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Final Report

Responding to the Urban Heat Island: A Policy and Institutional Analysis

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The views expressed herein do not represent those of the Victorian Government. They are the views of the report authors and those stakeholders interviewed for the project.

Information

Visit the VCCCAR website for more information about the Urban Heat Island Project: www.vcccar.org.au

Executive Summary

Dealing with heat stress in Australian cities is of increasing concern to decision-makers. Indeed, heat is already an issue affecting Melbourne with people, buildings, and infrastructure all evidenced as being vulnerable to episodes of extreme heat. It is likely that without deliberate interventions the urban heat island (UHI) will be further amplified by a combination of increasing urbanisation to cater for anticipated population growth and increasing temperatures associated with global climate change.

One important adaptation option for moderating the impact of urban heat (which also has multiple societal benefits and contributes to a broader urban liveability agenda), is to increase the cover of a range of vegetation types across the urban form; known collectively as the city's 'Green Infrastructure' (GI). This study – based on literature review, policy analysis, semi-structured interviews and actor mapping – sought to better understand some of the key barriers to, and opportunities for, an increased implementation of GI across the Melbourne conurbation as an important adaptation measure for combatting urban heat stress.

The initial framing of the 'problem' proved more problematic than was originally anticipated. Not only were there discrepancies in stakeholders' understanding of both UHI and GI concepts (discussed further in the report), but it was also identified early in the research that there was a marked disconnect between 'inner' and 'outer' UHI impacts across the metropolitan area. Councils in the 'outer metro' areas, particularly in the western suburbs, expressed greatest concern for impacts that occurred during the day. In contrast, 'inner urban' councils identified the UHI as having greatest impact at night-time, when more densely urbanised areas release their heat. Additional complexities, such as differential rainfall patterns and drier landscape characteristics in the west, also created reinforcing feedback loops between UHI and GI, with some municipalities reporting problems with keeping large areas of street tree plantings alive, particularly during periods of low rainfall.

These findings suggest that the framing of effective policy responses will have to be flexible enough to address the complexities of urban heat at differing scales, not only geographical but also temporal. To do so, policies and practice will need to ensure analysis of vulnerability hotspots and adaptation planning considers local, neighbourhood and broader scales; and that connections between different policies, as well as the roles and responsibilities of different actors, are given due attention. Findings also indicate that there is a need to be more explicit about the multiple benefits that arise from greening urban areas, as moderating the UHI is unlikely to be the primary driver for greater 'greening'. Rather, alignment with other societal objectives such as water conservation, storm-water retention, and health agendas will be a crucial part of developing a GI narrative.

It was found that one of the key challenges facing the increased implementation of GI relates to the limited control that local councils have over the management of land. Accordingly, any attempts to genuinely address UHI across Melbourne's metropolitan region will require a coordinated effort between layers of government, businesses and communities. Project's like City West Water's 'Greening the West' appear to be a good case

study of attempts to provide a more coherent multi-stakeholder approach. In addition, the interviews also suggested that despite the evident benefits, considerable challenges remain to increased implementation. Perhaps the most important of these relates to costs – critically, the ever-present question of the distribution of private and public benefits (particularly relating to maintenance costs in new developments). A better understanding of public-private costs and benefits, and how to incentivise private action for the public good, would be of great benefit to this agenda.

Based on the analysis of the institutional enablers of, and barriers to, increased implementation of GI, the report puts forward some considerations for Federal, State and Local government policies and programs. These include needs to:

- **Clearly identify the problem and what will actually be addressed.**
- **Be a roadmap, portal or central point of reference.**
- **Recognise that the Urban Heat Island is not generally the primary driver for GI**.
- **Recognise the value of case study material.**
- **Consider the future Urban Heat Island as well as current day.**
- **Guide assessment of the magnitude of the Urban Heat Island phenomenon.**
- **Be a 'living' guide.**

This report on the 'policy and institutional context affecting the implementation of Green Infrastructure' is part of a larger project funded by the Victorian Centre for Climate Change Adaptation Research (VCCCAR). The research activity involved three main components that were ultimately drawn together to inform the development of a Green Infrastructure Implementation Guide. These were: 1) mapping of Urban Heat Island transects across Melbourne; 2) analysing the cooling functions performed by different vegetation types (and their potential benefits for different locations / contexts); and 3) seeking to better understand the institutional enablers and barriers to an increased uptake of Green Infrastructure. It is this third component – exploring the institutional enablers and barriers from the perspective of local governments – which this report focuses on.

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Hume City Council

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Contents

Executive Summary **3**
1. Introduction **8**
2. Background **9**
2.1 Melbourne's urban heat under a changing climate 9
2.2 Addressing urban heat through Green Infrastructure 9
3. Research Methodology **11**
3.1 Literature review 11
3.2 Documenting Actors & Policies 11
3.3 Semi-structured Interviews 11
4. GI: Institutions & Policies **13**
4.1 Definitions & Interpretations 13
4.1.1 The Urban Heat Island effect 13
4.1.2 Green Infrastructure 16
4.2 Implementation Enablers 18
4.2.1 GI supports multiple objectives 18
4.2.2 Policies that support 'co-benefits' 21
4.2.3 Provision of public (and private) good 22
4.3 Implementation Barriers 24
4.3.1 Lack of technical guidance 24
4.3.2 Costs 24
4.3.3 Spatial variability of urban heat and land use change 25
4.3.4 Local Government Capacity and Resources 27
4.3.5 Land Ownership 28
4.3.6 Understanding and communicating the challenges and values of GI 29
4.3.7 Whole-of-government approach 29
4.3.8 Land use planning and development 30
4.3.9 Policy objective conflicts 33
5. Prospects for Improved Implementation **35**
5.1. Federal Government 35
5.1.1 Incorporation of GI objectives into Federal codes and 'roadmaps' 35
5.1.2 Require a comprehensive assessment of heat event risks 36
5.1.3 GI guidelines as a mechanism to improve older buildings' thermal comfort ... 36

5.1.4 National (Infrastructure) Sustainability Rating Tool 36
5.2. State Government 37
5.2.1 Undertake state-wide GI planning 37
5.2.2 Provide an overarching policy framework 38
5.2.3 Design and implement programs to support establishment of GI 39
5.3. Local Governments 40
5.3.1 Develop a long-term GI plan 40
6. Conclusion 43
7. References & Bibliography 46
Other information sources 50
8. Appendices 51
Appendix A: Policy Map for GI Implementation across Melbourne 51
Appendix B: Examples of Policy-based Incentive Mechanisms 59

1. Introduction

This report contributes to a broader research project funded by the Victorian Centre for Climate Change Adaptation research (VCCCAR) that aimed to develop a better understanding of Melbourne's Urban Heat Island (UHI); to assess the effectiveness of different 'Green Infrastructure' (GI) systems in minimising heat accumulation and optimising cooling; and to develop a systematic approach for urban land managers to optimise the selection and implementation of different related GI adaptation options. Alongside these practical challenges are important institutional factors – perceptual, cultural, and political – that influence whether and how implementation of GI may or may not occur.

Whilst there are differing definitions for GI in both the literature and in practice, for the purposes of this project, it is defined as:

> ***… the network of designed and natural vegetation found in our cities and towns, including public parks, recreation areas, remnant vegetation, residential gardens, street trees, community gardens, and innovative and emerging new urban greening technologies such as green roofs and green walls.***

This project report focuses on the institutional barriers and opportunities (in both policy and practice) that either inhibit or enable strategic implementation of GI as a means of addressing the UHI effect in the greater metropolitan region of Melbourne, Australia. It draws from three research activities: a review of the relevant literature; tabulation of policies that influence or have the potential to influence implementation of GI in Victoria; and semi-structured interviews with government personnel and other key stakeholders.

Conclusions drawn from this analysis highlight a number of policy opportunities for Federal, State and Local governments that could enable improved implementation of GI in our urban landscapes. The findings have also contributed to the development of the project 'Green Infrastructure Implementation Guide' (GIIG) for local governments (Norton *et al.* 2013).

2. Background

2.1 Melbourne's urban heat under a changing climate

Urban development replaces natural surfaces and vegetation with dry, hard, impervious surfaces such as roads, footpaths, roofs and buildings; exacerbating run-off and reducing water quality. Removal of vegetation can also reduce shading of these hard surfaces and the evapotranspirative cooling[1] benefits that plants can provide (especially when little water can infiltrate into soils), storing and releasing sunlight as heat. The combination of these and other factors commonly leads to urban areas being significantly warmer than rural surrounds, an effect termed the 'Urban Heat Island' (Voogt 2002; Coutts *et al* 2007; Coutts *et al* 2010). The UHI phenomenon exposes the urban population to longer and more intense periods of heat stress, particularly during heatwave events, and increases urban energy demands for cooling. It can also have substantial implications for air quality (Stone and Rodgers 2001).

Climate change projections suggest south-eastern Australian heatwaves will increase in intensity and frequency (Alexander and Arblaster 2009). At the same time, it is anticipated that warming associated with the UHI effect will continue to intensify by approximately 1°C per decade, over and above that caused by global warming (Voogt 2002). Thus, urban dwellers will increasingly have to cope with the impact of heat stress caused by the compounding effects of the UHI and a changing climate. This is particularly important in the Australian context. According to the Bureau of Meteorology, "heatwaves have accounted for more deaths in Australia than any other natural hazard" (BoM 2013).

By 2030 it is estimated that an additional 600,000 new dwellings will be needed to accommodate Melbourne's growing population. Under the recently replaced *Melbourne 2030* plan, 284,000 of Melbourne's new dwellings were to be constructed in the outer growth areas, while almost 316,000 were to be built closer to the central business district in established areas (DPCD 2008). Given that the 'middle suburbs' are potentially the spaces into which more than half of new homes are likely to be accommodated, they must be a focus for adaptation if cities are to remain sustainable in the longer term (Simon 2011). Consequently, efforts to reduce existing and potential urban heat effects need to consider a range of different urban landscapes, from new greenfield development to brownfield redevelopment sites.

2.2 Addressing urban heat through Green Infrastructure

Contrary to assertions that the UHI is solely a product of urban density, UHI intensity is influenced by multiple factors; including urban form, development intensity, and building materials (Stone and Rodgers 2001, cited in Coutts *et al* 2007). As a consequence, different urban land use types such as city centres, parklands, and various suburban residential

[1] The transfer of water from the land through vegetation to the atmosphere, as part of the water cycle and occurs as plants lose water to the air.

areas are characterised by distinct differences in net radiation, heat storage, and sensible and latent heating; resulting in variable local climates (Fehrenbach *et al.* 2001; in Coutts *et al.* 2007). By incorporating different kinds of vegetation, GI has the potential to cool these different urban micro-climates at a variety of spatial scales by providing shade and reducing the amount of heat buildings and other hard surfaces hold and subsequently release.

It should be noted that the availability of water is critical for the effective functioning of GI. However, whilst there remains some level of ambiguity in the literature as to the exact definition of GI (and its relationship to water sensitive urban design), for the purposes of this research activity, 'green' and 'blue' infrastructure were dealt with as distinct entities, though with an explicit recognition that there are many inter-linkages between the two.

The potential of, and scale at which, GI can moderate urban heat is greatly influenced by the configuration of any GI 'network' within an urban form, which can vary significantly. The network or typology of GI is an important planning consideration because, at a landscape scale, different typologies contribute differently to the reduction of the UHI and provision of other ecosystem services. For example, consider Figure 1 below. A thin corridor of GI running through a landscape provides good flood storage capacity but limited shading or evapotranspiration benefit beyond its localised area. In contrast, a matrix might provide less flood storage capacity but greater infiltration and shading averaged across the landscape. However, none of this discounts localised effects of even small patches of GI (vegetation) on transpiration and shading.

From a landscape or neighbourhood perspective, the planning and development of new greenfield sites and the re-designing of brownfields provide excellent opportunities to minimise or reduce the UHI via incorporation of different kinds of GI. Combined with innovative, design-led approaches, GI has the potential to cool our urban areas, improve our health and well-being, as well as enhance biodiversity.

Importantly, GI can provide multiple benefits where synergies between a number of sustainable design elements such as building energy efficiency standards, water-sensitive urban design (WSUD), and urban design for community health, are utilised.

Figure 1 Different GI typologies (Gill et al. 2007)

3. Research Methodology

As mentioned previously, the report findings draw on three broad research activities: a review of the relevant literature; tabulation and mapping of policies that influence or have the potential to influence implementation of GI in Victoria; and interviews with local government personnel. The methodology for each is outlined below.

3.1 Literature review

The literature review established definitions of key terms, and also identified international examples of institutional enablers and barriers in policy development and implementation with respect to the use of GI to reduce urban heat. The review encompassed academic literature, government reports, and other relevant studies. However it was found that there was limited documentation or publication of studies relating to institutional factors in GI implementation beyond fairly cursory acknowledgements of their existence. Nonetheless, issues identified by both the sourced literature and interviewees are highlighted in this report, contributing to a better understanding of current practice and the final recommendations.

3.2 Documenting Actors & Policies

In order to comprehend the governance context within which implementation of any policy, goal or practice occurs; the actors and policies that influence or could influence GI implementation were mapped and assessed. Understanding the formal context within which actors must operate also provided an appreciation of the potential relationships and existing dependencies among the actors who share interests and responsibilities in the development and implementation of relevant policies and programs.

3.3 Semi-structured Interviews

Semi-structured interviews were conducted with a range of professionals involved in advocating, planning, implementing, maintaining and evaluating GI and its variants. While a range of viewpoints were sought from different organisations with different roles and involvement with GI across Melbourne's urban areas, the vast majority of interviewees were from local government associations. However, input was also gained from water authorities, academia, private enterprise, industry groups and non-profit organisations. As GI is a relatively new approach for addressing UHI – with greenspace, urban tree programs, etc. generally aimed at issues other than reducing heat – interviews were conducted with people who had a range of responsibilities with the *potential* to influence implementation. Such responsibilities included management of green space, open space, parks, sustainable design, water management, city design, and urban landscapes. In many instances, the research team were often directed to people within local councils.

The interviews sought to gather insights from those tasked with developing and implementing policies related to addressing UHI and/or managing GI implementation; to learn from each participant's knowledge and experience of factors that enable or constrain the identification of the need and feasibility of GI; as well as practical issues such as design, installation, and maintenance. Interviewees also discussed addressing the identified

constraints and opportunities to enable greater implementation aimed at addressing urban heat.

A semi-structured interview protocol was developed following Yin (2003). All interviews were face-to-face, and held at the interviewee's place of work. While notes were taken during the interviews, individual identities were kept anonymous. Respondents were approached to participate in the study because of their professional experience, knowledge and responsibilities. Contact details were obtained either directly from an organisation's website, or from a colleague within that organisation who suggested the participant may have knowledge that could inform the research. In addition, several participants directly approached the project research team upon hearing of the study from colleagues.

4. GI: Institutions & Policies

GI implementation and, more specifically, implementation aimed at addressing UHI, varied quite widely amongst the Local Governments' interviewed. This variation extended from those councils just commencing analyses of their green space and trees, to those where GI is being implemented specifically to address UHI (always among other factors) via an established policy, strategy or program. The success of these policies and programs was considered dependent on a variety of factors; many of which are discussed below (a comprehensive tabulation of the policy landscape is provided in Appendix A).

4.1 Definitions & Interpretations

A key institutional factor in any policy development and implementation is communication and shared understanding of central terms and concepts. An essential starting point for this research was therefore an analysis of stakeholder interpretations of the terms 'Green Infrastructure' (GI) and 'Urban Heat Island' (UHI), in comparison with the definitions as understood and applied by the research team.

4.1.1 The Urban Heat Island effect

An appreciation of different perspectives of the UHI effect not only aids in the development of a broader understanding of its complexity, but also ensures that any policies, practices and guides are clear about 'the problem' that they are being developed to address. In this study, interviewee descriptions and definitions of the UHI effect largely centred upon two core concepts: that inner city areas were hotter and/or that large built up areas create pockets of heat. These descriptions are consistent with research that shows that urban areas such as Melbourne exhibit distinct urban heat profiles, within which inner city and built up areas tend to have higher ambient temperatures. For example, Figure 2 below shows some of the differing spatial and temporal patterns of urban heat (which can also vary depending on how heat is measured, as illustrated by the dotted and solid lines).

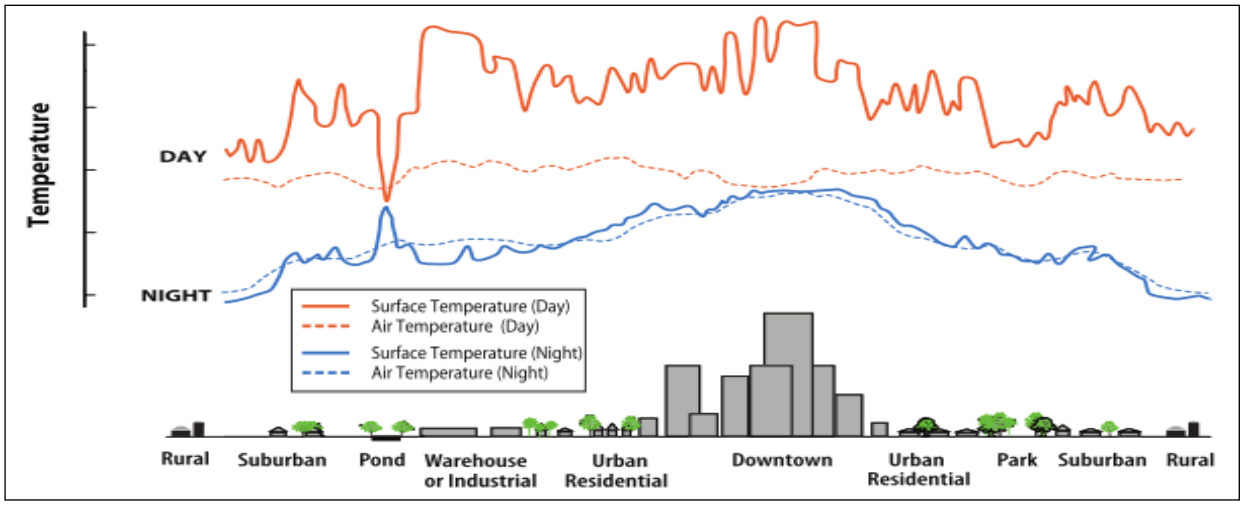

Figure 2 Variation in UHI Readings based on Measurement Type (EPA 2009)

Equally, interviewees tended to focus their concern with UHI at the scale that was relevant to the scope of their work. For example, discussions with developers and landscape architects focused strongly on increased energy efficiency through building surface cooling, while municipality-level actors expressed interest in cooling streetscapes and communal or open space in activity centres (Figure 3 below).

Figure 3 Differing Scales of UHI Visualisation (CoM 2012; Loughan, Nicholls & Tapper 2009)

A key finding from this study was the marked difference between 'inner' and 'outer' local government understandings of when the UHI is at its greatest. In general, 'outer metro' councils identified the UHI as having greatest impact during the day. In contrast, 'inner urban' councils identified the UHI as having its greatest impact at night, when more densely urbanised areas release their heat. Both sets of views are valid within their respective local contexts, strongly correlating with data such as observations of the 2009 heatwave in Melbourne (shown in Figure 4 below). These findings highlighted the importance of developing GI policies and practice that address the differing heat profiles across Melbourne's urban areas by allowing consideration of localised UHI impacts and issues.

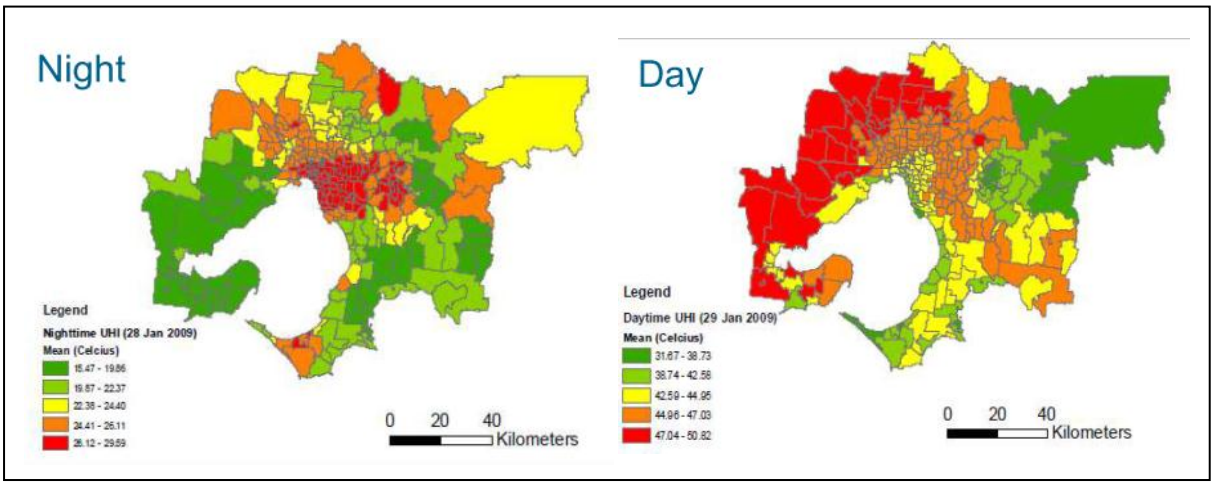

Figure 4 Variation in UHI readings based on Measurement Type (Monash 2007)

Findings regarding definitional differences regarding UHI suggest that policies will have to be flexible enough to address the complexities of urban heat at differing scales, ranging from surface temperature in an allotment or streetscape, through to differences in day and night time heat profiles across the metropolitan area. To do so, policies and practice will need to ensure analysis and planning considers local, neighbourhood and broader

scales, and that connections between different policies, as well as the roles and responsibilities of different actors, are given due attention.

4.1.2 Green Infrastructure

This project defined GI as “the network of designed and natural vegetation found in our cities and towns, including public parks, recreation areas, remnant vegetation, residential gardens, street trees, community gardens, and innovative and emerging new urban greening technologies such as green roofs and green walls” (Melbourne University, GI Research Group).

Yet the phrase ‘Green Infrastructure” was found to have multiple - and sometimes even conflicting – interpretations by policy makers, stakeholders and the community at large. These ranged from low-carbon or energy efficient ‘hard’ infrastructure (such as roads and solar-passive buildings) to ‘open spaces’ (such as public parks). Several respondents suggested that the term is somewhat obscure and thereby open to misinterpretation. They argued that this is primarily because many people interpret the term infrastructure as referring to ‘hard’ built components such as pipes, roads and buildings, and ‘green’ as relating to infrastructure that supports sustainability and/or climate change action, such as promoting water and energy efficiencies.

Reflecting this argument, several interviewees defined GI as including non-living and non-vegetative sustainable urban design components, such as bike paths and even photovoltaic installations. Although such techniques have the potential to reduce the UHI effect to some degree, they do not fit within the concept of GI used here. They are also largely inconsistent with definitions currently used in the international literature (Tzoulas *et al.* 2007).

Nonetheless, while recognising a multitude of interpretations of the term GI, most local government interviewees related the term to the management of open or ‘green’ spaces (reflective of their professional roles). A few described GI as relating to a combination of built and natural forms of infrastructure that co-function to provide ecosystem services such as improved water quality through filtering and stormwater management through impact abatement and flow control. A smaller number referred to GI as ‘living things in the urban landscape’ that contribute to the sustainability of urban areas or rather the ecosystem of an urban landscape itself. An interviewee from private enterprise argued that they deliberately use the phrase ‘living roofs and vertical gardens’ so as not to confuse their clients about the intended focus of their work.

Although a range of definitions of GI may confer some flexibility in its practical application, it is yet to be established whether some definitions may be more useful than others when discussing efforts to address urban heat. While there is no single agreed definition, it is important that whichever definition is used be clear. Because of these differences in interpretations, the present study sought to make this variation explicit, and contribute to a broader but shared appreciation of the concept of GI and its multiple benefits. Highlighting these different conceptual understandings will be central to the communication and implementation of any future adaptation strategies.

Examples of interviewee definitions of GI

'Materials and water not just vegetation. There's a need to quantify options so that they are not limited solely to the most expensive'.

'Both built and natural forms in the urban landscape, and relates to how they interact and function from an ecosystems services perspective, a range of perspectives ….in talking with communities, simpler language such as 'creating cooler urban areas' may be more useful'.

'Hard infrastructure with a green edge…the point is to make these things assets'.

'It's about green space and urban design'.

'Two things - sustainability and the long-term, and community infrastructure and facilities….Living things in the urban landscape'.

'Buildings and works created to have a minimum greenhouse gas footprint, plus adaptation'.

Not all Green Infrastructure is 'Green'

A concern raised during this study was the suggestion by a number of interviewees that there is increasing use of artificial turf or grass on private and council-owned lands, because it is perceived to be 'environmentally friendly'. One industry representative stated that they don't call artificial turf 'green' infrastructure "because you can paint a wall green, but that doesn't make it sustainable".

Several interviewees argued that artificial turf is therefore not GI, even when coupled with underlying water retention tanks or other mechanisms. Although often portrayed as a solution to limited water availability, the literature suggests that artificial turf is not as green or eco-friendly as may have been claimed. McNitt et al (2008) state that "surface temperatures of synthetic turf are significantly higher than natural turfgrass surfaces when exposed to sunlight, with traditional synthetic turf being as much as 35-60°F higher than natural turfgrass surface temperatures". Additionally, Claudio (2008) refers to work by Stuart Gaffin of the Center for Climate Systems Research at Columbia University, stating that "synthetic turf fields can get up to 60°F hotter than grass, with surface temperatures reaching 160°F on summer days" and concludes that the fields rival black roofs in their elevated surface temperatures.

4.2 Implementation Enablers

The following section discusses the key factors either described by interviewees, or illustrated in the literature, as enabling the implementation of GI generally. Broadly, implementation is seen to be enabled where it simultaneously addresses several policy objectives or can be shown to have multiple benefits, beyond just that of reducing urban heat. In addition, implementation appears to receive further support where it can be shown to contribute to both public and private good.

4.2.1 GI supports multiple objectives

A review of local GI programs and projects found that most had been initiated to address a number of policy objectives, rather than urban heat mitigation per se. One respondent suggested that GI might therefore be considered an ecological system rather than a form of infrastructure. This person provided the following example: a green facade installed on a commercial building for aesthetic and marketing purposes simultaneously insulated the building and cooled the air intake of the building's chiller, thereby leading to a two-fold reduction in the building's energy demand. Another interviewee described a vertical garden primarily established for aesthetic and cooling purposes that also filtered and treated grey-water.

These observations are consistent with evidence in the international literature: a 2008 review of global GI policies identified public recreation, active travel route enhancement, and wildlife habitat establishment as the three most frequently identified policy objectives respectively, while evaporative cooling and shading ranked 24th and 25th respectively of the 29 objectives identified in terms of frequency cited (City of Liverpool 2008). This suggests that GI policy and practice needs to be framed in the context of achieving multiple objectives, such as is depicted in the City of Liverpool's Green Infrastructure Strategy (Figure 5), and in GI-related policies and programs such as the City of Melbourne's Urban Forest Strategy 2012. Some key 'co-benefits' of GI are discussed below.

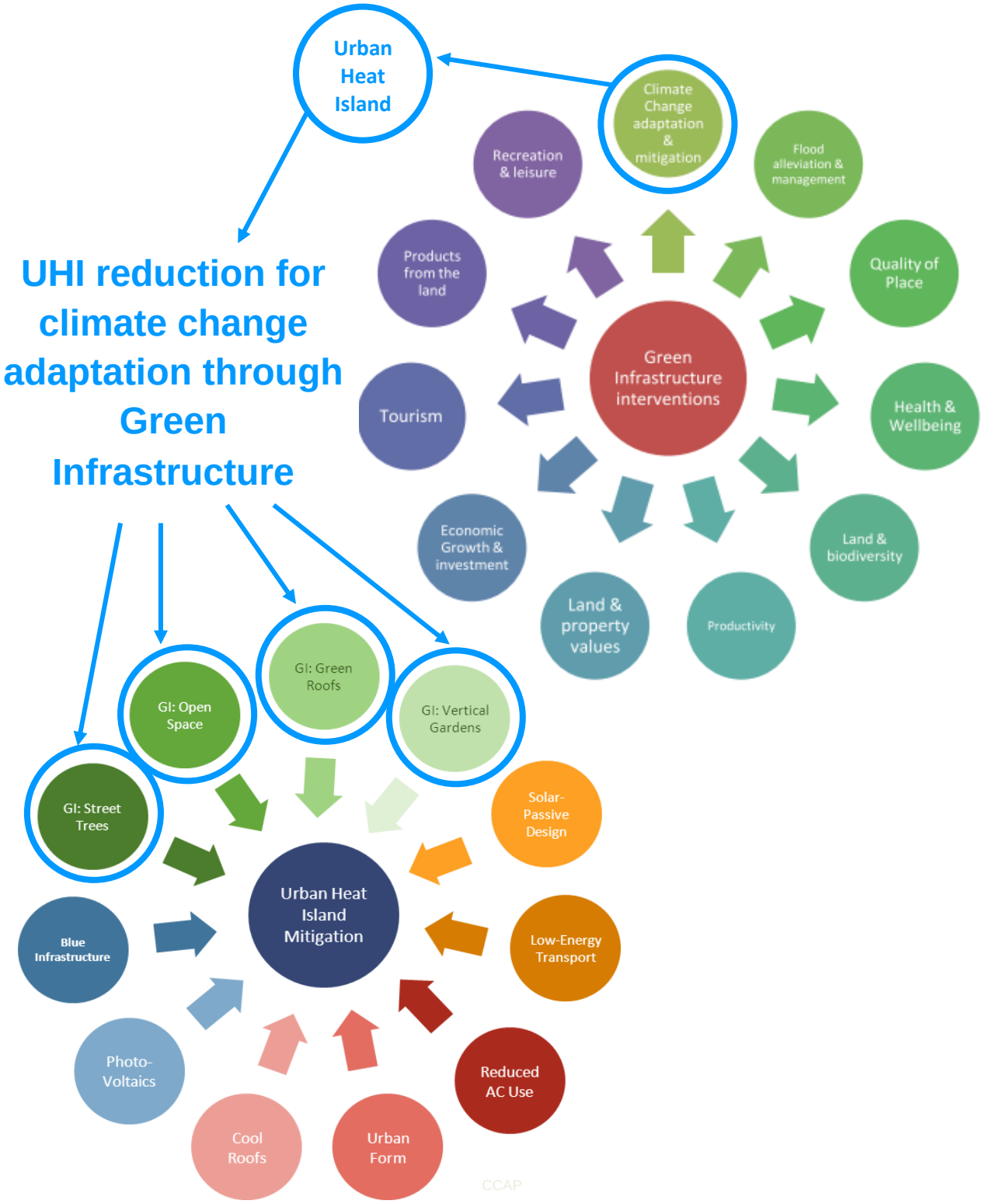

Figure 5 UHI Mitigation Strategies and the Co-Benefits of GI (CCAP & City of Liverpool 2008)

Water conservation

Most interviewees linked green with blue infrastructure; particularly water conservation and Water Sensitive Urban Design (WSUD) projects. Respondents suggested that this focus, in the Melbourne context, has been driven by the dominance of water conservation strategies during the decade-long drought and associated State and Federal Government policies. The association with WSUD emphasises the need for a multi-objective approach to GI implementation. One example that was noted was that the integration of WSUD into hard or existing open spaces allows use of stormwater rather than potable water for GI maintenance; as well as pollutant runoff management, improved water filtration, reduced impacts of initial storm flows and subsequent urban flooding. Although presented here as a key enabler, it is worth noting that a number of respondents mentioned that certain water conservation measures and policies in the past had also led to reductions in GI at local and household scales, where 'green spaces' were replaced with artificial turf and hard surfaces to address water restrictions.

Reduced costs of 'hard' infrastructure

For a number of participants an equally if not more important role for GI was to reach beyond the support of WSUD and to reduce the need for costly 'hard' infrastructure such as pipes and stormwater drainage; as well as improving economic efficiencies, productivity, and costs of drainage management. As with UHI, the relative costs of different forms of water infrastructure vary significantly spatially across the city, largely due to relative distance from reservoirs, treatment plants and stormwater exit points into Port Phillip.

Natural hazard impact reduction

A few interviewees suggested that certain forms of GI could also reduce the consequences of natural hazards beyond heatwaves. One respondent suggested that because tree canopies slow rainfall impact and tree-trunks direct water into permeable soils, potential storm impacts are secondarily reduced. Because of potential lessening of natural hazard impacts, one respondent argued that GI can also help reduce the 'down time' of damaged infrastructure and thereby recovery costs following extreme weather events. These observations also reflect one of the dominant drivers behind WSUD, which is frequently justified on the basis of reduced storm-water flow.

Sense of connection to environment

An increased appeal of urban public spaces was argued to be a key enabler of public acceptance and appreciation of GI, and conversely, a co-benefit. One interviewee suggested that local stakeholder involvement in the design, establishment and maintenance of local GI enables individuals to express their concerns for the environment and/or climate change in their local area. This kind of active community involvement was described as both empowering and rewarding. Such insights are salutary for any efforts toward increased establishment of GI across the Melbourne conurbation.

Contributes to an area's liveability

The role of GI in enhancing an area's 'liveability' was identified as the strongest community-level benefit from a local government perspective. Useable and accessible GI was seen as fundamental to community support for and 'ownership' of public open space, particularly with respect to community members being able to exercise and relax in such spaces. However, the degree of this co-benefit was argued to be dependent upon both scale and location; smaller open space restricts activity and capacity to relax, while the scarcity of open space in higher-density areas heightens its value in certain localities. Such considerations also parallel findings in the literature regarding the importance of network design in its contribution to UHI reduction.

Building energy efficiency

While interviewees were unable to identify information or data to quantify the role of GI in reducing energy demand, there was a general sense from the participants that there is potential for both energy savings and improved energy efficiency through the shading and insulation of buildings. This is consistent with observations in the literature; for example a study in Auburn, Alabama, USA, estimated that every 10% increase in shade cover would reduce electricity consumption by 1.29Kw/day for a 'typical' house (Pandit & Laband 2010). A key issue in this argument is that such benefits are individual rather than social, a disparity discussed below.

4.2.2 Policies that support 'co-benefits'

Policies and strategies aimed at streetscapes, open spaces, sustainable urban design, and WSUD, are considered to be ideal vehicles for an increased uptake of GI, as they support the notion of 'co-benefits'. Moreover, the imperative to reduce the UHI provides an additional argument in any business case for these existing policies, strategies, and programs. All participants indicated that their council had some form of policy and/or strategy aimed at (or that could incorporate) increased greening of the municipality. The research suggested that Water Sensitive Urban Design (WSUD) or stormwater management appear to be the primary drivers for GI and related open spaces in the Melbourne context (examples are in Appendix A). Findings also indicated that there is an extensive, albeit broadly uncoordinated, amount of work aimed at improving the 'green or open space' across Melbourne's urban landscape, all of which could support efforts to moderate Melbourne's UHI.

4.2.3 Provision of public (and private) good

If urban heat is to be effectively managed at a city-wide or landscape scale, GI programs need to engage a full spectrum of actors. Although co-benefits were highlighted and a number of potential levers and opportunities for encouraging the implementation of GI were identified, it was equally evident that there is somewhat of a divide between those who implement or fund GI projects and those who stand to benefit. Benefits were generally described as being divided between the public at large – where establishment of GI reduces ambient temperature in public open space and streetscapes improving broad thermal comfort - and those available to individual landholders or building occupants – where GI provides insulation for individual buildings, benefiting energy efficiency, and reducing energy costs. This differentiation, more than the nature of the benefits themselves, appeared to be a key factor in determining the extent and type of GI implementation. Interviewees suggested that those projects perceived to share the benefits across multiple stakeholders appeared to have greater chances of implementation.

Importantly for the focus of this study, using GI to moderate urban heat can provide cross-scale benefits, therefore not only presenting a key opportunity for engagement across a range of stakeholders, but also an opportunity for policy synergies. Table 1 below provides examples of the different collective and individual costs and benefits of one form of GI - green roofs.

Private (building-level) benefits	Public (building-level) benefits
• Increased service life for roof membrane • Reduced energy use for cooling • Sound insulation • Food production • Aesthetic value	• Reduced stormwater runoff expenditures • Reduced urban heat island • Improved air quality • Reduced greenhouse gas emissions • Improved public health • Aesthetic value
Private Costs	**Public Costs**
• Net cost of green roof • Maintenance costs	• Program administration and setup

Table 1 Private and public benefits and costs of green roofs (Rosenzweig *et al* 2009)

Government interviewees were most interested in the 'collective' benefits of GI. Community health issues in terms of reducing extreme heat impacts, as well as 'liveability' and 'active lifestyles', were the focus of this particular group. Consequently, their interest focused largely on the role of public open-space and streetscapes; though inner city council respondents discussed the limitations of open space due to issues of density, occupancy and social characteristics. Local government participants generally argued that most municipalities focus on public spaces because the ability and capacity of councils to modify privately-owned land is limited. However, a handful of respondents discussed the importance of community engagement in addressing this challenge, including the role of urban agriculture and 'home-grown' food or 'smart garden' programs. Certainly, projects such as 'Greening the West' (a partnership between City West Water and a number of

western Melbourne industry and local government partners) are aimed directly at collaborating with private landholders to achieve a more landscape-wide effect.

Conversely, respondents interested in allotment or local development scale implementation, such as architects and landscapers, focused on the individualised benefits to be derived from GI. In particular, energy saving for building interiors, marketing and aesthetic benefits, and private access in areas of GI scarcity. Interestingly, these participants did not raise the potential for GI to generate health benefits; suggesting an opportunity exists for policies that support and/or encourage GI implementation in private property development.

International literature also suggests that the benefits derived from GI vary significantly between GI types and locations (Gill et al. 2007; City of Liverpool 2008). For example, large open spaces presents numerous aesthetic and health benefits, but high density, inner city areas provide limited opportunities for this form of GI. However, the economic (energy-efficiency), recreational, and aesthetic benefits derived from rooftop intensive gardens for instance are often limited to building occupants. Consequently, a collection of co-benefits from one type of GI may outweigh the capacity of another type to reduce surface-level temperatures. The need to allow for these kinds of variation in benefits is clearly a central consideration for any strategy or policy response.

4.3 Implementation Barriers

The interviews highlighted a number of institutional barriers to the implementation of GI to address urban heat, several of which were paralleled in the literature. Identification and a better understanding of these barriers can help to inform broader policy reforms and options.

4.3.1 Lack of technical guidance

Several participants argued that while there is a large amount of information about differing aspects of GI, it is not consolidated enough to provide sound and reliable guidance to planners and other relevant policy practitioners. This is a gap at which the project GIIG was aimed. [Moreover, this small but significant finding suggests that the GIIG should not attempt to provide guidance on every single aspect of GI, but rather be a roadmap, portal, or central point of reference through which detailed information can be sought from pre-existing information and guides].

4.3.2 Costs

Every interviewee raised the issue of costs associated with establishment and maintenance of GI. In short, the more complex and innovative, the more costly. Most interviewees guessed that street trees would be the cheapest GI option and green walls the most expensive, high-maintenance option on a coverage basis – an assertion consistent with empirical assessments in the international literature (see for example, EPA 2007). While GI such as street trees and rain-gardens were seen as achieving multiple outcomes, several interviewees described costs, time, and expertise as particularly prohibitive to the implementation and maintenance of green walls and roofs. One example provided was a trial green wall that was starting to look a little 'scruffy' due to a lack of maintenance funding and thereby considered a poor 'ambassador' for green walls generally. A number of the interviews indicated similar experiences with green roofs.

Another cost-related concern was associated with the situation when 'greenspace' or GI has been incorporated into a development and then the subsequent management of the public space in that development - including the GI - becomes a council responsibility irrespective of council financial and technical capacities. This raises an important issue for a strategic approach to the implementation of GI. If State Government is to enable and support local governments, communities, and businesses, then a better understanding of costs and benefits is required. While there are some arguments in the literature that 'in any comprehensive and fair calculation urban trees and landscapes are worth more than they cost' (Moore 2009), this needs to be assessed and documented for the Melbourne context. Moreover, just as any GI program must address multiple objectives, any cost benefit analysis should also explicitly consider the range of multiple benefits.

Some respondents also suggested that the cost of thermal mapping and identifying 'hotspots' was limiting strategic planning. Yet, while the need for an evidence-based approach was emphasised by several participants, such detailed technical understanding of urban heat dynamics was not seen by all respondents as necessary in planning and implementing GI. Several participants argued that where technical expertise and data is either not available or prohibitively expensive, the UHI issue can be addressed through a

more simplistic, binary model, where satellite photos and existing GIS data can be used. It must therefore be critically considered whether locally-specific quantification of the aforementioned multiple benefits is either justifiable or cost-effective once the generalised net benefit of GI has been established.

One example of a simpler approach to 'hotspot' analysis is the Greencover Demonstration Project in Penrith and Liverpool in NSW (NSW Government Architect 2011). The approach used "provides a lower cost alternative to expensive thermal imagery processes by using aerial photos and site visits to identify and map existing GI, roof types, and 'heat island effect contributors' such as roads, pavements, carparks etc" (*ibid*). The produced maps (e.g. Figure 6 below) can then be used as the basis for targeting urban heat "hotspots" and strategic GI planning on a coverage basis.

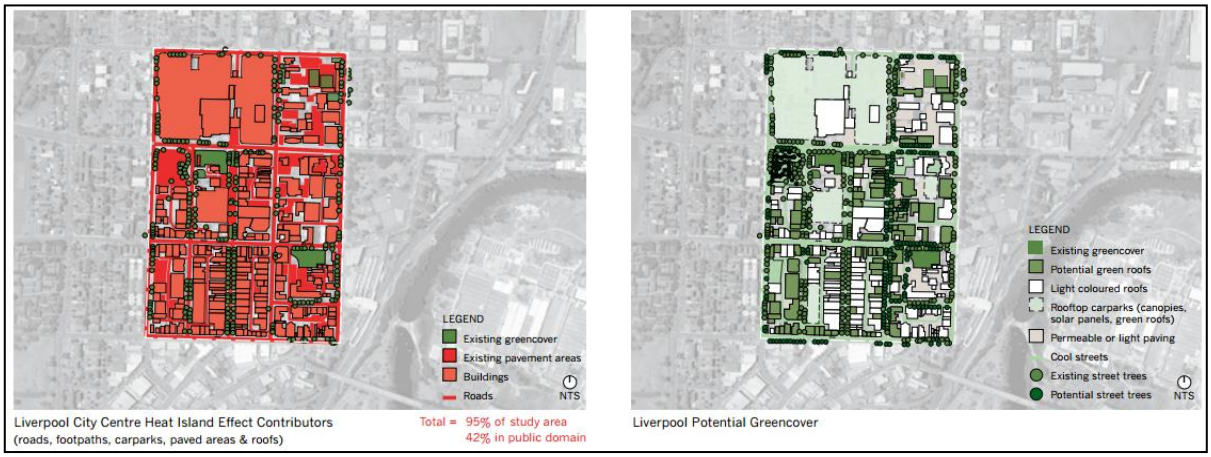

Figure 6 Greencover Measurement & Application Approach (NSW Government Architect 2011)

4.3.3 Spatial variability of urban heat and land use change

As mentioned earlier in this report, the research identified significant spatial variability in UHI effects and physical enablers of local GI implementation. The diversity of these spatial contexts highlighted that development of a State-level strategy must provide for flexible, innovative responses that, as argued above, are underpinned by a broader vision of metropolitan Melbourne's GI. The spatial variability of Melbourne's urban heat profile, along with changing land use patterns of different municipalities (particularly those with a shifting urban growth boundary and rapid population growth) and variability in the capacity of local stakeholders to implement GI, highlights several policy issues. Primarily, policies aimed at increasing GI implementation to moderate urban heat need to provide some guiding principles for application of a range of options that can address different physical, spatial and institutional contexts.

For example, a consistent narrative throughout the interviews was the idea of an East-West disparity in existing green coverage and space; with emphasis by participants on the perceived wealth of the eastern municipalities and their leafier suburban character. This disparity presents particular challenges for State-level policies aimed at encouraging canopy coverage and/or GI to address urban heat across the broader Melbourne conurbation; namely, the need for contextually-specific variations in implementation, informed by existing differences. This challenge is highlighted by the very title of the 'Greening the West'

program, which is currently being undertaken across a number of western municipalities (www.planbig.com.au/greening-the-west). Several interviewees from western councils highlighted that this distinctive GI distribution was due to variation in average annual rainfall across the city (Figure 7), and thereby the city's western native vegetation tends to be of the sparser, drier systems such as those occurring in the bioregion known as the Victorian Volcanic Plains (DSE 2007).

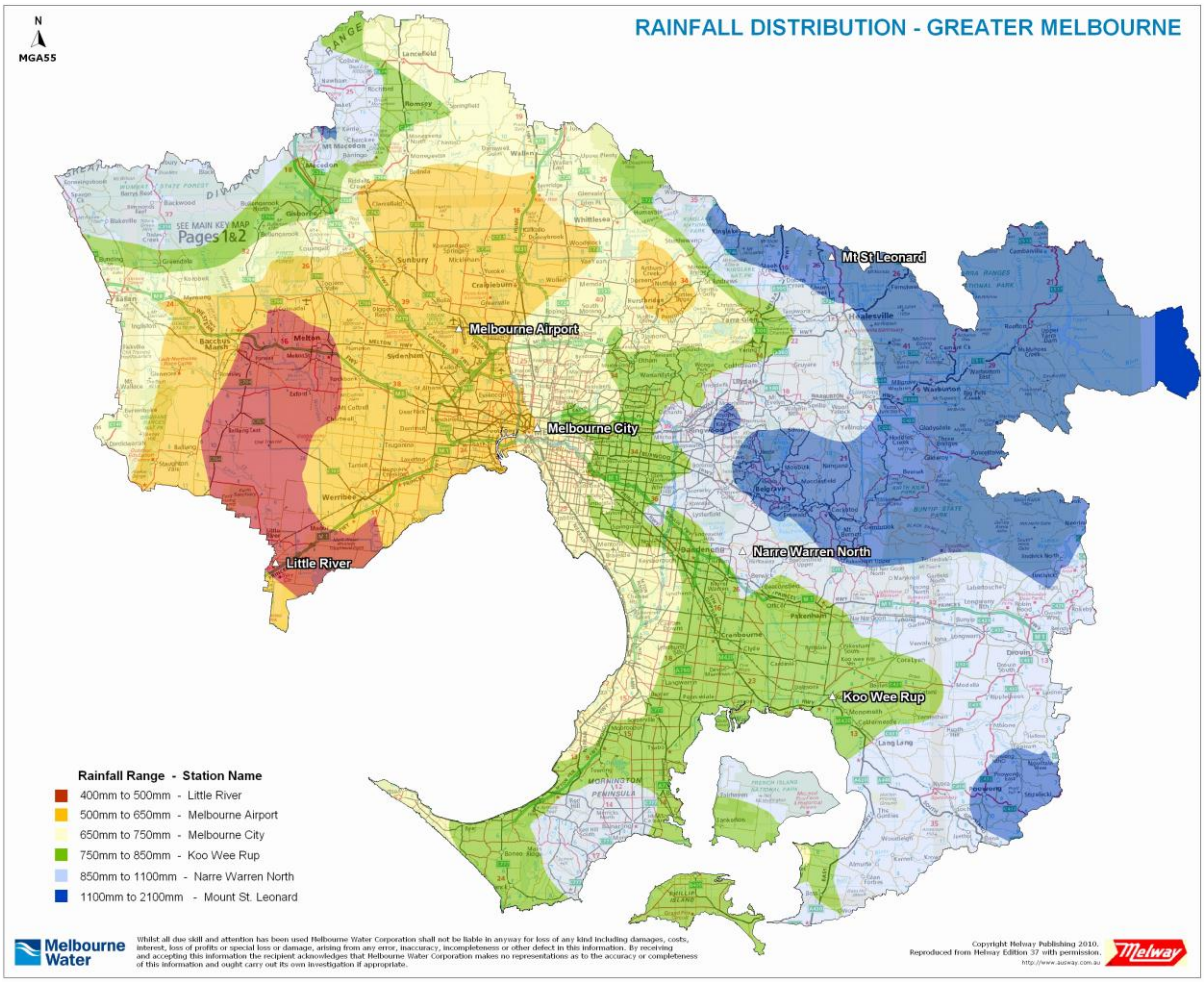

Figure 7 Rainfall Distribution across Greater Melbourne (Melbourne Water 2010)

A consequence of these (drier) landscape characteristics is that some western municipalities struggle to keep street trees alive, particularly during periods of low rainfall. Interviewees also drew links between daytime UHI extremes in the west during recent heatwave events, rainfall patterns, and local interest in using GI for UHI moderation. For example, there was concern that, given the west's higher temperatures and lower rainfall, maintaining recent street tree plantings presents a large enough challenge for local councils, without adding the additional complexity of a program that expanded both the coverage and types of GI being implemented. State-level policy would need to recognise these concerns in order to engage western municipalities, and avoid framing the UHI effect as an inner city, high urban density, issue. Thus, it requires a focus beyond the use of nocturnal thermal imagery for the identification of 'hotspots', at an appropriate scale to have actionable implementation areas.

If GI coverage is to be improved across the entire metropolitan area, then existing patterns of vegetation distribution provide a logical starting point for the analysis of barriers to and opportunities for development of city-wide green infrastructure initiatives or policies.

4.3.4 *Local Government Capacity and Resources*

Directly related to the costs of establishing and maintaining GI was the broader issue of varying financial and resource (human, infrastructure, skills) capacity among Victoria's local governments. An example of variation in financial capacity across urban councils is that the smallest council has an annual budget of $6 million per annum while the budget of the largest is $312 million (VCEC 2010). Similarly in 2008-09, the Borough of Queenscliff employed 44 staff, while the City of Melbourne employed 1211 people (Borough of Queenscliff, 2010:30; City of Melbourne 2009:12). One respondent stated that because their council has limited funds they are unable to explore a range of GI options, consequently restricting themselves to approaches currently considered reliable.

A simple lesson here is that current knowledge and experience surrounding implementation needs to be shared across council boundaries if a city-wide GI policy is to be considered. Programs such as City West Water's 'Greening the West' may go some way to promote this (as might the GIIG developed for the VCCCAR project). Numerous reviews of GI planning and implementation recommend increased grants and funding for GI establishment (e.g. NDRC 2011). However, one respondent in this study argued that currently available grants are short-lived and lack long-term strategic vision. Moreover, while such grants may support initial establishment, they do not adequately account for the long-term maintenance programs required for GI (a situation likely exacerbated by the absence of a long-term strategy or program). These findings suggest that a valuable policy support mechanism would be recurrent, strategic, funding for GI that meets individual local requirements.

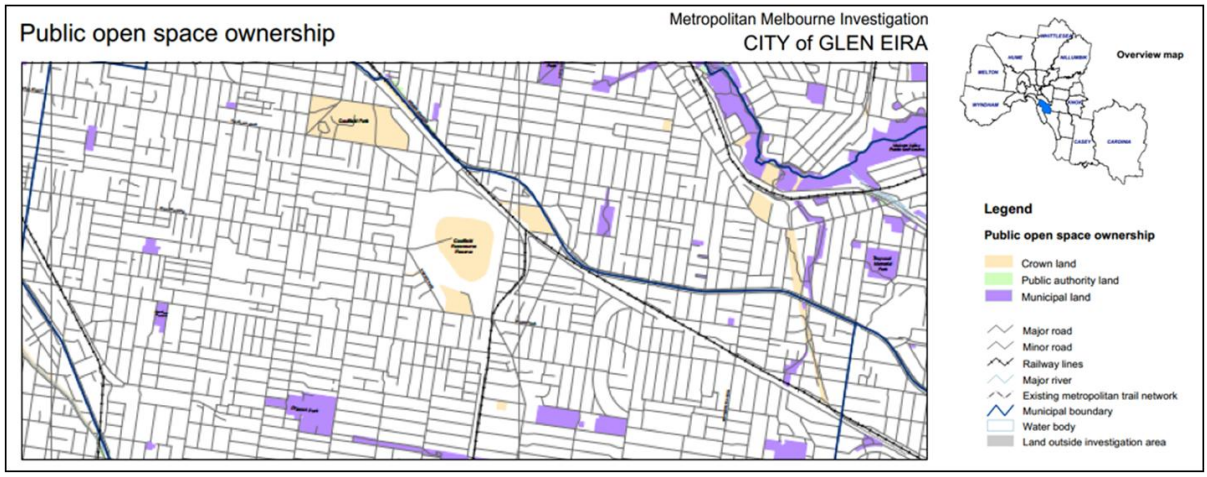

Figure 8 Extract from a VEAC analysis of land ownership across Metropolitan Melbourne (VEAC 2011)

4.3.5 Land Ownership

One of the most obvious and perhaps challenging findings of this study was the reality that greater implementation of GI to address UHI through management of local council-owned land alone is unlikely to achieve a city or municipality-wide reduction in (or avoidance of an enhanced) UHI. In large part, this is due to local councils having limited ownership or direct control over the management of land, as demonstrated in Figure 8 above.

Victoria's metropolitan municipalities cover 562,740 Ha, of which only 16% is public open space (VEAC 2011). This land is also unevenly distributed across the region; for example, an outer urban council like Nillumbik has 27% open space, while an inner city council such as Glen Eira has only 6% (VEAC 2011b, VEAC 2011c). Additionally, council ownership of this land is similarly variable, limiting their capacity to directly implement GI. In all, local council owned public open space makes up only 2.8% of the entire metropolitan area (VEAC 2011). As a result, reliance on council-controlled open space as the primary mechanism to address UHI would not produce optimal outcomes.

At the same time, the amount of GI on private properties appears to be shrinking (DSE 2011). To date, the relationship between the growing scarcity of GI and open space access, and the willingness for joint private and public investment in GI projects remains largely unexplored in the peer-reviewed literature. Nonetheless, interview data correlated with the limited literature on the matter that was available, which indicates that "in growth areas where the largest proportion of Melbourne's new housing is being constructed, lot sizes are becoming smaller while house sizes are increasing" (Goodman *et al* 2010). In this context, addressing UHI (created by growing urbanisation) through GI is limited where little room remains for any vegetation on individual private properties. Therefore, if city-wide changes in GI coverage are required to achieve similarly-scaled cooling objectives – such as a British proposal to reduce Greater Manchester's UHI by 2.5% through a 10% increase in GI coverage (Gill et al. 2007) – then regulation and incentives for GI on privately-owned land

will need to be considered, alongside co-ordination with state-level utilities and other government agencies. This presents a novel opportunity for a sophisticated program or practice that works with a range of decision-makers, such as residents, private open-space owners, developers, and industry.

4.3.6 Understanding and communicating the challenges and values of GI

An interviewee from a western council highlighted that although there was great enthusiasm for various forms of GI, they thought that, until recently, staff did not really appreciate how difficult plant establishment is in the area because of the dry and poor soils that typically carried very open woodlands or grasslands. Moreover, one interviewee described a situation of good intent, but that "prior to 2002, whatever species were in the glasshouse were the species used", rather than species known or understood to perform particular functions. Most research that had been conducted by councils into vegetation options and species was focused on a singular function or objective (e.g. warm season grasses for sports fields or tree species able to cope with extended drought periods), and often lacked scientific rigour; namely, evidence was built mostly on trial and error and based purely on plant survival rates. One participant stated that the fact that many of these (unsuitable) plants died was then used as an argument against further investment in GI (although the respondent also stated that such resistance has largely dissipated since the breaking of the 1997-2010 drought). Such findings indicate important considerations for any GI program; that sound guidance (species selection, maintenance, and evidence of success) is needed to support policies and/or strategies.

While there seemed to be a wide variation in the extent of awareness and acceptance of GI across councils (as a mechanism for directly addressing the UHI), some respondents argued that it is a new concept for communities and presents a communication challenge for governments and other interested stakeholders.

4.3.7 Whole-of-government approach

Many respondents suggested that while they are aware of a myriad of information and data, it is not provided or available in any consolidated manner that acts as a useful guide for development of local GI policies. Many also suggested that there is a distinct lack of clarity in the overarching policy context and a more coherent, coordinated or regional approach between the different municipalities is needed. For example, while the Victorian Heatwave Plan encourages state and local government to 'foster better urban planning that addresses climate change and promotes heat-proofing the built environment' (p6), only generic advice is provided and largely directed at a reactive, or at best pre-emptive, framework in the event of a heatwave occurrence.

Moreover, interviewees consistently made the point that perceptions of the value, purpose and management of GI among different groups of people was an important influence both on policy development and very often on GI establishment and maintenance. For example, 'engineering' departments were consistently described as being concerned about the potential for the root systems of street trees to wreck roads, footpaths, and pipe

infrastructure for water, gas and electricity. According to one respondent, differing perceptions of the purpose and value of initiatives such as rain-gardens meant that their program took eight years to be considered, let alone established, within their local authority. Learning from such experiences can only improve attempts to establish different GI options that, arguably, might be considered even more avant-garde than rain-gardens: green roofs and walls.

Varying levels of policy influence

Broadly speaking, local planning choices and decisions surrounding GI operate within a layered policy landscape that is not necessarily hierarchical. Although new developments in growth areas occur at a council scale, the actual decision-making process appears to often be a negotiation between developers and State Government, with local council only able to provide minimal input. For example, plans at the 'precinct scale' are designed by developers, with input from local council, but were ultimately approved by the Victorian Minister for Planning on advice from the statutory Growth Areas Authority (GAA). This highlights that while an Open Space Policy provides councils a key mechanism for being directly involved in decisions surrounding the approval and implementation of such developments, ultimately broader State Government has greater influence over the design, approval and implementation of large urban areas such as neighbourhood or precinct scales. As discussed earlier, the challenge of such interacting policy (and decision) scales is that UHI 'hotspots' may not occur on lands whose development and management councils can directly modify or influence. This is irrespective of the vulnerability of these locations to heatwaves or the UHI (such as old-persons homes, disadvantaged areas, childcare facilities etc).

Some interviewees reinforced a concern raised in a VCEC report (2010) about consistency in the application of any Federal requirements: "there are persistent and increasing concerns about significant problems associated with the use of the planning system to improve the environmental performance of buildings. Generally, these include creating other inconsistencies across councils, potential for overriding state building regulations, and eroding the benefits of national consistency". The same report identifies the need for flexibility in such requirements: "State governments including Victoria can make variations to the *Building Code of Australia*, thus if the Victorian Government considered that standards for the environmental performance of new buildings are too low, it could seek to enact regulatory changes that would give effect to its objectives". This flexibility would appear to aid local application of national standards to suit a particular environmental context without undermining the strategic intent of a Federal standard. A cautionary point is that any legislative or policy requirements for GI implementation would have to be broad enough to allow for spatial variation in climatic and environmental conditions, urban type and development, and UHI impacts across Melbourne's diverse urban landscape.

4.3.8 *Land use planning and development*

A number of respondents identified that the State's Planning Scheme could give GI credence and importance via provisions of key principles, with many respondents suggesting that the Victoria's Planning Scheme does not currently reflect the goal of enhancing GI or open space. The weakness of the Planning Scheme in this area was seen as being a constraint on council actions, as council strategies are not incorporated documents and are therefore not a legal requirement (rather are voluntary) when applied by developers. Without clear state-level policy to back council guidelines and strategies, implementation beyond council owned land and property relies on the good will of developers and has consequently been limited.

In light of this issue, four municipalities recently submitted "Amendment C117 Local Planning Policy – Stormwater Management (Water Sensitive Urban Design)", a local planning policy proposal, to the Minister for Planning. According to the City of Port Phillip's website, the policy aims to "encourage new developments to incorporate the use of best practice stormwater treatment measures (water sensitive urban design) in their planning applications". A number of GI-related WSUD options are among potential measures identified within the proposed policy as components of vegetated swales and buffer strips, rain gardens, wetlands and suspended growth biological processes.

One respondent also suggested that "limitations within the planning system … with respect to driving sustainability [are often due to a] lack of data, lack of verified response measures, and the absence of 'source policy' (from relevant agencies - and the 'business case' rationale and funding model to provide authorisation of the change) … it's rarely that a simple fix to planning provisions will solve the problem despite the common hope that planning provides the magic formulation". A number of the planning issues that, according to respondents, will influence strategic GI implementation to address UHI are discussed below.

Zoning

One industry representative explained that green roofs and vertical gardens are currently marketed towards medium to high-density developments because these urban forms better distribute installation and maintenance costs. This cost-sharing approach, coupled with increased demand for (and reduced supply of) GI in built-up areas, presents a potential opportunity for both policy focus and industry-engagement, albeit driven by individual or organisational GI co-benefits rather than the predominantly social goods derived from reduced surface temperature.

Integration of commercial and industrial developments through 'mixed-use' zoning was also seen as providing conditions that are amenable to the incentivisation of vertical and roof-based green infrastructure, with the marketing and aesthetic benefits being perceived as having immediate returns for business; in contrast to the delayed re-sale benefits derived from a residential property. In some instances these desirable marketable qualities may even outweigh the social goods themselves, with interior vertical gardens requiring high-energy lighting installations to ensure their survival, resulting in a positive net heat output and associated energy-based emissions. Such examples provide further evidence for the need for an improved whole-of-system understanding of the effectiveness of GI types and plant species in reducing local temperature, in order to prevent instances of maladaptation.

Growth boundaries & densification

As Melbourne's urban footprint both expands and intensifies over time, the characteristics of its GI options and the intensity of its UHI are similarly undergoing constant change. To date, indicators such as private ownership of open space are trending downward, while areas of government owned open space continue to be rezoned for development (VEAC 2011). These dynamic and temporal components present a challenge for GI management, with the continuation of current trends having the potential to counteract the positive impacts of current GI implementation efforts.

Projections of change to Melbourne's UHI suggest that under the recently superceded *Melbourne by 2030* plan, there may be an increase in nocturnal UHI of up to 2.6°C by 2030 (Coutts *et al* 2008, Figure 9 below). A practical example of this issue was highlighted by one respondent who suggested that consideration needs to be given to how best influence what happens in growth areas and newly rezoned brownfield sites, such as Docklands, which currently has only a 5% canopy cover.

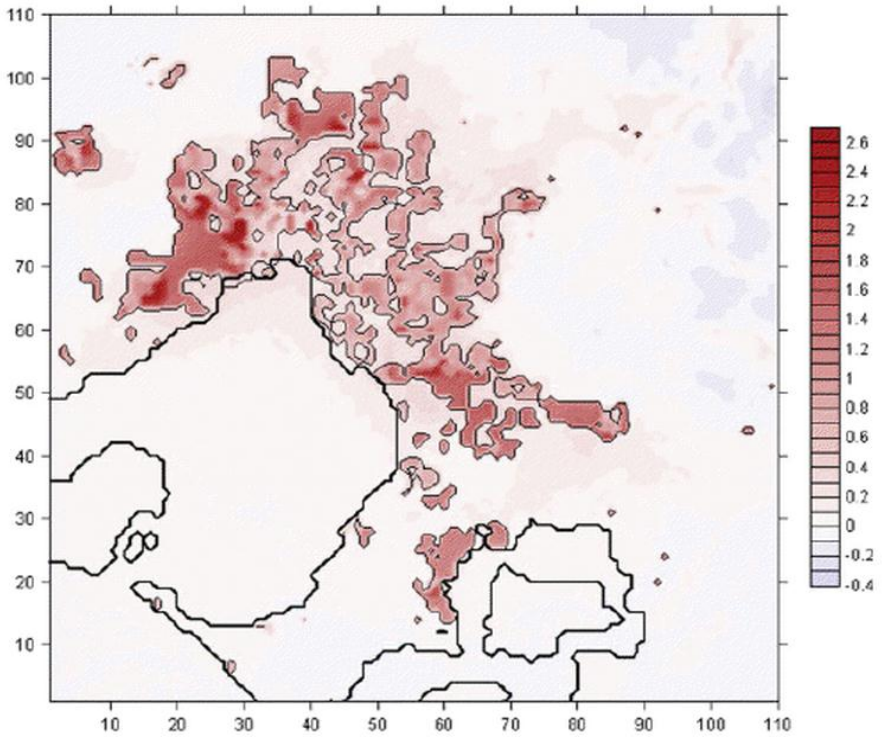

Figure 9 Change in Mean Night Time Temperature with planned development under Melbourne 2030 (Coutts *et al.* 2008)

Greenfield sites present different opportunities for GI implementation compared with those of re-development or retro-fit sites within existing suburbs. In particular, growth area council representatives argued they were limited in resources (as rates were yet to be paid by incoming constituents), decision-making power (much of which lies with the State planning minister and the Growth Areas Authority in these designated areas) and planning timeframes (driven by land release pressures). The literature reinforces this, identifying the demands of housing affordability and development speed as reducing the capacity to innovate, while shrinking lot sizes equally reduce the capacity for establishment of privately owned green cover (DSE 2011; VEAC 2011).

Potential role for the Growth Areas Authority (GAA)

There are a number of regulatory and planning areas where the Growth Areas Authority (GAA) could play a more active role in enabling GI in greenfields precinct planning, specifically targeting the day-time UHI impacts that are prevalent in Melbourne's growth areas. For example, the current GAA Engineering Design and Construction Manual (GAA 2011) does not explicitly consider issues such as permeable pavements, high thermal emittance surface materials, and sustainable product sourcing. Similarly, the Authority's Precinct Structure Planning Guidelines only prompt *consideration* of appropriate design responses for addressing heatwaves, while Open Space requirements do not require consideration of climate change adaptation (GAA 2011 p 25).

4.3.9 *Policy objective conflicts*

Roadside tree setback requirements

The Greater Shepparton Southern gateway Landscape Strategy (2006), refers to Figure 7 of the VicRoads 'Guide to Tree Planting within Road Reserves', which indicates that "the minimum desirable clear zone width is 3m for 85th percentile speeds of 60 kph, up to a 9m width for 85th percentile speeds of 95 km/h and over with approach volumes of greater than or equal to 5,000 vehicles/day" (Haworth *et al* 1997). One interviewee suggested that if the 3 metre setback "were applied to the letter of the law, there wouldn't be an avenue along Royal Parade". Such setback requirements not only conflict with GI objectives, they also appear to conflict with an increasing body of research that suggests roadside trees may actually slow driver speed and thereby reduce speed-associated crashes (*cf*. Wolf and Bratton 2006:175; Wilde 2010; and Rosenblatt *et al* 2006 & 2008).

Utility pipeline access and interference

Similarly, Melbourne Water has "standard pipe clearances in non-floodway areas for species that can be planted over or close proximity to underground pipe" (MWC 2009). These can readily be taken into account in any GI planning. However, an interviewee raised an interesting case on this subject. They suggested that some 60 year old trees were not able to be replaced because there was an argument that new trees will interfere with gas mains (even though the existing trees and their root systems have been there for 60 years). According to the Melbourne Water guide, "from a legal aspect, property owners generally have the right to plant any tree or shrub species in any location within their property. However, they become responsible for any adverse effects caused by their trees or shrubs to nearby buildings, footpaths, pipes, and other structures that may, or may not be within their property boundary" (MWC 2009).

Electricity line clearance

According to one source, electricity distribution businesses (DBS) are not required to undertake regular maintenance (pruning) of roadside trees to avoid impacts on above-ground powerlines. Yet when these trees (or parts thereof) impact powerlines as a result of storm, wind or other events, councils are held responsible for the 'disruption to distribution of supply'. The respondent suggested that on several occasions the DBS find it easier to remove the whole tree. This situation clearly has implications for the role of street trees as a GI option. According to the MAV's website (June 2012), Energy Safe Victoria released a discussion paper that "questions whether councils should continue to have a role in electric

line clearance. One option proposed in the paper is that councils' responsibilities be reallocated to the distribution businesses". The MAV "will stress that no council should have its electric line clearance responsibilities changed unless the council first agrees". Meanwhile negotiations continue (since late 2010) "to gain approval to use a risk-based approach … a strong need to balance the safety, amenity and environmental concerns of councils and communities" (MAV update 2012).

5. Prospects for Improved Implementation

Based on the analysis of the institutional enablers of, and barriers to, increased implementation of GI, this section of the report puts forward some considerations for Federal, State and Local government policies and programs. One of the most obvious and challenging findings of this study relates to the fact that local councils own or have direct control over the management of limited amounts of land. Accordingly, any attempts to genuinely address UHI across Melbourne's metropolitan region will require a coordinated effort between layers of government, businesses and communities. Project's like 'Greening the West' appear to be a good case study of attempts to provide a more coherent approach.

Many of the issues identified are consistent with findings in the international literature. Consequently, many of the recommendations draw from those studies, including recognition that GI strategies are primarily encouraged via incentives, zoning and permitting programs; as well as state and local government investments in public property (NDRC 2011). The following recommendations are presented within the context of the below caveat, taken from a Navigant Consulting report conducted for the US Department of Energy (2009), and several relate to further research to better inform policy and practice:

> *"Despite existing uncertainties about the overall magnitude of savings that can be accessed through public policy driven UHI counter measures the latter are still justified in many cases because the uncertainties are not so great as to require the delay in measures within urban areas that clearly stand to derive significant benefits from commencing ameliorative actions.*
>
> *Furthermore, the apparent potential scale of mitigation impacts from countermeasures targeting negative radiative forcing are so large that they justify a significant policy and research effort to clarify the phenomena and respond with policy efforts if the mitigation scales are validated." (NC 2009)*

5.1. Federal Government

Any legislative or policy-based requirements for implementation of GI similar to those applied internationally would have to be broad enough to allow for spatial variation in climatic and environmental conditions, urban type and development, and UHI characteristics across Australia's diverse urban and climatic locations. Nonetheless, a number of Federal policies, regulations and programs have the potential better support increased implementation of GI across Melbourne's urban landscape. These include:

5.1.1 Incorporation of GI objectives into Federal codes and 'roadmaps'

According to the Federal Attorney-General's website, on the 29th of June 2012, "Ministers considered the *Enhancing Disaster Resilience in the Built Environment Roadmap* to improve the consideration of natural disaster hazards in land use planning and building code regulation ……and successful implementation will lead to significant long term improvements to the resilience of Australian towns and cities" (SCPEM 2012). Incorporating

some urban design and GI objectives to reduce the impact of heatwaves and UHI more broadly, could be explicitly addressed in this roadmap.

Other opportunities lie in building codes and federal environmental legislation. For example, in Germany, widely considered the international leader in GI an in particular green roof implementation (Buehler *et al.* 2011, Hodges, 2011), green roof requirements are integrated into building codes and nature conservation legislation for cities. While these are implemented on a city-by-city basis, at a federal level in Australia there are legislative opportunities within the Building Code of Australia (BCA) and the Environment Protection and Biodiversity Conservation (EPBC) Act. The Federal Government might consider how each of these could better incorporate GI objectives to support the conservation objectives of the EPBC Act, and whether building codes could support broader purposes of moderating the UHI.

5.1.2 *Require a comprehensive assessment of heat event risks*

A Price Waterhouse Coopers (PWC) report (2011) points to "a range of infrastructure, urban planning and building measures that offer ways to reduce the extent of future impacts from heatwaves". Specifically, that report argues that "once the Australian government undertakes a comprehensive assessment of heat event risks, state and territory governments and local councils should ensure the results of this risk assessment are reflected in their urban planning and development approval processes" (PWC 2011). According to one of this study's respondents, the PWC recommendations present a good platform for collaboration at the federal level, potentially including the work of the Australian Building Codes Board (ABCB) – see above. However, another participant argued that undertaking such an assessment needs to acknowledge the complexity of heatwave thresholds and triggers, and that agreement on how these are defined, should be reached with the State's health departments.

5.1.3 *GI guidelines as a mechanism to improve older buildings' thermal comfort*

Price Waterhouse Coopers recommends that the Federal "home modification and maintenance element under the Home and Community Care (HACC) program would appear to be a prospective starting point to modify older buildings to improve the thermal comfort of at-risk individuals". Incorporation of GI measures could be one approach that could both complement and assist this objective. If revision of the program were to occur, GI guidelines could be incorporated; again, with the caveat of reaching agreement on thresholds and triggers with health departments.

5.1.4 *National (Infrastructure) Sustainability Rating Tool*

One interviewee also argued that the National (Infrastructure) Sustainability Rating Tool recently released by the Infrastructure Sustainability Council of Australia (formerly the Australian Green Infrastructure Council) provides a significant opportunity to transition to more sustainable urban development. However, the incentive for implementing GI to achieve 'climate change adaptation points' within the tool is limited as it focuses on identifying climate change impacts and risks, rather than treating them (AGIC 2012). It is not yet clear as to whether strategies such as GI can contribute across multiple tool categories; however

such an approach may further incentivise implementation due to its additional benefits, such as energy efficiency and ecological connectivity. Other accreditation schemes, such as the Green Building Council of Australia's Greenstar rating tools (GBCA 2011), also provide further opportunities that are discussed further in the project's Green Infrastructure Implementation Guide.

5.2. State Government

Seattle, Malmo, Stuttgart, Berlin, and the Mersey Forest in the UK, may provide some internationally leading examples in how to address some of the challenges identified in this study. 'Other Sources of Information' in the references section lists a number of reports and guidelines relating to these initiatives. While there are some examples in Europe of city-wide compulsory green roof targets incorporated into planning schemes, it would be difficult to justify such an approach in the case of Melbourne's more varied urban landscape and disaggregated local government system. Nonetheless, based on the interview data, there a number of actions the State government could undertake to support greater implementation of GI to address Melbourne's existing UHI and to avoid further intensification into the future.

5.2.1 Undertake state-wide GI planning

To achieve a co-ordinated, whole-of-government approach to improved GI implementation, particularly as it relates to addressing the UHI, the State might designate a lead department responsible for coordinating and integrating state programs. That department could:

- Establish a vision for metropolitan Melbourne's GI (and reduction of the UHI).
- Facilitate coordination among state, regional and local bodies to achieve the subsequent recommendations. In particular, state-wide planning should support and facilitate local government in its planning, implementation and advocacy role.
- Ensure that GI and WSUD planning are integral parts of the state's planning alongside transport and communication infrastructure. A first step could be final approval of the proposed Local Planning Policy Amendment c117. Seattle's *Green Stormwater Infrastructure Best Management Practices*[2] provides a working example.
- Establish policy dialogues that help raise awareness of the UHI phenomenon, the significance of its impacts, and mitigation potentials, and of the range of policy options that can be deployed. These dialogues should aim to consider the best way to roll-out UHI countermeasures while supporting efforts to minimize uncertainties; and inform key state and local government officials such as energy and planning advisors of the significance of UHI and opportunities and mechanisms to abate it.
- Develop a UHI online clearinghouse where all relevant information is stored and maintained (similar to that provided by the US EPA), through which decision makers can have access to tools and expertise (an online GIIG is proposed as an ideal hub for such information).

[2] The Seattle Green Stormwater Infrastructure Best Management Practices is available at: http://seattle.gov/util/About_SPU/Drainage_&_Sewer_System/GreenStormwaterInfrastructure/StormwaterCodeCompliance/index.htm

- ❖ Establish mechanisms that:
  - Assess the expected temperature, radiative forcing, urban air quality and energy use impacts of the systematic adoption of key countermeasures such as cool roofs, roadways, pavements and green areas at the national level;
  - Calculate and value the CO_2-equivalent mitigation impact of the countermeasures;
  - Determine the cost-benefits of the adoption of such measures from a public-good and private stakeholder perspective;
  - Monitor and report on progress in implementing countermeasures and on determining the associated impacts and cost-benefits; and
  - Allow for variation in achieving a range of objectives and mutual benefits.

Provide baseline data for improvement measurement

Effective and efficient UHI moderation policies will be those targeted at low-GI, high-surface temperature localities. Correlations have been shown between localised thermal UHI impacts and vegetation density in numerous international studies (Corburn 2009, Foster *et al.* 2011). Consequently, State Government could produce comprehensive maps of public and private vegetation across metropolitan Melbourne, building upon the VEAC study of 'open space' 2011. The State could facilitate consolidation of existing data of public *and* private 'greenspace', and if necessary, undertake measurement of the public and private vegetation/GI mix across metropolitan Melbourne, as a baseline against which to measure progress.

5.2.2 *Provide an overarching policy framework*

Through sound policy analysis, State Government can support coordination of policy levers, and incorporate GI requirements and guidelines into relevant policies, standards and manuals, or at the very least, ensure existing policies and standards do not pose an unreasonable barrier to GI. This study has identified several policy portfolios, standards and manuals that could be revised or utilised in support of increased GI implementation to address Melbourne's UHI.

Infrastructure Design Standards

Implementation of the new Infrastructure Design Standards and associated processes across all Victorian Councils may enable infrastructure design, particularly in new subdivisions, to address climate change issues and opportunities (see *Subdivision Act 1988* part 3, section 16-17) (Victorian Government 2011). One respondent suggested that these activities have been complemented further by the federal government's Local Government National Reform Fund supporting councils in the areas of asset management and financial sustainability. Using such standards could support greater implementation of GI in developments such as Melbourne Docklands.

While technical recommendations are beyond the scope of this component of the research project, an option that might be considered for incorporation is the setting of on-site stormwater retention standards to help manage stormwater and to address other regulatory and/or planning issues. For example, in Philadelphia, the first inch of rainfall must be

managed onsite through infiltration (if feasible) in all new development and redevelopment projects with at least 15,000 square feet of earth disturbance; in Pittsburgh, the first inch of rainfall must be retained on-site through infiltration, evapotranspiration, or rain harvesting for new development and redevelopment larger than 10,000 square feet (NRDC 2011). This serves as another example of the closely integrated relationship between green and blue infrastructure.

GAA's Manuals

The Growth Area Authority's (GAA) Infrastructure Manual plays a central role in providing the constraints under which greenfield precinct development and design occur. The Manual's ongoing review process provides an opportunity to explicitly integrate UHI and GI concepts, and could provide an appropriate platform for setting out explicit GI requirements. One participant identified that as the Manual and its associated GAA processes aim to expedite council engineering approvals (by ensuring that minimum design criteria are met), it may also be a useful platform for familiarising contractors with more unusual or contemporary GI designs and technologies, which they may otherwise be less familiar with.

Department of Transport's street tree setback policy

In light of an increasing body of research showing that 'more trees' tend to reduce driver speed, VicRoads could review its tree setback requirements in urban areas, particularly in streets where the speed limit is 50kph or less.

Departments of Health and Human Services

The state could promote, link and possibly fund UHI moderation through GI – primarily because numerous GI benefits relate directly to health and well-being. For example, six of Australia's top ten disasters in the past century were heatwaves, and the top two in the southern states were those of 1939 and 2009. In the 1939 event, 438 people died. In the 2009 event 404 people died.

Living Melbourne, Living Victoria Policy

Simply put, the State should implement recommendation 3 of this policy: "coordinate and/or support Melbourne specific research into quantifying associated cost/benefit of green infrastructure".

5.2.3 *Design and implement programs to support establishment of GI*

- Provide finances, information and skill sets to local government and local communities via support programs for green/blue infrastructure initiatives. These can be modelled on initiatives such as Seattle's Residential RainWise Program that uses a web-based tool to explore different Green Stormwater solutions for private property, find case studies contractors, and additional information.
- Develop GI demonstration projects for testing and monitoring at both building and neighbourhood scales.

- Coordinate investment of limited resources (both capital and revenue) throughout an extensive geographic area. City West Water's 'Greening the West' program is likely to be a good case study of such an approach.

5.3. Local Governments

The recommendations below relate to the development and implementation of a local government policy or strategy aimed at GI implementation to address UHI.

5.3.1 Develop a long-term GI plan

There are a number of international guides for strategic planning for GI in local government areas. Moreover, there appear to be a relatively consistent set of steps within these guides. Simply *having* a strategic GI plan is a crucial first step to enabling greater implementation of GI across LGAs. A review of a range of literature and guidance suggests several key tenets to any strategic plan, examples of which are outlined below and, where possible, links to illustrative examples provided.

Consider a range of scales

Council plans should consider the three scales at which GI planning and implementation can occur: local/site, neighbourhood and municipal. Local/site-based implementation can include a combination of rain gardens, green roofs and walls, and permeable pavements etc. Neighbourhood scale includes street networks, parking arrangements, integration of residential and other street uses. Finally, the municipal and strategic level planning considers the arrangement of council open space, infill development, and future or planned development.

Have an analytical and evidence basis

A long-term, strategic GI plan should, ideally, be based on identification and analysis of the following points. These will help inform a strategic plan that will likely incorporate a range of actions; including GI installation, policies (direct and indirect), regulations, and incentives.

- Stakeholders and potential partners who (may) benefit from, and lobby for, green infrastructure.
- Available information, including maps, regional and national guidance, datasets, relevant policy frameworks, regional and national strategies. Maps will show existing green infrastructure types and locations.
- Existing GI – what functions it is currently performing, and objectives it is currently addressing (beyond UHI, such as aesthetics, biodiversity conservation, etc.), and what functions it may contribute to broader, strategic GI objectives. This analysis should also consider the current status or health of the existing GI, maintenance requirements, and ongoing functionality/usefulness.
- Existing UHI analysed through satellite data (this resource is provided by the project GIIG).
- Future land use planning and development designs and plans that have potential to create or moderate the UHI.

- A system to map and monitor changes in public and private GI distribution and coverage across the municipality.
- Priorities and scope of the plan based on resources, objectives and information available, as well as organisational and partner support for the plan.
- Integrate with existing WSUD linkages where possible.
- Existing policies, standards and manuals that could be used to leverage or require GI [or ensure that they do not pose an unreasonable barrier to GI]. These policies might include, but are not limited to: open or green space planning policies, urban design and sustainability strategies and policies, biodiversity and/or environment strategies. For example, other councils could a adopt a similar local planning policy such as the Amendment c117 developed by the 'Inner Melbourne Action Plan- Making Melbourne More Liveable' (IMAP) currently comprised of the cities of Melbourne, Port Phillip, Stonnington and Yarra Council. http://www.yarracity.vic.gov.au/Planning--Building/Yarra-planning-scheme/Planning-Scheme-Amendments/Amendment-C117/. Environment strategies could also be used to protect existing GI, maintain connectivity, and reduce potential for further contributions to UHI.

5.3.2 *Establish a supportive policy framework*

A sound policy framework is central to better enabling strategic implementation of GI across a local authority area. Implementation would include policies and regulations related to land use planning and development, land acquisition and capital investments, building design, and internal policies concerning management of council-owned lands. Another incentive is to facilitate acceptance of systems such as the U.S. LEED (Leadership in Energy and Environmental Design) or Green Building Rating System or Green Building Council of Australia's Greenstar rating, through provisions of special privileges for developers who implement green buildings with certification.

Local governments should explore opportunities to leverage State government plans and funding in the provision of commercial and residential adoption of GI. Once again, there are numerous international examples of programs that are either directly related to GI or associated sustainable water management. For example, the innovative approach adopted in Seattle, called Open Space Seattle 2100, which involved civic, environmental, business, neighbourhood and community groups along with the University of Washington to create a 100-year plan for Seattle's open spaces. "On February 3 and 4, 2006, over 300 citizens on 23 teams collaborated in the Green Futures Charrette to develop open space plans that address the entire city". Results can be viewed here: http://open2100.org/

International analyses indicate there are five broad and primary types of GI incentives used by states and municipalities – stormwater fee discounts (equivalent of water provisions and sewerage management fees); development incentives; grants; rebates and installation financing; and awards and recognition programs. Drawing on work from the USA, some illustrative examples of these incentives are provided in Appendix B. A supportive policy framework would likely use different combinations of these incentives, supported by provision of information and advice. As recommended above, State Government could provide an information hub that councils and their communities could use as an enabling resource.

5.3.3 Collaborative procurement of GI materials and services

It was suggested to this study that the range of procurement initiatives being developed by the Victorian Local Government Association (VLGA) in conjunction with municipal councils, could provide a useful means for procurement of GI materials and services by groups of councils. For example, the Procurement in Practice project conducted through the Local Government Reform Fund enabled five local councils to achieve considerable savings over current contract costs for bituminous road resealing. “By combining their spend, in excess of $4.6 million a year, the five councils were able to drive down procurement costs and have made considerable savings” (DPCD 2012). The project developed a number of tools and templates that might be used similarly in the procurement of GI materials and services. These templates include a Strategic Procurement Plan and Tender management documentation.

As remarked by one respondent, such approaches “offer opportunities to save time and effort in developing procurement specifications and tender requirements for GI (so knowledge on GI specifications for goods and services is shared); to save money via 'collaborative procurement' (i.e. combined orders, making otherwise more expensive GI products more cost competitive); and share development of performance specifications”. Collectively provided services could include the provision of technical assistance to professionals and property owners for implementation of GI and WSUD approaches.

6. Conclusion

The UHI phenomenon exposes urban populations to more intense and longer lasting periods of heat stress, and also increases urban energy demands for cooling (which further intensifies the UHI as a consequence of the waste heat produced, in addition to contributing to anthropogenic climate change through increased energy demand). Combined with projected changes in Victoria's climate, these impacts are likely to be further exacerbated for the Melbourne conurbation in the future. Enhanced implementation of GI has the potential to cool the urban climate at a variety of spatial scales by providing shade and reducing the amount of heat surrounding buildings and other hard surfaces may hold (which in turn, means less heat released to contribute to the UHI).

This report has contributed to a wider initiative aimed at a providing a systematic approach for urban land managers to optimise the selection and implementation of different GI options, in response to managing the UHI over time. The research focused on the institutional barriers and enablers in both policy and practice to strategic implementation of GI in urban areas, as a means of addressing the UHI effect. One of the most obvious and challenging findings of this study relates to the fact that local councils own or have direct control over the management of very little land. Accordingly, any attempts to genuinely address UHI across Melbourne's metropolitan region will require a coordinated effort between layers of government, businesses and communities. This will require policy, legislative and incentive options that include council, private state and crown-owned land. Clearly, there is a role for State Government in developing a vision for metropolitan Melbourne's GI (alongside its growth boundaries), and for establishing a supportive policy framework that includes training and funding for local governments. There is also a role for local governments, through their open space and urban forest plans, as well as other land use planning and development regulatory mechanisms and policies. As noted, green – blue infrastructure interactions are critical in the Melbourne / Australian context, in particular due to heightened climate variability.

A clear implication is that for any sophisticated program or practice to be successful, a range of decision-makers will need to be engaged in the program - residents, private open-space owners, developers, industries, state government departments, etc. Ultimately, policies and programs should aim to "improve the knowledge base about green infrastructure, support real-world demonstration sites, and better integrate green infrastructure into the day-to-day regulatory structure with which communities, governments and developers are already familiar" (NDRC 2011).

Through the identification of policy and institutional enablers and barriers, the contents of this report seeks to inform a more strategic approach to increased implementation, including identification of key stakeholders and potential partners. Based on the analysis, a Green Infrastructure Implementation Guide should explicitly address the following:

- **Clearly identify the problem and what will actually be addressed.** In many instances, it was evident that respondents had limited understanding of the UHI phenomena; a misunderstanding that often resulted in potential actors disengaging from UHI mitigation. The guidance materials should properly define and explain UHI, and explain what cooling surface temperature will actually do, including the actual effect it may have on UHI. This requires clear articulation of which aspects of the urban landscape are targetted by what GI options, and use this to inform decision-makers about the various scales of UHI and how they interact. More widely, the guide should also succinctly explain the various scales at which UHI can impact on the thermal footprint of an urban area.
- **Be a roadmap, portal or central point of reference** through which detailed information can be sought from the extensive range of existing information and guides. For example, there are a number of international examples of a GI guide, including the UK's Green Infrastructure Valuation Toolkit (Natural Economy Northwest 2008) and in the US, The Value of Green Infrastructure Toolkit. Both are aimed at enabling users to "measure and value the benefits provided by green infrastructure. It allows communities to more accurately compare different infrastructure investments and choose the option that provides the greatest long-term benefit"
- **Recognise that UHI is not generally the primary driver for GI** and that local governments (and other relevant bodies) will consider these multiple benefits in making decisions – strategic or localised – around identification of need, selection, implementation and maintenance of GI
- **Recognise the value of case study material** as a key learning platform.
- **Consider the future Urban Heat Island as well as current day.** This will require consideration of climate change scenarios as well as population growth, planned growth areas, etc.
- **Guide assessment of the magnitude of the UHI phenomenon** in council areas as well as estimation of the expected impact of the adoption of GI countermeasures. This could involve relatively simple, broad approaches using freely available data through to those more detailed (and costly) approaches.
- **Be a 'living' guide** – something that users can provide feedback on as they use the guide and hence be continually updated. This will also be particularly important as understanding improves about techniques to assess the expected temperature, radiative forcing, urban air quality, and the energy use impacts of the systematic adoption of key countermeasures of differing types of GI.

More broadly, the interface between green, blue and grey forms of infrastructure must be contextualised within both the dynamic demands of a changing and growing urban population, and the existing urban form of the city in which the vast majority of the population resides. Moving forward, the balance between renewing – and in many cases increasing the density of – existing infill areas, and developing increasingly limited Greenfield options is shifting from the latter to the former, where GI experiences heightened scarcity (particularly on a per capita basis), as well as increased demand (especially in high-rise environments with little or no private outdoor space). Opportunities to identify innovative and unconventional approaches and GI technologies (such as the application of vertical edible gardens or the re-activation of desolate structures such as the New York High Line) require flexible regulatory environments, as well as appropriate supportive legislation and funding support.

In the outer suburbs, unique resourcing requirements, growth rates and state-government led design requires an 'enabling' role by state government, in partnership with local councils. However the 'blank canvas' of greenfield development also provides opportunities for low cost GI options that are no longer feasible in inner-city areas due to their existing urban form. Additionally, the beneficial role of private GI (both in terms of public goods and those gained private landholders), must be considered as a long-term trade off when considering allowable allotment size to building footprint coverage ratios.

Finally, although public, policy-maker, and stakeholder understandings of terms such as 'Green Infrastructure' and the 'Urban Heat Island effect' will become more established with time, it is equally important to recognise the current inconsistency in their application at present. Without clear definition of these central concepts, the problem of urban heat, and potential solutions such as green infrastructure, will not be effectively addressed in the short to medium term.

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8. Appendices

Appendix A: Policy Map for GI Implementation across Melbourne

	SCALE ADDRESSED	SCALE of GI	POLICIES/ PROGRAMS	FOCUS	IMPLEMENTATION & MONITORING RESPONSIBILITIES	INFO AVAILABLE FOR PRACTIONERS
National		Individual buildings	Building Code of Australia	Building Standards -private, commercial & govt owned	LGAs	The Code - available
		Urban infrastructure	Our Cities, Our Future – National Urban Policy	Sustainability, CCA & GHG reduction in urban infrastructure	Federal and State governments	http://www.infrastructure.gov.au/infrastructure/mcu/files/Our_Cities_National_Urban_Policy_Paper_2011.pdf
		Individual buildings	Green Building Council of Australia	to drive the transition of the Australian property industry towards sustainability by promoting green building programs, technologies, design practices and operations	Voluntary	http://www.gbca.org.au/
		Urban infrastructure	National (Infrastructure) Sustainability Rating Tool (Australian Green infrastructure Council) http://www.agic.net.au/	Infrastructure related to transport, water, communication and energy	Voluntary. However, formal certification from the AGIC is necessary for the user or any other party to promote the IS rating achieved	http://www.agic.net.au/ISratingscheme1.htm

	SCALE ADDRESSED	SCALE of GI	POLICIES/ PROGRAMS	FOCUS	IMPLEMENTATION & MONITORING RESPONSIBILITIES	INFO AVAILABLE FOR PRACTIONERS
State	Strategic design and planning legislation (EG UGB and WSUD) Major areas of green space can be created, & green corridors can be created to link smaller areas of GI. These areas can help to improve health, biodiversity & reduce climate change impacts[3] Supports WSUD	Strategic	Victorian Planning Provisions	Land use planning & development	DPCD LGs Referral Authorities	http://planningschemes.dpcd.vic.gov.au/VPPs/
			Living Victoria, Living Melbourne	Urban water	Recommendation 3 includes: coordinate and/or support Melbourne specific research into quantifying associated cost/benefit of green infrastructure	Roadmap & implementation plan: http://www.water.vic.gov.au/livingvictoria/implementation-plan
			Urban Renewal Authority (trading as Places Victoria). Stat Authority	"Promotes housing affordability and diversity, and best practice in urban and community design…drives major long-term urban renewal projects".		
			Urban growth boundary 50K new lots p.a.	Developments within the UGB	Growth Area Authority	
			Statewide Adaptation Plan under Victoria's Climate Change Act 2010	Range of issues – heatwaves, DRR, etc	State government	Plan is 'under development'
			Environment Protection Act 1970 (the Act) and State Environment Protection Policies (SEPP) especially 'Waters of Victoria'	Water quality.	Statewide	
			DHS – 'Rainwater Use in Urban Communities Guidelines for Non–drinking Applications in Multi-residential, Commercial and Community Facilities'	Relates to WSUD, but would influence GI design when incorporated with WSUD	State govt	

[3] Adapted from: http://www.bebirmingham.org.uk/documents/GI_Evidence_Base_for_Birmingham_FINAL.pdf

Regional	Range	Regional Parks Flood Plains Walking Trails State & national parks Reservoirs Green Corridors	EG Greening the West (City Wet Water program)	Increased vegetative cover across a number of western councils	City West Water w implementation committee of LGs, PV, DoH, DSE	Thermal interpretation of satellite data Species guidance Community engagement http://www.planbig.com.au/greening-the-west

	SCALE ADDRESSED	SCALE of GI	POLICIES/ PROGRAMS	FOCUS	IMPLEMENTATION & MONITORING RESPONSIBILITIES	INFO AVAILABLE FOR PRACTIONERS
Municipality	Larger areas of GI can contribute to biodiversity, & create integration opportunities between different communities. Can also create opportunities for CCA & mitigation3	City Parks Creeks and Rivers BioLinks Council Parks Lakes Large Recreational Spaces As well as Small Parks Gardens Urban Squares Cemeteries Play Areas Local Nature Reserves Subdivisions	Local Government Act 1989	Gives Councils power to create local laws to assist in delivering democratic, efficient and effective LG… can be adopted to protect public health, safety or amenity. Can be aimed at preventing actions having a negative or undesirable impact. Support other legislation	Local governments and State Govt	
			Planning and Environment Act 1987 and the State Planning Policy Framework (SPPF)	Has statement of general principles for land use and development planning. Clauses that could relate to Gi include: • Clause 11.01 – net community benefit & sustainable development • Clause 11.03 –best practice environmental management and risk management approach • Clause 12.07 – manage water resources, reduce the impact of stormwater on bays and catchments using stormwater management (Melbourne 2030) • Clause 14.01 'Settlement' – consistency with any relevant requirements of SEPPs • Clause 15.01 –consistency with SEPP (Waters of Victoria and catchment policies) • Clauses 15.01 and 18.09 – consideration of Urban Stormwater Best Practice Environmental Management Guidelines	Local governments and State Govt	VPPs, DPCD, MAV and other councils
			- Municipal Strategic Statements	Statement of key strategic planning, land use and development objectives, include:. - Application of zones, overlays & particular provisions in the planning scheme - Decision-making by the responsible authority	LGs	VPPs, DPCD, MAV and other councils
			- Clause 56 for Residential Subdivisions:	Various clauses could support GI E.g. 56.07-4 (urban stormwater/runoff)[1] for WSUD strategies		VPPs, DPCD, MAV and other councils

			Open/ Green Space Policies		“	“
			Environment Strategies	LGAs		“
			Tree Inventory	LGAs	Eg Hume CC (Jason S)	“
			Climate Adaptation Plan (component)	LGAs		Other councils, ICLEI, etc

	SCALE ADDRESSED	SCALE of GI	POLICIES/ PROGRAMS	FOCUS	IMPLEMENTATION & MONITORING RESPONSIBILITIES	INFO AVAILABLE FOR PRACTIONERS
Municipality	Larger areas of GI can contribute to biodiversity, & create integration opportunities between different communities. Can also create opportunities for CCA & mitigation3	Strategic	Metropolitan Planning Strategy: A Vision for Victoria	One of it's key principles is environmental resilience: energy and water use, protecting green spaces, environmental and infrastructure assets and natural resources "will help Melbourne manage climate risks, respond to extreme weather events and establish Vic as a world leader in integrated water cycle mgt		Under development. Discussion Paper expected to be released in Spring 2012.
		Strategic/Growth Areas	Growth Areas Authority Engineering Design and Construction Manual (subdivisions) http://www.gaa.vic.gov.au/engineering_standards/	standardise engineering requirements for subdivision development across all of Melbourne's growth area councils	GAA (& LGs)	silent on GI issues such as permeable pavements, high thermal emittance surface materials, sustainable product sourcing (e.g eConcrete) etc
		Strategic/ infrastructure design	Guideline for Adoption of Infrastructure Design Manual http://www.designmanual.com.au/files/2010_32555_IDM_Adoption_Guideline_Template.pdf	shared infrastructure standards and procedures to satisfy objectives of LG Procurement Strategy	(Adopted by over 40 LGs)	Could enable bulk purchase of GI...to reduce costs
		Precincts	Precinct plans	Precincts in LGs	DPCD & LG	Precinct Planning Guidelines
		Activity centres	Activity Centre Guidelines	Street and building design Public spaces Malls and large stores Higher density housing Car parking	help support councils and developers in creating well designed activity centres in Vic. Guidelines provide advice to developers, planners and managers on best-practice	http://www.dpcd.vic.gov.au/planning/urbandesign/guidelines/activity-centre-design-guidelines

	SCALE ADDRESSED	SCALE of GI	POLICIES/ PROGRAMS	FOCUS	IMPLEMENTATION & MONITORING RESPONSIBILITIES	INFO AVAILABLE FOR PRACTIONERS
Street/ building	Individual buildings Residential Commercial Council owned buildings Subdivisions	Street Trees Green Roofs Green Walls Roof gardens etc Gardens Backyards	Vic Practice Note 2011-55 'Residential Sustainability Measures' (6 star energy rating)	Building design….GI may interact with and affect attainment of rating	Energy requirements under the Building Code of Australia (BCA) for new housing, alterations to existing homes and relocated existing homes in Victoria (unless exempt under Section 10(2) of the Building Act)	Energy star rating info is available. Nothing regarding potential interactions with GI
			Growing Green Guide	Green walls and roofs	Voluntary	In development
			My Smart Garden program Eg Hobsons Bay and Moonee Valley City		Voluntary	http://www.mvcc.vic.gov.au/mysmartgarden http://www.hobsonsbay.vic.gov.au/Environment_and_waste/My_Smart_Garden
			Proposed local planning policy amendment c117 - initiative of the 'Inner Melbourne Action Plan- Making Melbourne More Liveable' (IMAP) - cities of Melbourne, Port Phillip, Stonnington and Yarra Council.	Calls on Urban Stormwater Best Practice Environmental Management Guidelines, CSIRO 1999 to address the objectives of the State Environment Protection Policy (Water of Victoria) Eg Proposed Amendment c117	Applicants for New buildings; Extensions to existing buildings ≥ 50 sq metres in floor area or greater; or Subdivisions in business zone. Councils are responsible for monitoring	http://www.yarracity.vic.gov.au/Planning--Building/Yarra-planning-scheme/Planning-Scheme-Amendments/Amendment-C117/

[1] Standards to be met include performance objectives set out in the Urban stormwater best practice environmental management guidelines (BPEMG). These standards can be met by incorporating water sensitive urban design (WSUD) elements as part of the drainage system. There are a number of guidelines, engineering 'design' manuals, software modelling packages (STORM, MUSIC) and training courses available to assist the development industry and local government to design and construct appropriate WSUD technology and meet the BPEM objectives for urban stormwater. EPA has produced Maintaining water sensitive urban design elements as a manual to help local government with maintenance issues and costs associated with WSUD structures. The site management objectives (clause 56.08-1) require that subdivision planning permit applications describe how the site will be managed to minimise environmental impacts such as erosion and sediment, run-off and litter. This will also assist in achieving the objectives of SEPP (WoV), and ensuring that construction works are managed effectively to prevent and minimise run-off of sediments and other pollutants to surface waters. For further

information on clause 56 and the establishment of the Office of Living Victoria, go to DSE's website. The Office of Living Victoria will lead the process to amend the Victoria Planning Provisions to apply the current performance requirements of clause 56.07-4 for the management of stormwater more broadly.

Appendix B: Examples of Policy-based Incentive Mechanisms

Stormwater/ Water Management Fee Discounts

Require a stormwater management fee that is based on impervious surface area. If property owners reduce the need for service by reducing impervious area and the volume of runoff discharged from the property, the municipality reduces the fee. Examples include:

Initiative	Detail	Website Access
Portland Bureau of Environmental Services' Clean River Rewards (2006-present)	- Stormwater utility discount program for private property owners who manage stormwater on their property - Discount of up to 100% of on-site stormwater management charge	none
Metropolitan Sewer District (MSD) of Louisville & Jefferson CountyClean Water Act EPA Mandate	- "MSD assists commercial, industrial and institutional property owners on a priority basis with green infrastructure incentives to reduce stormwater runoff to sewers and creeks"	www.msdlouky.org/pdfs/Green_Infrastructure_Incentives_Savings_Weba.pdf

Development Incentives and regulations

One of the most effective ways of implementing Green Infrastructure is through integrated

land use and development design, planning, and policies. Incentives and regulations can be used to support these approaches. For example, incentives might be offered to developers during the process of applying for development permits, such as: zoning upgrades, expedited permitting, reduced stormwater management requirements and increases in floor area ratios. In other cases, GI might be mandated for particular types of development. Examples include:

Initiative	Detail	Website Access
Department of Construction and Permits Chicago, Illinois. *Green Permit Program*	- Developers and building owners can be part of an expedited permit process by adding elements of green building strategies and technologies - Projects approved for the Green Permit Program can receive permits in less than 30 business days instead of the 60 to 90 days normally required to secure permits - Projects that display a high level of green strategy can possible result in the fees waived for consultant code review - A team of green building experts are available to assist applicants with navigating the permitting process to ensure timely implementation of these technologies	http://www.chicagocodes.com/display_news.cfm?news_id=252 http://cityofchicago.org http://www.epa.gov/greeninfrastructure
Toronto's Greenroof Bylaw (adopted 2009)	- A bylaw to require and govern the construction of green roofs on new development - Applies to new building permit applications for residential, commercial and institutional development made after January 31, 2010 and will apply to new industrial development as of April 30, 2012 - Requires green roofs on new commercial, institutional and residential development with a minimum Gross Floor Area of 2,000m^{2}as of January 31, 2010	http://www.toronto.ca/greenroofs/overview.htm

Seattle's Green Factor	- A landscape requirement designed to increase the quantity and quality of planted areas in Seattle while allowing flexibility for developers and designers to meet development standards - Currently applies to new development in commercial and neighbourhood commercial zones outside of downtown, and is proposed for multifamily residential zones	http://www.seattle.gov/dpd/permits/greenfactor/Overview/
Portland Bureau of Environmental Services' Private Property Retrofit Program (2009 to present)	- The Tabor to the River Program offers design assistance and construction dollars for on-site stormwater management on targeted private properties - The program is available only in areas where stormwater retrofits will allow the city to avoid more costly sewer replacement projects - The city will install rain gardens, stormwater planters, swales or ecoroofs on sites that meet program criteria at no cost to the property owner - Property owners who want to install a facility themselves could qualify to receive financial incentives and technical assistance	none

Grants

Provide direct funding to property owners and/or community groups for implementing a range of green infrastructure projects and practices. Examples include:

Initiative	Detail	Website Access
NYC Department of Buildings, New York City	- Building owners in New York City who install green rooftops will now receive a significant tax credit - Under this law, building owners in New York City who install green roofs on at least 50 percent of available rooftop space can apply for a one-year property tax credit of up to $100,000 - The credit would be equal to $4.50 per square-foot of roof area that is planted with vegetation, or approximately 25 percent of the typical costs associated with the materials, labour, installation and design of the green roof	http://www.nyc.gov/html/dob/html/sustainability/green_roof_faq.shtml
Portland Bureau of Environmental Services' Community Watershed Stewardship Program	- Grants of up to $10,000 to schools, churches, businesses and other community organizations for projects that connect people with watersheds and protect & enhance watershed health - Includes an Innovative Wet Weather Program, which promotes stormwater management projects that contribute to healthy watersheds - $2.6 million to fund over 25 innovative public and private projects (2002-2005)	none

Rebates & Installation Financing

Provide funding, tax credits or reimbursements to property owners who install specific practices, often focused on practices needed in certain areas or neighbourhoods. Examples include:

Initiative	Detail	Website Access
Stormwater Partners Network in Montgomery County, Maryland - *RainScapes Rewards* (2008 until funding depleted)	- Residential, commercial and private institutional property owners are granted financial rewards for the installation of rain gardens, rain barrels, green roofs, native plants, tree canopies and permeable pavers - Reward of $1,200 per single-family lot and up to $5,000 per multi-family or commercial property -	http://www.stormwaterpartners.org
Portland Bureau of Environmental Services' Grey to Green Program	- Portland city offers incentives of up to $5 per square foot to add new ecoroofs - The city also offers treebates to encourage people to plant eligible yard trees. - The treebate is a credit on the recipient's sewer bill of up to $40 per tree ($50 for native species)	none

Awards & Recognition Programs

Provide marketing opportunities and public outreach for exemplary projects, which may include monetary awards. Examples include:

Initiative	Detail	Website Access
Greening In Place Awards - King County, Washington, USA	- Annual awards that honour the planning and design teams of public facilities that reflect environmental sustainability	none
Australian Initiatives (various	- Banksia Awards - (Victorian) Premier's Sustainability Awards - Property Council of Australia Innovation and Excellence Awards - Victorian Architecture Awards - Melbourne Awards - United Nations Association of Australia Victorian Division's range of sustainability related awards - Local government awards (eg. City of Yarra Sustainability Awards)	various