station is to be located in general development area where land levels will be raised to prevent flooding.
Parkville Station	Site located approximately in the middle of catchment slope, but with large drains in the area	Unlikely
CBD North Station	Site located approximately in the middle of catchment slope.	Unlikely
CBD South Station	Site located towards bottom of catchment.	Potential – Street flooding occurs at junction of Swanston Street and Flinders Street.
Domain Station	Site located approximately in the middle of catchment slope.	Unlikely – there is a low spot at the centre of the station box, but this will not affect the station entrances

Figure 10.11. MMRA (2016), Drainage and Flooding Reference Design Report, Table 7-2, page 33.

In terms of Biophilic Design, the assessment offers little applicability and the disappointment is that no capacity in the station designs has been made available for water harvesting and storage that would have aided and supported biophilic design initiatives.

1.5.5 Aquatic Ecology and River Health Assessment

The Aquatic Ecology and River Health Assessment (2016) provides an assessment of the potential impacts on water quality, stream health and aquatic biodiversity in waterways from activities associated with construction and operation. The focus for the assessment was upon the natural and man-made waterways that lie within the tunnels alignment or that could be impacted by stormwater runoff from associated construction and operational activities.

Relevant major waterways, relevant to the railway stations, in the study area include:

Moonee Ponds Creek, under which the tunnels would run and which is approximately 100 m from the Arden station

Yarra River, under which the tunnels would run, is approximately 120 m from the CBD South station, and could also potentially receive runoff via the stormwater system from the eastern portal at South Yarra

Albert Park Lake, which could potentially receive runoff via the stormwater system from the Domain station

The impact assessment considered the nature of risks and the potential for these risks to result in an impact on waterway water quality and aquatic flora and fauna.

The following Table summarises the relationships between precinct and relevant receiving waterway:

Precinct	Yarra River	Moonee Ponds Creek	Maribyrnong River	Albert Park Lake
3 - Arden station (including substation)		X		
4 - Parkville station		X		
5 - CBD North station	X			
6 - CBD South station	X			
7 - Domain station	X			X

Figure 10.12: MMRA (2016), Aquatic Ecology and River Health Assessment, page 5.

The following Table summarises the aquatic ecology and river health conclusions, as it relates to the stations only:

Station areas:	Risk Assessment conclusions::
Arden Station	No benefits or opportunities associated with the Concept Design or alternative design option have been identified for the precinct in relation to aquatic ecology or water quality.
Parkville Station	No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.
CBD North Station	No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.
CBD South Station	No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.
Domain Station	No benefits or opportunities associated with the Concept Design have been identified for the precinct in relation to aquatic ecology or water quality.

Figure 10.13: MMRA (2016), Aquatic Ecology and River Health Assessment, pages 48-51.

In terms of Biophilic Design, the assessment offers little applicability.

1.5.6 Terrestrial Ecology Impact Assessment

The Terrestrial Ecology Impact Assessment (2016) report provides an assessment of the potential impacts on terrestrial flora and fauna and relevant environmental management requirements associated with the construction and operation of the MTP. These include potential threatened species issues and other impacts to matters listed under relevant state and federal environmental legislation, including the loss of vegetation.

Key risks identified included: Impacts on healthy mature trees, both indigenous and exotic, and Impacts relating to the removal of native vegetation and threatened species habitat, with a conclusion drawn that mitigation measures, generally associated with avoiding natural assets, could be implemented to reduce all risks to low.

The report identified:

Station areas:	Risk Assessment:
Arden Station	removal of 10 indigenous and removal of 6 non-indigenous trees would occur at the Arden station site with a low risk impact to the terrestrial ecology
Parkville Station	no impact on terrestrial flora and fauna given the lack of relevant vegetation/habitat in the area at the Parkville station site with no risk impact to the terrestrial ecology;
CBD North Station	removal of no indigenous vegetation and removal of 8 non-indigenous at the CBD North station site with a low risk impact to the terrestrial ecology;
CBD South Station	removal of no indigenous vegetation and removal of 8 non-indigenous at the CBD South station site with a low risk impact to the terrestrial ecology;
Domain Station	removal of 10 indigenous and removal of 8 non-indigenous trees would occur at the Domain station site with potential impacts upon the area being used for seasonal or foraging habitat for some threatened bird species, including the Grey Goshawk, Powerful Owl and Swift Parrot, but is not considered critical habitat given the availability of similar trees in the wider area, with a low risk impact to the terrestrial ecology.

Figure 10.14. AJM (2016: v-vi)

The report concluded that "*the Concept Design would avoid the majority of terrestrial flora and fauna issues"* and that impacts, particularly to individual scattered trees … would be offset accordingly. Revegetation opportunities would help improve the overall biodiversity values in the study area through suitable landscaping and legacy plantings" (AJM 2016: vii).

In terms of Biophilic Design, the assessment is only concerned with the connection between endangered species (principally avifaunal) and tree loss, and does not concern itself with common native and introduced fauna and avifaunal that are present and will likely continue to be present in and at the railway station sites.

1.5.7 Daylight Modelling Report

The Daylight Modelling Report (2016) sought to assess the simulated performance of the train stations against the Green Building Council of Australia 'Green Star' daylighting criteria for train stations. It specifically focuses on the criteria 'IEQ credit 16.1 Daylight' that aims to encourage and recognise designs that have good levels of natural light. The station platforms have been excluded from this study due to their depth underground and having no access to natural daylight.

In order to obtain 2 Green Star credit points for daylighting, at least 20% of the entry and concourse must have a daylight factor of >2.0%, as measured at finished floor level.

Findings of this investigation for the station entry portals are:

Station	Area of entry (m^2)	Area with DF>2% (m^2)	%	Green Star threshold	Pass / Fail
Arden	-	External	100	20%	Pass
Domain	-	External	100	20%	Pass
Parkville	450	315	>70%	20%	Pass
CBD South	4532	869	19%	20%	Fail
CBD North	260	<26	<1%	20%	Fail

Figure 10.15

Findings of this investigation for the station concourses are:

Station	Area of Concourse (m^2)	Area with DF>2% (m^2)	%	Green Star threshold	Pass / Fail
Arden	2900	261	9	20%	Fail
Domain	2750	550	20	20%	Pass
Parkville	3550	639	18	20%	Fail
CBD South	4745	<47	<1%	20%	Fail
CBD North	5843	69	1%	20%	Fail

Figure 10.16

In terms of Biophilic Design, there considerable importance in maximising natural daylight into the station platforms, concourses and associated spaces to aid both human and vegetation access to this resource.

1.5.6 Urban Design

The Urban Design Strategy (2017: 3) and associated Public Realm Reference Design Report (2016) seek to provide urban design guidance relating to the design, procurement and implementation of the Metro Tunnel, and in particular:

> State the broad urban design expectations for Metro Tunnel.
>
> Ensure that the project's landscape and visual impacts are addressed in a way that maximises the project's positive contribution to Melbourne.
>
> Set out design guidelines that, along with further detailed content, will inform the technical specifications for the project's procurement phase.
>
> Identify areas of concern to be assessed through an expert peer review process during the development and finalisation of designs for the project.

The vision of the Urban Design Strategy (2017: iv) recognises that:

A legacy of outstanding rail stations and associated public spaces that put people first, contribute to Melbourne's reputation for design excellence, and deliver an overall substantial benefit in terms of urban quality for Melbourne, for the transport network, and for local areas influenced by the project.

This Urban Design Strategy (2017) addresses the finished built form and use of the project and associated spaces, and not temporary works to be undertaken as part of the project construction process. The focus of the Strategy (2016: 3) is upon *"the design of public streets and spaces at ground level and the relationships of the Metro Tunnel infrastructure and other development with those spaces, rather than on underground station design, or on potential commercial redevelopment of properties above or adjoining the metro infrastructure."*

Central to the Urban Design Strategy (2017: 18-19) is the following Aims, Objectives and Design Guidelines, set out in the following table. A more detailed layer of design guidelines are tabled elsewhere in this report

Aims	Objectives	Design Guidelines
The MTP stations will be well connected to the surrounding city to maximise its value in provision for access and movement.	1. Ensure that the stations are easy to access for all people and that they are well connected to the surrounding precinct. 2. Improve provision for movement through the city, giving priority to sustainable transport modes that complement the Metro Tunnel. 3. Improve inter-modal transport connectivity. 4. Provide streets and other access ways that function well for their allocated transport modes and that are also comfortable, engaging and safe places for complementary activities.	1. Station precinct environments must support safe and predictable movements that are prioritised along the following transport hierarchy: -- active transport — pedestrian and cycling, including people entering the station as well as passing the station entrances -- sustainable transport — train, tram, bus and coach -- emergency and short-term vehicles — emergency vehicles, service vehicles, commercial / private transport, taxi ranks, kiss and ride -- private transport — disabled-access car parking, staff and maintenance car parking, park and ride car parking. 2. Provide for integration of all transport modes in line with the modal hierarchy above: -- Integrate station entrances with the wider pedestrian network. -- Ensure clear visual and physical connections to nearby bus, tram and taxi stops and kiss-and-ride facilities. -- Provide bicycle parking as appropriate. 3. Minimise conflicts between transport modes and intersecting routes of travel: -- Design station entries with adequate space for people to transition from stairs, escalators and lifts to travel routes along the ground surface so that congestion in surrounding thoroughfares is minimised and appropriately managed. -- Define pathways and promote awareness of crossing transport modes, e.g. using changes in surface treatments and other visual cues. -- Ensure that aboveground station infrastructure does not create unnecessary barriers or obstructions to pedestrian or cycle flows in the streets. -- Integrate balustrades and other required barriers and safety devices into the overall precinct design.

Aims	Objectives	Design Guidelines
		4. Support ease of wayfinding: -- Create well-structured paths and clear sightlines so that wayfinding is intuitive and reliance on directional signage is minimised. -- Ensure that paths of travel to and from station entries that are not directly connected to main streets are easy to identify and follow. -- Design stations to capitalise on view lines to existing local landmarks and spaces that will assist with orientation. -- Create new visual markers and treatments that will assist with orientation and recognition of specific locations. -- Provide clear, consistent and easy-to-follow directional signage, responding to the particular local requirements and nearby destinations. -- Establish appropriate links between directional signage provided as part of Metro Tunnel and directional signage used in surrounding precincts. 5. Create and improve strategic walking and cycling routes that connect the stations into surrounding areas: -- Create opportunities for public pedestrian links through non-ticketed areas of station buildings to provide safe crossings of major streets. -- Create convenient and safe alignments of footpaths and walking routes that facilitate access to the stations and to other destinations in the precinct. -- Consider the needs of future growth, long-term development patterns, and changes to demand.
		-- Provide generous path widths, safe and accessible slopes and cross-falls, and the placement of features to maintain clear circulation space, with priority generally given to circulation areas along the building line. -- Design of crossings and Shared Zones (where pedestrians, cyclists and motorised traffic share the same road space) to ensure safety and prioritisation according to the modal hierarchy. -- Provide bike paths, shared paths and on-street bike lanes, with widths and treatments that maximise safety and allow for future growth in demand. 6. Provide universal access throughout public spaces and stations, with intuitive paths of travel for people with visual impairments, accessible grades along paths, and appropriate use of ramps, kerb ramps, and tactile paving. 7. Provide for vehicular traffic lanes as appropriate, with consideration of lane widths, kerb radials at corners and intersections to suit swept paths, and appropriate levels, slopes and cross-falls. 8. Provide for vehicle parking, as appropriate, with consideration of locations and arrangements, management systems (ticket machines etc.) and motorcycle parking.

Figure 10.17: Urban Design Guidlines.

In terms of Biophilic Design, this carefully conceived Urban Design Strategy (2017) that is closely aligned to Biophilic Design patterns and outcomes, offers a set of Aims, Objectives and Design Guidelines in which to scaffold a comparable set of aims, objectives and guidelines to permit both documents to synergistically work together to aid designers and tenderers.

1.5.7 Landscape and Visual.

Chapter 16 of the EES addresses Landscape and Visual considerations provides an assessment of the landscape and visual qualities and impacts associated with the construction and operation of Metro Tunnel.

Attempting to identify the quality of the existing landscape and visual settings, the chapter sought to identify sensitive viewing locations, assess the visual modification to existing settings that would occur as a result of the project, assess the visual sensitivity of viewers to the level of visual modification, and thereupon proposed landscape mediation measures aligned with the Urban Design Strategy (2017) to delimit the potential loss of landscape character.

Proposed Stations	Existing Landscape and Visual Qualities
Domain Station	The Domain station precinct is located at the interface between the St Kilda Road commercial and residential precinct and the Domain Parklands. The precinct is characterised by wide streets that provide views, particularly along the tree-lined St Kilda Road. Of note in this area is the Shrine of Remembrance, which is located on higher ground to the east of St Kilda Road within the Domain Parklands. Fawkner Park to the east and Albert Park to the west are some of Melbourne's most significant green spaces. The Albert Road Reserve is surrounded by mature elm trees, contains the South African Soldiers Memorial and provides open space and shade that attracts workers from nearby office buildings during lunch time. In recent years, major developments have taken place in the Albert Road area which now contains a dense mix of residential and commercial multi-storey buildings. The wide boulevards, particularly the Victorian Heritage Register listed Royal Parade (with its double avenue of mature elm trees planted in the verge and median strips), also make an important contribution to the visual amenity of the area. Views south along Royal Parade to the Haymarket roundabout create a significant northern gateway to Melbourne's CBD.
CBD South Station & CBD North Station	The CBD North and South station precincts are located at either end of Swanston Street, which is the main civic spine of the city and a strong feature in Melbourne's identity. A key function of the public spaces in these precincts is to provide the opportunity for people to experience a sense of civic pride and ownership. At the northern end of the street, the area contains a number of major city institutions and heritage listed buildings (such as the State Library of Victoria and the City Baths). The State Library forecourt is one of the most highly used urban spaces in the northern CBD, and it is valued for its open aspect and grassed area. The cutting edge contemporary architecture of RMIT University buildings combined with heritage architecture creates a vibrant streetscape of contrasting, yet cohesive character. At the southern end of Swanston Street, the area contains Flinders Street Station (Victoria's most used railway station) and heritage listed buildings such as Manchester Unity, Melbourne Town Hall, Nicholas Building, St Paul's Cathedral and Young and Jackson Hotel. The contemporary Federation Square provides a visual counterpoint to these buildings. The area is the gateway to Southbank and major sporting facilities at Melbourne Park, Olympic Park, AAMI Park Stadium and the MCG, the Arts Centre precinct in St Kilda Road and the Domain Parklands.

Proposed Stations	Existing Landscape and Visual Qualities
Parkville Station	The Parkville station precinct is located within Melbourne's premier education and medical treatment and research zone, which houses the University of Melbourne, Royal Melbourne Hospital, Royal Children's Hospital, Walter and Eliza Hall Institute of Medical Research, Grattan Institute and Victorian Comprehensive Cancer Centre. The contrast between recent high quality contemporary architecture (for example, at Royal Children's Hospital, Royal Melbourne Hospital and Victorian Comprehensive Cancer Centre) and the classical sandstone architecture of the University of Melbourne – along with visually significant street tree plantings – gives the area a unique and high quality urban character.
Arden Station	The Arden station precinct is located within a largely industrial area that was developed as a manufacturing and warehouse hub servicing Melbourne's port and railway facilities. The precinct and surrounding area maintains much of this industrial heritage, with a substantial amount of land still used for these purposes. The precinct's built form is mostly low-scale, with a few exceptions such as the public housing complex east of Boundary Road and the wheat silos on Munster Terrace (a prominent local feature that represents the area's industrial heritage). Broad streets lined with small workers' cottages and a strong heritage character contributes to visual amenity in residential parts of the precinct. CityLink is a dominating visual element to the west.

Figure 10.18: Landscape and Visual Qualities. MMRA (2016), EES Chapter 16: 10

The assessment recognises:

> that loss of trees will have a deleterious impact upon the landscape and visual qualities of the Domain and Parkville station areas;
>
> major visual and audible distractions would occur at all station sites arising from the physical and audible effects of the construction activities; and
>
> that quality urban design, through the Urban Design Strategy (2017) implementation, would mediate the two effects this is despite the Strategy (2017) qualifying that its substantive ambit is not applicable to the construction phase.

In terms of Biophilic Design, the quality of resolution set out in the Chapter as to the landscape and visual qualities of the proposed railway station sites, during and after construction, is superficial lacking any guidance so as to inform and influence the quality physical forms of structures and landscape engagement that could occur.

1.5.9 Landscape and Visual Impact Assessment

The Landscape and Visual Impact Assessment (2016) report assessed the potential landscape and visual impacts of the project including those on recreational values. While noting that the majority of the proposed rail alignment and subsequent works are to be located underground, such locations were within close proximity to several above ground structures that would experience some level of landscape and visual impacts during the project's construction and operation phase. Additionally, it recognised that the project area includes several high quality streetscape environments defined by their canopy trees including the significant Royal Parade, Swanston Street and St Kilda Road boulevards.

Defining evaluation criteria and indicators for potential landscape and visual impacts, sought to avoid or minimise adverse effects on landscape, visual amenity and recreational values as far as practicable, to assess the potential impacts of the project's construction and operation on its viewshed.

Such included a qualitative and quantitative assessment included:

Qualitative Assessment	Sensitivity	How sensitive would viewers be to the proposed development?
	Visual modification	How does the proposed development contrast with the existing landscape character of the surrounding setting? What is the quality of the existing landscape setting?
Quantitative Assessment		Where would the proposed development be visible from? How much of the project would be visible from particular viewpoints with regard to the occupied field of view? This component is closely linked to the determination of Visual Modification.
Amelioration / Mitigation Measures		What measures are appropriate to reduce the project's construction or operating impacts?
Residual Visual Impact		What is the difference between the existing views pre-development and the views once the proposed amelioration and mitigation measures have been applied such as when revegetation has reached maturity?
	Monitoring	What is the likely effectiveness of the mitigation measures proposed for both the construction and operational phases?

Figure 10.19: Visual Assessment.

The overall assessment resulted in the following discursive abridged summative conclusions for the construction and post-construction phases specific for the railway station areas:

Station Areas:	Summative conclusions
Arden, Parkville, CBD North, CBD South, Domain Construction Phase	The project would have a significant, construction footprint. During the construction phase, high-level visual impacts would result to sensitive viewpoints within close proximity to the construction zone. While temporary, these are acknowledged as medium to high-level impacts during the project's construction. Although it is recognised that those who live, work study and visit Melbourne, particularly its inner suburbs and the CBD, may prefer views that do not include construction sites, it is acknowledged that construction activity has been, and will continue to be, a noticeable component of Melbourne's urban landscape. It is common for appropriately hoarded and mitigated construction sites, as well as tall cranes and other structures, to be encountered on a daily basis. Therefore, the visual sensitivity to the visual impacts of construction sites is tempered by these common and recurring experiences. On this basis, it is considered that visual sensitivity is reduced somewhat, compared to what would be expected in more pristine settings. Construction impacts can be mitigated through a range of management measures implemented during the construction process, particularly through well considered approaches as outlined in the Urban Design Strategy (2017). Mitigation treatments such as hoardings and sheds to screen construction activities could help reduce visual impacts from non-elevated viewpoints. Views from sensitive elevated locations (such as residential apartment towers) where overlooking of construction activities would be possible, would be more difficult to mitigate. Views from sensitive elevated locations, where overlooking of construction activities would be possible, would be more difficult to screen. However, for many of the more elevated apartments/rooms, the area of construction site or operational components visible from further back within the apartment/room would progressively decrease with increasing elevation. With increased elevation, one would only be able to obtain the view of the construction site by standing directly at the window [or on the balcony] and looking down.

Station Areas:	Summative conclusions
	(Continue) Further, any downward looking views would also include rooftops of other buildings below the viewer which, although they might present an interesting view, may not be as desirable compared to outward looking vistas of the CBD skyline and beyond that may also be possible from these elevations. Users of the retail spine of the city along Swanston Street, particularly tourists and visitors, would experience a high visual impact during construction, particularly with views along Swanston Street to St Kilda Road and the Shrine of Remembrance potentially being blocked by construction activities. There would be high impacts for users of open space and civic spaces during construction at parks, gardens and open spaces as well as at education and health facilities. The project construction method and station design would ensure retention of significant vegetation at key locations such as Parkville (Royal Parade), Swanston Street, St Kilda Road (Tunnels Precinct works north and south of Domain Station), Domain Parklands and Fawkner Park. With the implementation of these mitigation measures, the project meets the scoping objectives of the draft EES during the construction phase.
Arden, Parkville, City North, City South, Domain Post-Construction Phase	The residual impacts of the project once operating were determined based on the expectation of the delivery of an outcome that is consistent with the directions of the Urban Design Strategy (2016), the Project Construction Management Plan (CMP), the Project Principal Requirements (PPR) and Infrastructure Sustainability Council of Australia (ISCA) requirements. The architectural and public realm components of the project would be new elements within the fabric of the city, but would be of a form and scale similar to those that regularly appear as part of new buildings or public realm and streetscape upgrades. The operational impacts are considered in the visual context of a modern and dynamic city for which change is commonplace. However, the historical fabric and key viewlines must be respected. The Urban Design Strategy (2016) provides recommendations for these key attributes, and others so the project does not detract from the vibrancy, liveability or history of Melbourne. The Swanston Street to the Shrine of Remembrance visual axis would not be impacted by the project once operational.

Figure 10.20: Visual Impacts.

In terms of Biophilic Design, the quality of investigation offers valuable insights as to visual qualities and attributes of places, corridors, trees and associated vegetation, key characteristics, and a social perspective about the qualities of the city per place analysed. The latter in particular is relevant to Biophilic Design.

1.5.10 Soils and Geology

A review of the sools and geology of the landscape traversed through by the MTP project are contained in the Groundwater EES chapter and associated Technical Reports. The route of the underground line passes through several geological Periods, Epochs and Stratigraphic Units. In essence, land to the north of the River Yarra is heavily influenced by volcanic layers of the Pliocene and Oligocene to Miocene Epochs (of harder and younger geological layers) whereas land to the south is more influenced by the Pleistocene epoch (of softer and older geological layers).

The below Table summarises the Geological Periods, Epochs and Stratigraphic Units and their nomenclature and characteristics, and the below Figure maps their locations.

Geological Period	Geological Epoch	Stratigraphic Unit	Description
Quaternary	Holocene	Coode Island Silt (Qhi)	Soft clayey sediments with shells and organic materials, and lenses or thin layers of sandy materials
		Holocene Alluvium (Qha) 1	Fine to medium grained alluvial sands
Quaternary	Pleistocene	Jolimont Clay (Qpj)	Marine clay with minor silts and sands
		Newer Volcanics (Qvn) (Burnley Basalt Flow)	Olivine basalt, variably weathered and fractured
		Pleistocene Alluvium (Qpa)	Alluvial sediments typically comprising clay, silt and sand. The proportion of each of these materials is variable, with firm to stiff silty or sandy clay being dominant material.
		Fishermens Bend Silt (Qpf)	Marine sediments with high contribution of continental origin materials along former shallow embayment. Clay, silt with sand size particles and occasionally sand lenses and interlayers. Proportion of sand is higher towards the base of the unit (lower Fishermens Bend Silt sub-unit, Qpfl) and along former shallow embayment. Finer material encountered typically towards the top representative of deep sea depositional environment (upper Fishermens Bend Silt sub-unit, Qpfu).
		Moray Street Gravels (Qpg)	Alluvial sediments, medium to coarse grained quartz sands with minor gravels, clay and silt.
		Fluvial Sediments (Qpc) – Early Pleistocene Colluvial and Alluvial Sediments	Colluvial and alluvial sediments comprising medium to coarse sands, gravels and clays with coarse boulder and cobble typically of basalt material.
		Newer Volcanics (Qnvs) – Swan Street Basalt	Olivine basalt variably weathered and fractured. Typically referred to as lower Newer Volcanics.
		Punt Road Sands (Qpp)	Colluvial and alluvial sediments comprising boulders and gravels of siltstone, and river gravels and sands.
Neogene	Pliocene	Brighton Group (Tpb)	Sand, sandy clay, clayey sand, silt, clay and occasionally gravel.
Paleogene	Oligocene to Miocene	Older Volcanics (Tvo)	Olivine and pyroxene basalt with abundant volcanic glass, variably weathered and fractured.
		Werribee Formation (Tew)	Fluvial quartz sand, minor gravels, silty clays and clays.
Devonian		Igneous rock (Dgr)	Granodiorite and quartz porphyries, feldspar porphyries and lamprophyres dykes.
Silurian		Melbourne Formation (Sud)	Interbedded siltstone and sandstone, folded, fractured and variably weathered.

Footnote: 1 In Geology of Victoria (Birch, 2003) a formal name of Batman Avenue Gravels was suggested for Holocene Alluvium. We kept the old terminology herein as the term "Alluvium" describes better the depositional environment of the unit.

Figure 10.21: Geological Periods, Epochs and Stratigraphic Units Source: Golder Associates Pty Ltd (2016), Melbourne Metro Rail Project Concept Design – Regional Groundwater Numerical Modelling – EES Summary Report, pages 5-10.

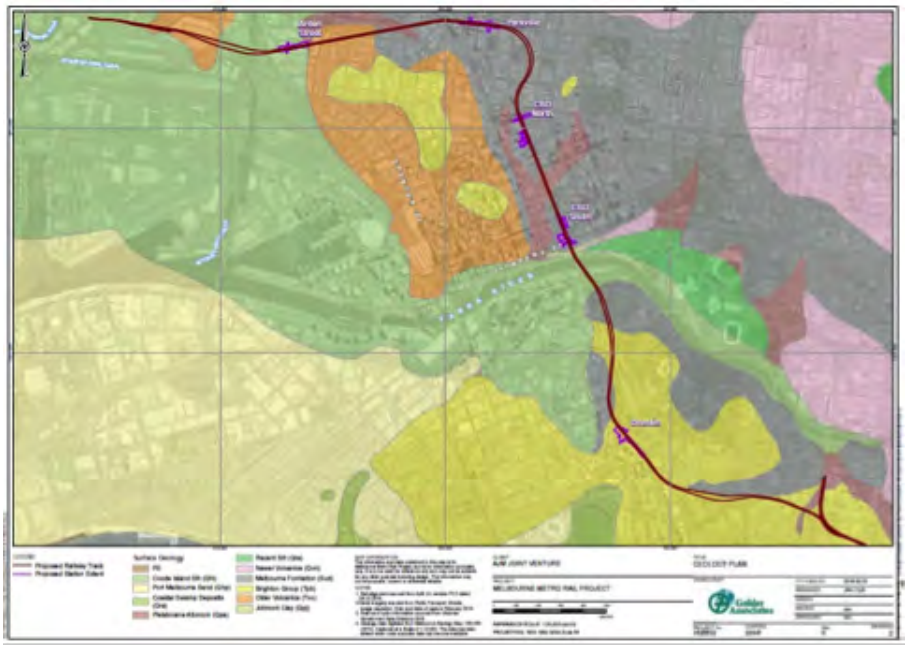

Figure 10.22: Geology Plan

Source: Golder Associates Pty Ltd (2016), Melbourne Metro Rail Project Concept Design – Regional Groundwater Numerical Modelling – EES Summary Report, Geology Plan.

In terms of Biophilic Design, the attribute here is the geological profile and potential narrative that the tunnels and station complexes can articulate about the geological history of Melbourne. This is especially so given the prolific use of the sawn volcanic basalt as a keynote material in formulating Melbourne urban design character.

1.5.11 Surface Drainage

A review of the surface drainage patterns of the landscape traversed through by the MTP project are contained in the Surface Water EES chapter and associated Technical Report. The route of the underground line passes underneath various topographical undulations and surface permanent, intermittent and flood-activated drainage lines. While the River Yarra is a permanent watercourse, drainage lines through the University of Melbourne, down the Elizabeth Street corridor, along the Kings Way corridor connecting to Albert Park Lake and the expansive flood plains of the Moonee Ponds Creek present risks and opportunities to the project. The main floods risks are associated with Arden Station, and to a far lesser extent Parkville and Domain stations because of surface water drainage patterns and pondings.

The below Figures summarises places that host a risk of inundation and surface drainage patterns.

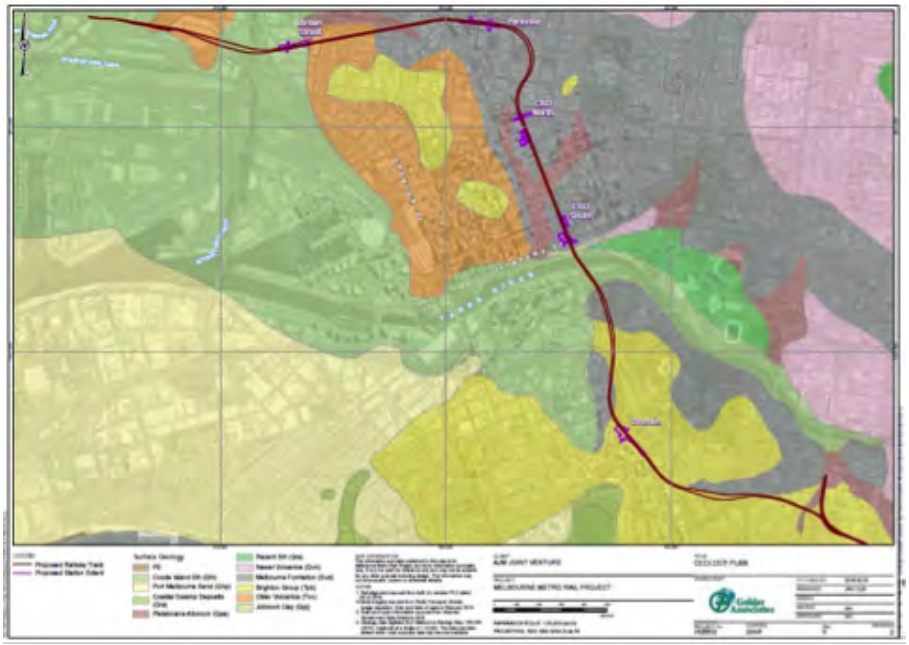

Figure 10.22. Source: MMRA (2016), Surface Water Impact Assessment, page 50.

Figure 10.23. Source: MMRA (2016), Surface Water Impact Assessment, page 53.

Figure 10.24. Source: MMRA (2016), Surface Water Impact Assessment, page 57.

Figure 10.25. Source: MMRA (2016), Surface Water Impact Assessment, page 63.

Figure 10.26. Source: MMRA (2016), Surface Water Impact Assessment, page 65.

Figure 10.27. Source: MMRA (2016), Surface Water Impact Assessment, page 72.

Figure 10.28. Source: MMRA (2016), Surface Water Impact Assessment, page 71.

In terms of Biophilic Design, the attribute here is the need to accommodate existing surface drainage patterns, and infrequent flood events and pondings. Additionally, and more importantly, calibrate these patterns in climate change modelling to cater for increased frequency of rain events (and thus flooding), but also to consider the capacity of Melbourne's existing underground infrastructure to cater for increased flow and volume loads.

City of Melbourne Council

The following documents are relevant under this sub-section:

- **City of Melbourne (2013)**, Melbourne City Council: Council Plan 2013-17. Melbourne: City of Melbourne Council.
- **City of Melbourne (2012)**, Urban Forest Strategy: Making a great city greener 2012-2032. Melbourne: City of Melbourne.
- **City of Melbourne (2016)**, Draft Urban Ecology and Biodiversity Strategy: The city as an ecosystem. Melbourne: City of Melbourne Council
- **City of Melbourne (2016)**, Melbourne Planning Scheme.

1.6.1 Melbourne's Council Plan 2013-17 (2013)

The City of Melbourne' Strategic Plan articulates a "*Vision to create a bold, inspirational and sustainable city.*"

The 8 goals of this Plan (2013) focus upon creating: "a *city for people, a creative city, a prosperous city, an eco-city, a connected city, that resources are managed well, that resources are managed well, and to create an accessible, transparent and responsive organisation*" (MMC page 6).

The most relevant goal, to this brief, is the goal to create "An eco-city" whereby:

"We provide solid foundations for the sustainability of Melbourne's communities. We embrace the unfamiliar if it helps us achieve our ambitions. We continue to encourage our community to take positive actions and we lead by example locally, nationally and globally" (MMC, p.7).

The benchmarks of this goal, within this Plan (2013), are to:

	Aim	Benchmarks
Long-term community goal	• An eco-city	• Municipal emissions: tonnes of greenhouse pollution (CO^2 - e) per resident and per worker in the municipality.
The Council's four-year outcomes	• Our greenhouse gas emissions are reduced. • Less municipal waste-to-landfill with less negative impact on amenity from collecting waste. • Sustainable water management. • Increased biodiversity and tree canopy cover in the municipality. • Climate change impacts on the municipality are managed.	• The proportional change in greenhouse gas emissions generated by City of Melbourne activities, per year. • The proportional change in total tonnes of waste to landfill. • The volume of complaints per capita about waste removal the City of Melbourne receives, per year. • The proportional change in the capacity of infrastructure to capture and reuse storm-water, per year. • The percentage of tree canopy cover of the municipality, annually. • The proportional change in the number of residents who are aware of climate change-related risks and the actions they should be taking, annually.

Figure 10.29. Source: City of Melbourne Council (2013), Melbourne City Council Plan 2013-17, page 14.

This Plan (2013) sets a goal forth of creating “an eco-city’ with benchmarks that seek to enhance the greening of the city against current vegetation patterns, densities and canopies in the City of Melbourne. Tree removal associated with the MMRA project represents an action that may severely comprise this goal and given the footprint of Biophilic Design interventions possible, recognising the constraints of this brief, only a small green contribution can be offered to mediate vegetation proposed to be removed, and thereupon replaced by the MMRA project.

1.6.2 Melbourne’s Urban Forest Strategy (2012)

This Strategy (2012) is one of the most foresighted urban forest strategies being implemented in the world. At the core of this strategy is “a vision to create a resilient, healthy and diverse forest for the future” that respects Melbourne’s unique character, responds to climate change and urban expansion, and underpins the health, liveability and wellbeing of the city and its inhabitants. To create resilient landscapes, community health and wellbeing and a liveable, sustainable city, this vision seeks to make the City of Melbourne greener – “to create a city within a forest rather than a forest within a city” (MMC 2012: 5).

Climate change, population growth and urban heating represent the three primary challenges for the City of Melbourne. These challenges impose a significant pressure upon the built fabric, services and people of the city. Healthy urban forests will increasingly perform a key role in ensuring the health and liveability of Melbourne. Climate change predictions for Melbourne over the next 20 years project that Melbourne will experience a changing climate, becoming increasingly warm, dry, and liable to more frequent extremes of heat and inundation. We can also expect that Melbourne’s urban heat island e_ ect will intensify.

From Melbourne’s perspective, the key functions of a health urban forest are to: provide shade and cooling; minimise the urban heat island effect and improve thermal comfort at street level for pedestrians. Accordingly, water sensitive urban design will play a pivotal role in mediating flooding and ensuring soil moisture for healthy vegetation growth thereby enhancing the city’s ecology.

Key guiding principles, and strategies and targets, in the Strategy (2012) include:

Guiding Principles	Strategies and Targets
• mitigate and adapt to climate change • reduce the urban heat island effect • become a 'water sensitive' city • design for health and wellbeing • design for liveability and cultural integrity • create healthier ecosystems • position Melbourne as a leader in urban forestry	Strategy 1: Increase canopy cover Target: Increase public realm canopy cover from 22% at present to 40% by 2040. Strategy 2: Increase urban forest diversity Target: The urban forest will be composed of no more than 5% of any tree species, no more than 10% of any genus and no more than 20% of any one family. Strategy 3: Improve vegetation health Target: 90% of the City of Melbourne's tree population will be healthy by 2040. Strategy 4: Improve soil moisture and water quality Target: Soil moisture levels will be maintained at levels to provide healthy growth of vegetation. Strategy 5: Improve urban ecology Target: Protect and enhance a level of biodiversity that contributes to a healthy ecosystem. Strategy 6: Inform and consult the community Target: The community will have a broader understanding of the importance of our urban forest, increase their connection to it and engage with its process of evolution.

Figures 10.30. Source: City of Melbourne (2012), Urban Forest Strategy: Making a great city greener 2012-2032, page 7.

This Strategy (2012) is benchmarked against current vegetation patterns, densities and canopies in the City of Melbourne, and sets a vision forward to ensure vegetation succession planning as well as strengthening this urban forest environment further. Tree removal associated with the MMRA project represents an action that may severely comprise the aims and guiding principles of this Strategy (2012) and given the footprint of Biophilic Design interventions possible, recognising the constraints of this brief, only a small green contribution can be offered to mediate the larger vegetation proposed to be immediately and progressively removed, and thereupon replaced by the MMRA project.

In terms of biophilic design, the Urban Forest Strategy (2012) recognises the key urban ecology variables of an urban environment, and it particular the significant and value of green foliage as aiding the overall health of the city. Thus, the Strategy seeks the maintenance and expansion of foliage to aid city health. Loss of foliage, as a direct consequence of this MTP project, will negatively impact upon both city health and the Strategy in meeting its milestones, and thereby the Council's overall strategic aim to create an ecocity. Implementation of Biophilic Design principles can assist in mediating the negative de-greening consequences of the MTP project.

1.6.6 Draft Urban Ecology And Biodiversity Strategy: The city as an ecosystem (2016)

A companion to the Urban Forest Strategy (2012), the Draft Urban Ecology and Biodiversity Strategy (2016) that has been recently released for public consultation, envisages that "*The City of Melbourne will support a diverse, resilient and healthy ecosystem that contributes to the health and wellbeing of our community and the foundation of a liveable city*" (MMC 2016: 6).

The Draft Strategy (2016) recognises that:

"… healthy ecosystems and rich biodiversity are vital for the liveability and wellbeing of our city. Protecting and enhancing biodiversity will support the health and wellbeing of our community and contribute to effective climate change adaptation actions. The City of Melbourne has developed this strategy to provide direction about how it manages and enhances the municipal ecology, biodiversity and ecosystem services. This strategy recognises that nature is diverse, that there are numerous benefits to supporting biodiversity, and that action is required to support and enhance it. By considering our city as an ecosystem, there is the opportunity to actively foster connections between people, plants, animals and the landscape, to create the legacy of a resilient, balanced and healthy urban environment for future generations to enjoy, and to nurture delight in the natural environment" (MMC 2016: 6).

The Draft Strategy (2016) draws upon the three key priorities identified in the Urban Forest Strategy (2012) to achieve the vision of the city as a diverse, resilient, and healthy ecosystem, with the accompanying actions, as follows:

Vision: City as an ecosystem	
Principle 1: Connect people to nature	
Strategy 1: Explore the ways in which cultural and practical 'Caring for Country' principles will assist in integrating people with nature.	• Investigate an appropriate and effective partnership model to support and inform this strategy in conjunction with key researchers, Traditional Owners and the local Aboriginal community. • Protect existing indigenous vegetation and increase the use of indigenous planting practices. • Support partnerships and research that further Caring for Country knowledge. • Identify initiatives that celebrate the cultural and environmental significance of the Yarra River and other waterways. • Work with Traditional Owners and the local Aboriginal community to explore opportunities to create a new public space where ceremonies and traditional practices can be carried out.
Strategy 2: Connect people to nature to improve social resilience, health and wellbeing	• Establish a 2017 social baseline of how people value nature. • Implement and support initiatives that educate and engage the community with nature in the city including creating unexpected encounters with biodiversity, and supporting urban agriculture such as community, home and rooftop food gardening. • Identify continued opportunities to improve, create and connect small green spaces throughout Melbourne's most urbanised areas, and begin implementation. • Increase the value of existing public open spaces by creating programs that activate stewardship and a sense of shared ownership for the people who live in, work in and visit Melbourne. • Provide opportunities for community involvement in the implementation of the strategy through the use of citizen science. • Create a digital platform to engage the community and share information about biodiversity in Melbourne.

Vision: City as an ecosystem	
Principle 2: Create a diverse, connected and resilient ecosystem	
Strategy 3: Protect and enhance existing habitat to support greater biodiversity in a changing climate	• Undertake an assessment of the municipality to evaluate existing habitat quality, identify opportunities for habitat enhancement and develop appropriate targets for enhancement. • Assess the vulnerability of key species in the ecosystem and identify target species and habitats for rewilding programs. • Research, implement, and advocate appropriate habitat opportunities such as dead trees, artificial tree hollows, and bee 'hotels'. • Develop a plan to increase soil health in parks, gardens and medians, including a review of chemical use in land management processes. • Develop best practice guidelines for an ecologically informed management of green spaces in the face of climate change • Develop and implement a monitoring program to evaluate biodiversity and habitat on an ongoing basis. • Further integrate biodiversity and urban ecology values into the planning of parks, green spaces, precincts and waterways through masterplans, structure plans, precinct plans, The Open Space Strategy and Total Watermark- City as a Catchment.
Strategy 4: Support habitat creation within the private realm and other public land to maximize diversity and connectivity	• Work with partners to undertake an assessment of existing and potential biodiversity corridors, including waterways and connections beyond the city's municipal boundaries. • Enhance ecological connectivity through stepping stones and corridors along streets and biolinks between larger green spaces. • Continue to investigate and research the barriers to urban ecology enhancement across different building types and stakeholders and understand the opportunities to influence behaviour. Implement programs and initiatives to encourage residents and businesses to support biodiversity and on their own properties, such as case studies and guidelines. • Assess the feasibility of a planning scheme amendment to encourage appropriate development that minimises impact and enhances urban ecology and biodiversity. • Work with the State Government to explore the opportunity to establish an incentive framework based on the global environmental accounting system to acknowledge and encourage the private sector to invest in biodiversity and reduce its ecological footprint.

Vision: City as an ecosystem	
Principle 3: Demonstrate local and global leadership	
Strategy 5: Demonstrate local and global leadership in urban ecology and biodiversity	• Undertake ongoing advocacy and education to increase awareness of biodiversity. • Undertake a community-wide survey to select an emblematic species to represent the City of Melbourne and further promote awareness of biodiversity in the city. • Partner with researchers to position Melbourne internationally as a hub for urban ecology and biodiversity research. • Support and partner with local volunteer groups to enhance biodiversity management. • Develop local and international networks on biodiversity (C40, ICELI, Biophilic Cities Network) • Deliver a flagship biodiversity and urban ecology project that is recognised locally and internationally as an innovative and outstanding example of rewilding in a dense urban fabric.

Figure 10.31. Source: City of Melbourne (2016), Draft Urban Ecology and Biodiversity Strategy, pages 8, 15, 16, 20, 22, 26, 31.

The Draft Urban Ecology and Biodiversity Strategy (2016) proposes principles and strategies to guide the long-term planning, development and management of the City of Melbourne's ecosystem, together with a set of actions and targets to evaluate the success of implementation. The Draft Strategy (2016) is framed in a 10 year scenario recognising that urban ecology technology is rapidly changing and technologically maturing presently, and that many innovations and developments are likely to emerge over the next decade.

In terms of biophilic design, this Draft Urban Ecology and Biodiversity Strategy (2016) is instrumental in recommending ground surface level and upper storey initiatives and actions aligned to the overall Urban Forest Strategy (2012). It offers valuable insights as to existing technological and environmental design knowledge, and articulates the need for flexibility to accommodate future knowledge recognising that this realm is rapidly changing. The latter in particular is relevant to Biophilic Design.

1.6.3 Melbourne Planning Scheme (2016)

The Melbourne Planning Scheme (2016) sets out policies and requirements for the use, development and protection of land.

Planning schemes refer to a large range of things, including limits for how tall a building can be, as well as ensuring orderly and sustainable use of land. Every local government municipality in Victoria has a planning scheme to govern the use, development and protection of its land, underpinned by current and future needs. These vary from one municipality to another. They are prepared by a local council or the Minister for Planning and then approved by the Minister.

Recognised in this Planning Scheme (2016) is the Vision of the City of Melbourne Council (Clause 21.03) and its Goal to become an Eco-City (Clause 21.02-7) as follows:

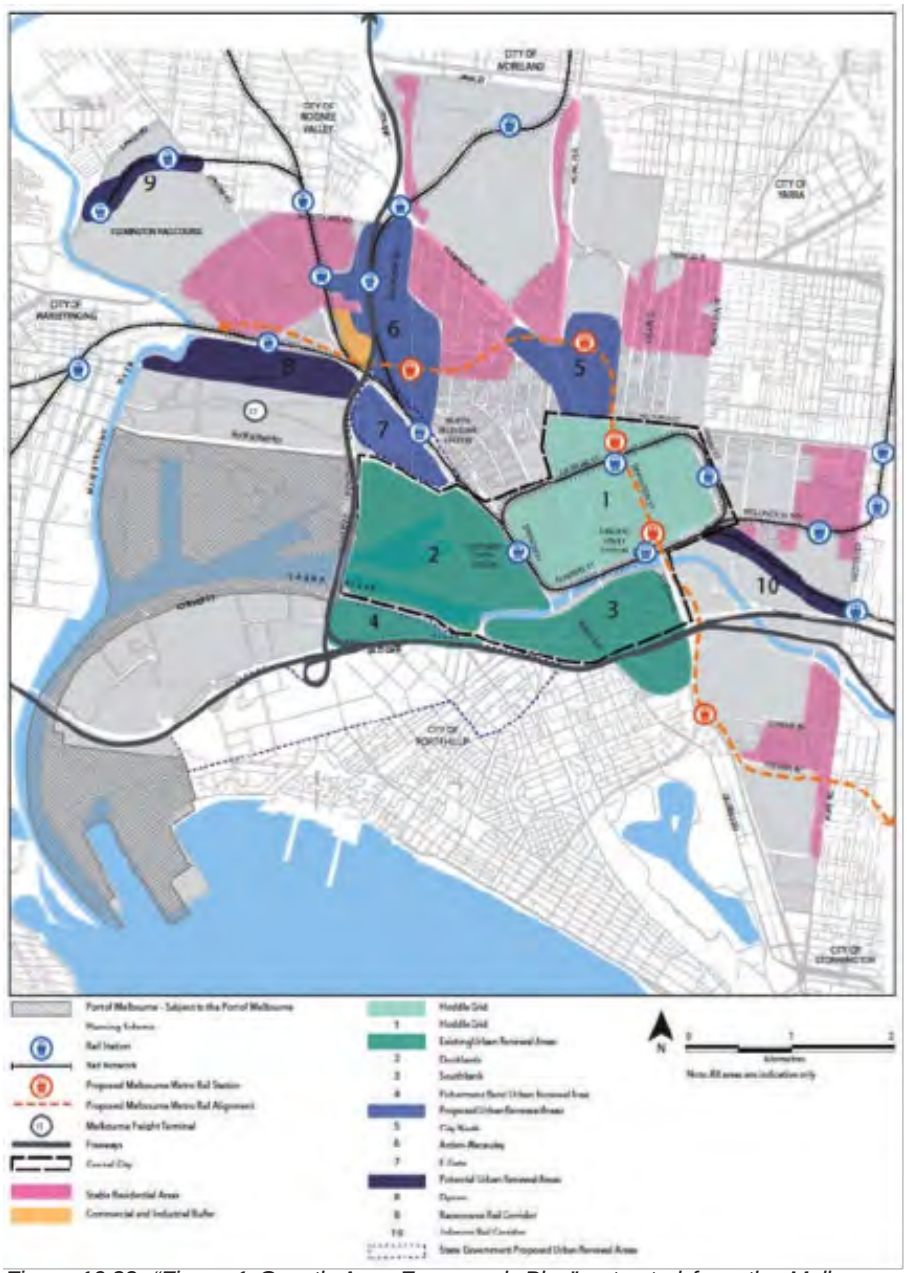

Figure 10.32: "Figure 1 Growth Area Framework Plan" extracted from the Melbourne Planning Scheme (2016: Clause 21.04: 2).

21.03 VISION	21.02 MUNICIPAL PROFILE
21.03 VISION Future Melbourne 2008 is the community's plan to grow Melbourne as a global city and as one of the top ten most liveable and sustainable cities in the world. The plan's vision for the municipality is of a bold, inspirational and sustainable city. To achieve this vision, Future Melbourne has six high level goals for Melbourne to be: • a city for people, • a creative city, • a prosperous city, • a city of knowledge, • an eco-city, and • a connected city.	**21.02-7 Eco-City** Metropolitan Melbourne has a far-reaching ecological footprint reflecting increasingly unsustainable trends of resources consumption, waste generation and greenhouse gas emissions. The City of Melbourne is one of the most compact, dense and mixed use part of the metropolitan area with the richest network of public transport services and generous reservations of public open space. These characteristics have intrinsic efficiencies and synergies and offer significant potential to drive down per capita energy use for building and transport services, to make the City robust against the predicted impacts of climate change particularly water scarcity and heatwaves.

Figure 10.33: Extract- City of Melbourne Planning Scheme

Specifically, in the Melbourne Planning Scheme (2016), the Growth Area Framework and Environment and Landscape Values and Built Environment and Heritage set forth certain aims and benchmarks.

The Growth Area Framework articulates that as the City of Melbourne continues to grow and develop, the culture and functioning of the City in 20 years time will be very different from today. However, through these changes the characteristics of the city we value today must be retained. This can be achieved by: targeting urban growth and development into specific areas of the City; enabling ongoing but incremental growth and development in those parts of the City needing constant renewal of their vitality, and by maintaining the existing character in valued established areas.

The Environment and Landscape Values and Built Environment and Heritage may be summarised as.

21.05 ENVIRONMENT AND LANDSCAPE VALUES	21.06 BUILT ENVIRONMENT AND HERITAGE
Land use and development activities in the municipality can undermine the health and biodiversity of its flora and fauna ecologies. Protect the open spaces and the waterways that support those systems. The quality of the city's waterways is vitally important to the municipality's recreational attractiveness and the health of its aquatic life. The city's parks, gardens, and aquatic environments have several sites with important indigenous flora and fauna habitat.	Melbourne's character is defined by its distinctive urban structure, historic street pattern, boulevards and parks, heritage precincts, and individually significant heritage buildings. Heritage buildings, precincts and streetscapes are a large part of Melbourne's attraction and the conservation of identified heritage places from the impact of development is crucial. The buildings in the private realm should be coordinated with the development of the streets, paths, parks and places in the public realm. Development must add positively to Melbourne's public realm and contribute to making it safe and engaging for users. Public and private open spaces should be able to support a range of uses including physical movement, communal exercising, social interaction, quiet enjoyment and connections to the natural environment. Climate change is predicted to deliver reduced rainfall, rising sea level and more extreme flooding, intense storms, and heatwaves. The built environment must be designed to moderate and provide protection from these

21.05 – 1 Biodiversity	21.06 – 3 Sustainable development
Objective 1 To protect and enhance the City's habitats and biodiversity. Strategy 1.1 Encourage the retention of native vegetation in the development of sites and enhance indigenous and remnant vegetation areas in the City including in parks and gardens and waterways. Strategy 1.2 Encourage the use of indigenous vegetation in open spaces and roof top greening. Strategy 1.3 Minimise the impacts of introduced flora and fauna on indigenous vegetation. Strategy 1.4 Encourage revegetation with predominantly indigenous species. Strategy 1.5 Create and enhance bio-links for native flora and fauna.	**Objective 1 To create an environmentally sustainable urban environment with reduced greenhouse emissions** Strategy 1.1 Ensure that new buildings and new public spaces are environmentally sustainable. Strategy 1.2 Promote innovative environmentally sustainable development. Strategy 1.3 Encourage the retention of buildings or parts of buildings that have efficient recycling potential and can be adapted to a variety of uses. **Objective 2 To make the built environment resilient to heatwaves, water shortages, extreme storm events and sea level rise.** Strategy 2.1 Design new buildings, streets and public open spaces to minimise their contribution to the urban heat island effect and to contribute to urban cooling. Strategy 2.2 Ensure that new development incorporates water sensitive urban design features including stormwater harvesting and flow attenuation, and water recycling and reuse. Strategy 2.3 Ensure that flood risk by stormwater surges, waterway flooding and sea level rise is mitigated and managed. **Objective 3 To encourage efficient resource use and waste reduction in the City.** Strategy 3.1 Encourage all new development to maximise water efficiency. Strategy 3.2 Encourage provision of purpose built storage for recyclable waste, in all development. **Objective 4 To encourage environmentally sustainable building design innovation** Strategy 4.1 Design all new developments to maximise the use of passive systems to achieve comfortable indoor conditions. Strategy 4.2 Support new developments that minimise their embodied energy by their use of materials, construction and retention of reusable building fabric. Strategy 4.3 Support on-site renewable and low emission energy generation, such as solar hot water, photovoltaic cells, wind powered turbines or combined heat and power generation systems in new developments.

Figure 10.34: Extract- City of Melbourne Planning Scheme

In terms of Biophilic Design, the Goal to become an ecocity strongly engages with Biophilia and Biophilic Design Patterns, and is very relevant to this investigation.

City of Port Phillip Council

The following documents are relevant under this sub-section:

- City of Port Phillip (2016), Port Phillip City Council: Council Plan 2013-17 (rev 2016). St Kilda: City of Port Phillip Council.
- City of Port Phillip (2009), City of Port Phillip Open Space Strategy. St Kilda: City of Port Phillip Council.
- City of Port Phillip (2016), Greening Port Phillip: Street Tree Planting Guide: 2010-2015. St Kilda: City of Port Phillip Council
- City of Port Phillip (2016), Port Phillip Planning Scheme.

1.7.1 Port Phillip City Council: Council Plan 2013-17

The City of Port Phillip's Council Plan 2013-17 (2016) consists of 16 strategic objectives in four areas. Each objective includes key actions: as follows:

Engaged - A well governed City	1.1 Provide clear and open communication and engagement that is valued by the community 1.2 Value transparent processes in Council decision making 1.3 Build and facilitate a network of active and informed communities 1.4 Build strategic relations with our partners 1.5 Achieve a reputation for organisational and service excellence
Healthy - A healthy, creative and inclusive City	2.1 Ensure our City is a welcoming and safe place for all 2.2 Support our community to achieve improved health and wellbeing 2.3 Ensure quality and accessible family, youth and children's services that meet the needs of our community 2.4 Foster a community that values lifelong learning, strong connections and participating in the life of the City 2.5 Promote an improved range of cultural and leisure opportunities that foster a connected and engaged community
Resilient - A strong, innovative and adaptive City	3.1 Build resilience through Council action and leadership 3.2 Support and increase community action for a resilient City
Vibrant - A liveable and connected City	4.1 Encourage viable, vibrant villages 4.2 Ensure growth is well planned and managed for the future 4.3 Improve and manage local amenity and assets for now and the future 4.4 Ensure people can travel with ease using a range of convenient, safe, accessible and sustainable travel choices

Figure 10.35: Extract- City of Port Philip council Plan

In terms of Biophilic Design, the Council Plan (2016) has little articulation to policy commitments to urban ecology enhancement, biodiversity conservation, except in terms of "*Reduction in Council's total greenhouse gas emissions per annum (reported annually)*" (PPC 2016: 17), nor to the Council's Greening Port Phillip Strategy (2010).

1.7.2 City of Port Phillip Open Space Strategy (2009).

The Open Space Strategy (2009) seeks to guide the actions of the Council "*to continue to offer open space that is diverse and can accommodate the future needs of a growing population in an established urban environment and in a sustainable way*" (PPC 2009: 4).

The Vision for the City of Port Phillip's Public Open Space is:

A city where public open spaces define the city's character and respond to its people's need for places to rest, recreate and be inspired (PPC 2009: 4).

The principles inform the Open Space Strategy and are intended to guide future decisions taken by Council in regard to the supply and management of public open space, as follows:

Principle 1: Optimum provision of open space	Provision of optimum open space will be addressed by: • Increasing the amount of useable open space in appropriate locations to offset increases in population and the decline in private open space • The use of urban design strategies that produce functional and pleasing spaces irrespective of size • Strong design elements in the creation and renewal of open space to inspire people and develop parks that will respond to community needs • Creating connections between spaces to maximise use and functional public open space • Community benefit to underpin the use of open spaces
Principle 2: Commercial events in public open space	Commercial events in parks need to demonstrate net community benefit. The impacts of commercial events upon public access to open space will be monitored and regulated.
Principle 3: New residential development and public open space	The boundaries of public and private open space in residential developments should be clearly delineated. Where residential developments border public open space, the values of the existing public open space must be enhanced or preserved not degraded.
Principle 4: Safe Access to Public Open Space	The objectives of the City of Port Phillip Lighting Strategy will be implemented in public open space to provide safe access to high profile spaces and public transport connections as a priority.
Principle 5: Access for all	Public open space will offer a diversity of functions and experiences, and be accessible to all.
Principle 6: Streetscapes as public open space	Streetscapes provide opportunities for public use particularly for communal meeting and exercise. Design and treatment of streetscapes should respond to these potential uses.
Principle 7: Public Open Space managed by others	The City of Port Phillip will continue to work with other public authorities as managers of public open space, to achieve high quality spaces for all residents.
Principle 8: Supply of Public Open Space	Parkland is a highly valued community asset. The inner city has a very limited supply of public open space, which is increasingly under pressure from high use by residents and competing demands from other community uses. Any loss of land currently used for open space will only be considered in the following situations: • The available land offers poor amenity for public open space use • Alternative sites of higher quality can be identified for acquisition • Net community gain can be guaranteed by an alternative land use.

Principle 9: Sustainable open spaces (New principle)	Sustained drought conditions have had an adverse impact on open space. To respond to this change in climate, environmentally sustainable design features will need to be considered in the management and renewal of open space. Examples of this could include the use of drought tolerant plants, warm season grasses, low energy public lighting, alternative water sources and water sensitive urban design.

Figure 10.34: Extract- City of Port Phillip Open Space Strategy

In terms of Biophilic Design, the Open Space Strategy (2016) substantially seeks the maintenance, and sustainable enhancement of existing open space resources and infrastructure. There is little articulation to policy commitments to urban ecology enhancement, biodiversity conservation, and a cursory link to the Council's Greening Port Phillip Strategy (2010).

1.7.3 Greening Port Phillip: Street Tree Planting Guide: 2010-2015

The Greening Port Phillip Strategy (2010) perceives that the mix of public and private trees and other vegetation collectively comprise an urban forest that provides:

… shelter, shade, beauty, cleans the air, regulates the temperature, reduces energy needs of nearby spaces, treats and cleans stormwater, reduces loads on stormwater drains, protects and increases the life of infrastructure and provides habitat. An urban forest is defined as the 'sum total of all trees and associated vegetation growing within an urban area (PPC 2010: 3).

Components of this urban forest include:

Front and backyard gardens.

Balcony gardens.

Rooftop gardens and green roofs.

Vertical gardens – vegetation growing up the walls of buildings and fences.

Street trees, shrubs and ground covers on nature strips, median strips and round-a-bouts.

Trees and gardens in public parks and reserves.

Trees and gardens in other open spaces – shopping strips, industrial properties, etc.

The Greening Port Phillip Strategy (2010) articulates a Vision that:

The City of Port Phillip will have a healthy and diverse urban forest that uses innovative greening solutions to enhance the community's daily experience, ensuring environmental, economic, cultural and social sustainability for future generations (PPC 2010: 3).

To achieve this Vision for Greening Port Phillip (2010), the objectives include:

1	Ensuring planning policies and strategies including the Municipal Strategic Statement, Urban Design Frameworks and Structure Plans incorporate trees as a strategy to achieve the desired neighbourhood character.
2	Ensuring greening activities in open spaces, including tree planting and alternative greening options, maintain and enhance the unique character and beauty of Port Phillip.
3	Maintaining and enhancing streetscapes for improved amenity, liveability, character and sustainability through tree planting and implementing alternate greening options.
4	Maintaining and enhancing trees in key boulevards.
5	Having an integrated approach to tree planting to ensure that tree planting aligns with key capital works projects and initiatives.
6	Managing and maintaining trees within the City of Port Phillip to ensure that they survive and an urban forest is maintained for future generations.
7	Minimising the impact of the heat island effect by increasing the number of trees and overall canopy cover in the City of Port Phillip and by seeking other greening opportunities where trees cannot be planted.
8	Ensuring equitable access to mature trees across the municipality over time by maintaining an optimum coverage and mix of tree type and age.
9	Enhancing wildlife habitat, strengthening wildlife corridors and increasing biodiversity within the context of Port Phillip's highly urbanised environment.

Figure 10.34: Extract- Greening Port Phillip

In terms of biophilic design, the Greening Port Phillip Strategy (2016) has a strong alignment to the vegetative, aesthetic, wellbeing and biodiversity patterns of biophilic design.

1.6.3 Port Phillip Planning Scheme (2016)

The Port Phillip Planning Scheme (2016) sets out policies and requirements for the use, development and protection of land.

Planning schemes refer to a large range of things, including limits for how tall a building can be, as well as ensuring orderly and sustainable use of land. Every local government municipality in Victoria has a planning scheme to govern the use, development and protection of its land, underpinned by current and future needs. These vary from one municipality to another. They are prepared by a local council or the Minister for Planning and then approved by the Minister.

Recognised in this Planning Scheme (2016) is the Vision of the City of Port Phillip Council (Clause 21.01-1) and it's Strategic Approach (21.01-2) as follows:

21.01 Vision	21.02 Strategic Approach
Port Phillip's vision is to create: • A city that produces low greenhouse gas emissions and is responsive to climate change issues; • A city that provides a healthy and safe environment for residents, workers and visitors; • A city where community diversity and harmony are sustained and encouraged; • A city where all members of our community feel connected through a strong sense of place, and can enjoy the benefits of the city and participate in community life;	To achieve the vision for Port Phillip, Council will make ecologically sustainable decisions which: • Respond to the issue of climate change by working towards achieving (by 2020): • A 50% reduction in per capita greenhouse gas emissions (based on 2006 levels). • A 50% reduction in per capita potable water use (based on 2001 levels). • A 75% reduction in per capital waste to landfill (based on 1999 levels). • Foster a liveable and attractive urban environment that uses fewer finite resources. • Encourage environmentally sustainable design in all new development. • Contribute to a more sustainable environment through increasing housing and employment densities in locations closest to public transport.nd uses on residential amenity are minimised. • Create an integrated and sustainable transport network which supports the use of public transport, cycling and walking above private car travel. • Reduce the impact of private cars on the liveability of the City.

(Continue)

- A city that promotes affordable, accessible and diverse housing types to meet the needs of all current and future residents;
- A city that promotes sustainable economic growth, high accessibility to goods and services, and prosperous conditions for all residents and businesses;
- A city that manages traffic and transport in a way that maximises use of environmentally sustainable modes of travel;
- A city of distinct neighbourhoods where an understanding of local character and heritage is an important element of a sustainable future;
- A diverse and creative city that is reaching out to the future with innovative design and development, high environmental awareness and a vibrant culture; and
- A city that respects and values its past, its diversity and its link with traditional owners.

(Continue)

To achieve the vision for Port Phillip, Council will manage land uses across the municipality to:

- Create attractive residential areas which are desirable places to live, and where the impacts of new la
- Provide significant opportunities for housing growth within designated strategic locations which offer greatest accessibility to shops, services and public transport.
- Limit development within established residential areas to that which respects existing neighbourhood character and heritage values.
- Build on Port Phillip's competitive strengths to maximise job opportunities in a changing economy through:
- Facilitating the transition of the Fishermans Bend Urban Renewal Area from a core industrial area to a mixed use area including increasing opportunities for commercial and industrial uses with limited amenity impacts.
- Maintaining the role of St Kilda Road as the City's premier commercial strip.
- Facilitating the transition of key business clusters to capitalise on the proximity to the CAD, and the emerging demand for advanced business services and knowledge based industries.
- Provide for a broader land use mix within Port Phillip's highly accessible Major Activity Centres, which support economic viability, local access to goods and services, and the social and cultural role of centres.
- Support a vibra nt, well managed local tourism industry that co-exists harmoniously with local residents, businesses, traders and the natural environment.
- Facilitate the clustering and co-location of relevant community facilities and services in accessible community hubs across the city.
- Support the development of high quality open space network that is safe, accessible, and diverse, and can support the increasing demands of a growing resident and worker population.
- Maximise public access to and enjoyment of the foreshore, through creating a series of activity destinations connected by quality walking and cycle links, whilst protecting its core environmental values.
- Support the capital city function of the St Kilda and Port Melbourne Foreshore precincts.
- Ensure that the viable and efficient operation of the Port of Melbourne (and associated freight corridors) occurs in a sustainable manner, which includes minimising the potential environmental and amenity impacts on the local area and its communities and ensuring that sensitive uses do not further encroach on the Port.

(Continue)

To achieve the vision for Port Phillip, Council will manage the built form of the municipality to:

- Protect and reinforce the key elements of Port Phillip's urban structure including; the foreshore, places and precincts of heritage significance, traditional linear retail strips, key boulevards, and the network of parks and open spaces.
- Reinforce the diverse character of individual residential neighbourhoods and the distinct place identity of retail strips across Port Phillip.
- Protect the natural environment and its heritage values.
- Offer a high level of amenity, good transport connections, and convenient access to services for residents, workers and visitors.
- Protect and revitalise our special places and precincts of cultural and tourism significance.
- Provide a high quality, safe public realm which encourages street-life and supports the cultural vitality of the city.
- Ensure an appropriate level and standard of physical infrastructure to support the community's needs and new development.

Figure 10.35: Extract- Port Phillip Planning Scheme

Specifically, the Port Phillip Planning Scheme (2016) Clause 21.03-1 Environmentally Sustainable Land Use and Development sets forth Issues, Objectives and Strategies and Policy Guidelines as to the implementation of Ecologically Sustainable Development, as follows:

Key Issues	Objectives and Strategies	Policy Guidelines
The built environment has a significant impact on the wider natural environment and most current development practices are not sustainable in the long term. Council's aim is to create a City and region with the smallest possible ecological footprint. To achieve this goal, Council considers sustainable land use and development as essential, including the promotion of a built environment that: • Moves towards the elimination of the use of non-renewable resources (such as fossil fuel based energy, mains water and materials). • Moves towards the elimination of solid waste production. • Moves towards the elimination of air, soil and water pollution. • Creates healthy indoor environments. • Protects and enhances natural eco-systems and cycles.	1. To promote sustainable design and development. 1.1 Encourage resource-efficient design, material selection and construction techniques ,that minimise negative and maximise positive environmental impacts. 1.2 Promote ecologically sustainable development through the use of industry standards and environmental performance assessment tools. 1.3 Encourage innovative landscape design that minimises water consumption and maximises biodiversity, including greater use of indigenous and drought tolerant plant species, recycled materials and water re-use and recycling, subject to heritage and urban character considerations. 1.4 Encourage water sensitive urban design in all new developments, to increase on-site stormwater retention and treatment to improve water quality to the bay, and to facilitate water conservation.	Assessing all planning permit applications for new development against the objectives and strategies for ecologically sustainable design and development, and encouraging all developments to incorporate best practice sustainable design principles and techniques. Applying the Environmentally Sustainable Development Local Policy (Clause 22.13) to ensure that best practice sustainable design is achieved in new development. Applying the Urban Design Policy for Non-Residential Development and Multi-Unit Residential Development (Clause 22.06) to ensure that energy and resource efficiency is considered in the design of new non-residential development and residential developments over four storeys.

Key Issues	Objectives and Strategies	Policy Guidelines
(Continue) Designing and managing built form and physical infrastructure to better respond to a changing climate will contribute to improving the liveability and sustainability of local buildings and public spaces for the benefit of the wider community.	(Continue) 1.5 Encourage the retention of buildings or building elements that have significant potential for on-site reuse or and can be adapted to a variety of uses. 1.6 Ensure industrial, commercial and retail uses are planned to allow environmental best practice methods of operation, including waste recycling, water-wise use and reuse, and more renewable sources of power. 1.7 Promote improved environmental performance and heritage conservation as mutually supportive planning considerations, including through the retention of building fabric, and the sensitive installation of sustainable building elements.	

Figure 10.36: Extract- Port Phillip Planning Scheme

In terms of Biophilic Design, while not explicit in the City of Port Phillip's Council Plan (2016), the Greening Port Phillip Strategy (2010) charts alignment to the concepts of Biophilic Design, and is very relevant to this investigation.

10.3 MMRA Sustainability Policy

10.3.1 MMRA Sustainability Principles and Approach

The MMRA, in their Sustainability Principles and Approach (2016), affirmed their alignment to the first internationally recognised and most frequently cited definition of the concept being:

Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

- World Commission on Environment and Development 1987, (Our Common Future) The Report of the Brundtland Commission

The Brundtland Commission's definition engages with the principles of environmental protection, social equality and economic growth (IISD, 2015).

The MMRA (2016: 3) has expressed its sustainability Policy as:

> *Through our delivery of Major Projects we're committed to connecting communities in the healthiest, most sustainable way possible. We'll help to ensure a lasting legacy for present and future generations for a more liveable Victoria - environmentally, socially and economically.*

Thus,

this integrated approach to sustainability translates into better building and infrastructure performance; economic growth; ecologically sustainable development; improved operational efficiency and minimised maintenance requirements; whole-of-life cost savings and healthy and safe environments for customers (MMRA 2016: 3).

To achieve this Vision the MMRA has committed to the following 5 Sustainability Policy Commitments:

- Optimising the Project's design to ensure it is delivered to operate sustainably
- Managing resources efficiently through embedding energy, water and material saving initiatives into the design, construction and operation of the Project
- Avoiding, minimising and offsetting harm to the environment and the loss of biodiversity
- Protecting and conserving the natural environment
- Preparing for the changes presented by climate change

The MMRA Sustainability Strategy (2016) incorporates the Sustainability Policy and specific Themes and benchmark initiatives / targets for integration into the project planning and design, procurement, construction and operational stages, that can be summarised as:

Sustainability Themes	Icon	Sustainability Objectives
Excellence		Demonstrate leadership in the commitment to a prosperous and integrated economic, social and environmental sustainable future.
Urban Ecology and Vegetation		Protect and enhance vegetation, functioning of ecosystems and maintain biological diversity.
Climate Resilience		Respond to the challenges of climate change impacts through adaptation and resilience planning and design.
Supply Chain		Demonstrate commitment to sustainable procurement.
Communities		Support and enhances social, cultural and community wellbeing.
Workforce		Facilitate economic prosperity and development and providing a resilient local workforce.
Energy		Promote energy efficiency throughout design and delivery and implement innovative uses of renewable energy on site.
Materials and Waste		Reduce the impact of materials over the lifecycle, and provide healthy environments through the reduction of emissions, pollution and waste.
Water		Reduce water through an energy efficient design and identify and use non-potable water from local sources.

Figure 10.37: Sustainability Targets, Themes and Objectives

The Strategy identified the following tools as international benchmarks and the MTP will seek formal certification under these:

Infrastructure Sustainability Council Australia (ISCA) IS Rating Scheme Tool; and

Green Buildings Council of Australia (GBCA) – Green Star Design & As Built Melbourne Metro Rail Tool.

In terms of Biophilic Design, while the over-arching sustainability policy vision is directly relevant, the Urban Ecology and Vegetation and the Communities themes are most relevant.

10.4 Technical Literature Summary Table

Biophilic Design Technical issue	Key Literature Citation	Literature Title	Key-topics
Light	(Edwards & Torcellini 2002)	A literature review of the effects of natural light on building occupants.	Psychological/ mental health benefits of natural light
	GreenStar	None reviewed	Various
	WELL Building Standard®	None reviewed	Various
	(Massa et al 2008)	Plant productivity in response to LED lighting	LED Lighting & Planting
	(Hogewoning et al 2010)	An artificial solar spectrum substantially alters plant development compared with usual climate room irradiance spectra	Artificial Light for plants
	(Folta & Childers, 2008)	Light as a growth regulator: Controlling plant biology with narrow-bandwidth solid-state lighting systems	Artificial Light for plants
	(Wheeler 2008)	A Historical Background of Plant Lighting	Historic overview on artificial lighting for plants
Air	(Dye 2003)	Guidelines for developing an air quality (ozone and PM2.5) forecasting program	Air Quality
	(Wolverton 1997)	How to grow fresh air: 50 houseplants that purify your home or office	Plant species impact on air quality
	(Wolverton 1988)	Foliage plants for improving indoor air quality	Plant species impact on air quality
	(Papinchak 2009)	Effectiveness of houseplants in reducing the indoor air pollutant ozone	Plant species impact on air quality
	(An et al 2010)	The Effectiveness of Eight English Ivy Cultivars in Removing the Indoor Air Pollutant Formaldehyde and Their Responses to Formaldehyde Stress	Plant species impact on air quality
	(Yu et al 2011)	Numerical simulation and construction of using indoor plants to improve indoor air quality	Plant species impact on air quality
	GreenStar	None reviewed	Various
	WELL Building Standard®	None reviewed	Various
	(Fernandez-Canero 2012)	Assessment of the cooling potential of an indoor living wall using different substrates in a warm climate	Cooling
			Wind veolcities and movement on psychology.

Biophilic Design Technical issue	Key Literature Citation	Literature Title	Key-topics
Structural/ weight loading		None reviewed	Plant loading on walls
			Plant loading on slabs
Water		None reviewed	Consumption
			Quality
			Recycling/ reticulation
			Salts/minerals
Sound	(Farina 2014)	Soundscape ecology: principles, patterns, methods and applications	Soundscape Ecology
	(Pijanowski et al 2011)	Soundscape Ecology: The Science of Sound in the Landscape	Soundscape Ecology
Wind		None reviewed	
Soil		None reviewed	Vertical garden mix
			structural soils
Maintenance		None reviewed	Pruning
Planting	(Growing Green Guide 2014)	Growing green guide: a guide to green roofs, walls and facades in Melbourne and Victoria, Australia	Melbourne specific
	(Hopkins & Goodwin 2011)	Living architecture: green roofs and walls	Green Roof and Wall
	(Perkins & Joyce 2012)	Living Wall and Green Roof Plants for Australia	Plant species
	(Dusolt et al 2016)	Grey to Green Final Design Report	Green Wall
	(Loci 2015)	Urban Forest Evidence Base: Model Template for Local Government	Urban Forest
	(Loci 2016)	Green Infrastructure Evidence Base	Green Infraastructure
	(Farrell et al 2015)	Urban Plantings: 'Living Laboratories' for Climate Change Response	Planting, climate change

Biophilic Design Technical issue	Key Literature Citation	Literature Title	Key-topics
Economics	(Newman 2012)	Can biophilic urbanism deliver strong economic and social benefits in cities?	Economic and Social Benefits
Health and Well Being	(Terrapin 2014)	14 Patterns of Biophilic Design: Improving Health & Well-Being in the Built Environment	Design Patterns and Principles
	(Bringslimark 2007)	Psychological benefits of indoor plants in workplaces	Psychological benefits indoor plants
	(Chen et al 2014)	Analysis and construction of stress relief model for healthy indoor environments	Indoor air quality
	WELL Building Standard®		Various
	(Lee et al 2015)	Interaction with indoor plants may reduce psychological and physiological stress by suppressing autonomic nervous system activity in young adults	Plants and young adults
	(McSweeney et al 2015)	Indoor nature exposure (INE): a health-promotion framework	Exposure to nature indoors.
	(Hartig & Staats 2006)	The need for psychological restoration as a determinant of environmental preferences	
	(Nielsen & Hansen 2007)	Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators	Green space & health
	(Reutler et al 2015)	Transit Riders' Perception of Waiting Time And Stops' Surrounding Environments	Public transportation, transit, rail, bus, stop, station, waiting time, time perception, environment, air pollution, traffic, tree, planning, urban design.
Performance	Green star	None reviewed	
	WELL Building Standard®	None reviewed	
	SITES		
	Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability (IS) Rating Tool	None reviewed	

Biophilic Design Technical issue	Key Literature Citation	Literature Title	Key-topics
Soil	(Leake & Haege 2014)	Soils for Landscape Development: Selection, Specification and Validation	Landscape, soils, urban, development.
	(Calkins 2012)	The Sustainable Sites Handbook	See soils section
	(Craul & Craul 2006)	Soil design protocols	Soil design.
	(Rawlins et al 2013)	A review of climate change impacts on urban soil functions with examples and policy insights from England UK	Climate change impacts on urban soil
Food Production	(Niu et al 2016)	Plant Factory: An Indoor Vertical Farming System for Efficient Quality Food Production	Technical vertical Food production
	(Darko et al 2014)	Photosynthesis under artificial light: the shift in primary and secondary metabolism	Artificial light, plants and food production

Figure 10.38: Technical Literature Summary

10.5 Soundscape Ecology

Natural soundscapes are part of the natural environment and are part of the total experience of nature. They can have benefits for human wellbeing, making them part of the overall biophilia experience. Soundscapes can contribute to generating a distinct sense of place, further connecting people to their environment.

The word soundscape was first introduced to the language towards the end of the 20th century and it is credited to R. Murray Schafer. Schafer was 'searching for ways to frame the experience of sound in new, nonvisual contexts' as part of drawing people's attention to the sonic fabric of their environment. His research showed that 'each soundscape uniquely represents a place and time through the combination of its special blend of voices, whether urban, rural, or natural (Krause 2012: 26-27).

Krause took Schafer's insights and evolved a system of analysing and understanding soundscapes in terms of their ecological relationships. He coined the term biophony to refer to the collective sound made by non-humans in their environment, placing that alongside geophony (non-biological natural sound) and anthophony (human-induced noise). Together, these describe soundscape ecology.

Soundscapes, as delineated and developed by Krause, 'are voices of whole ecological systems' in which every living organism 'from the tiniest to the largest' has its own acoustic signature, as does 'every site on earth' (Krause 2012: 27). The study of soundscapes has been facilitated by modern recording technology. That technology also allows for reproduction of soundscapes and it is now possible, to some extent, to replicate natural soundscapes in human-dominated environments.

Conventional urban design is primarily focussed on the visual landscape and movement of people and their machines. It tends to address the acoustic environment in terms of controlling or ameliorating unwanted noise. The Soundscape Ecology approach seeks to identify the noises that are desirable. Biophilic design can benefit from insights and analyses offered by soundscape ecology to help construct urban and human-dominated environments that not only reduce unwanted noise (typically machine generated noise and especially that generated by cars, trucks, buses, trains and air conditioning), but also reinforce and accentuate positive sounds, including the human-generated sounds that people enjoy (e.g., happy chatter, cheerful crowds, live music, etc.) – and the sounds of nature (e.g., birdsong and fountains).