

Can planning legislation in New South Wales support adaptation responses to the impacts of climate change in urban areas? A study of green infrastructure in the Greater Sydney Region.

Ana Carolina Napoli Carneiro

Master of Research

Faculty of Arts /Macquarie University Law School

Submitted on 25/11/2018

Contents

1. Introduction.....	5
2. Methodology and limitations.....	11
3. Climate adaptation in urban areas and the law	12
3.1 What is green infrastructure?	17
3.2 International case studies	20
4. International Frameworks and Australia.....	26
4.1 Ecological Sustainable Development and the law	29
5. Climate adaptation and planning law in NSW.....	30
5.1 The relationship between planning law and climate change adaptation	39
5.2 Environmental planning instruments and Development Control Plans	40
5.3 The role of local government	46
6. Green Infrastructure in NSW – Planning for climate adaptation.....	49
6.1. Western Sydney and the impacts of extreme heat	55
7. Green infrastructure, funding and the law.....	60
8. Challenges and opportunities.....	64
9. Conclusion	68
10. Bibliography	71

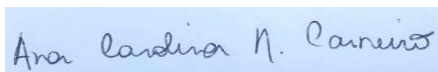
Abstract

Planning laws are essential to managing climate change adaptation in urban areas in Australia. Recently, the focus in New South Wales (NSW) has been on minimising the impacts of climate change on coastal and bushfire prone areas. Yet, the concern regarding the increasing impacts of extreme heat events in urban areas is growing. One of the adaptive responses has been through the development of green infrastructure. This concept is well-known for its multifunctional benefits, which extend beyond mitigating the urban heat island effect and improving air quality. This research explores how planning laws and other mechanisms of governance in NSW can support adaptive responses to climate impacts in urban areas through green infrastructure. Western Sydney, an area within the Greater Sydney Region is the focus area for this study. It has been selected due to its unprecedented urban and population growth, coupled with its escalating exposure to extreme heat events. The study investigates the NSW Government legal framework and instruments for planning, together with local government initiatives that underpin the rapid growth of this region. While this study acknowledges the growing commitment to green infrastructure through plans and policies, it argues for the need for green infrastructure to be incorporated in to the legal framework at state and local levels to support adaptation responses in vulnerable areas to extreme heat. International case studies provide exemplars as to how the law could evolve in the future. This includes the development of planning instruments for increased standards, funding and established responsibility between state and local government authorities.

Statement of Originality

I certify that this work has not previously been submitted for a degree or diploma in any university. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Date: 25/11/2018

A handwritten signature in blue ink on a light blue rectangular background. The signature reads "Ana Carolina N. Carneiro" in a cursive script.

Ana Carolina Napoli Carneiro

1. Introduction

This study will investigate New South Wales (NSW) different mechanisms of governance, including planning laws in relation to adaptive responses to the impacts of climate change in urban growth areas. This investigation will focus on one aspect of adaptation, green infrastructure. NSW planning law will be central to this thesis, and in particular, the *Environmental Planning and Assessment Act 1979* (NSW) (*EPA Act*),¹ which determines the regulation of land-use planning. The roles of environmental planning instruments, such as State Environmental Planning Policies (SEPPs), Local Environmental Plans (LEPs) and Development Control Plans (DCPs) will be discussed. The focus is on the legal aspects surrounding the uptake of green infrastructure, as one of the measures for urban adaptation, in the context of the predicted increase of extreme heat events in Western Sydney, an area within the Greater Sydney Region, which is experiencing unprecedented urban growth. This thesis will examine, the traditionally reactive nature of the law, and question whether a shift to a proactive legal paradigm is required, given the increasing pressures being placed on planning law.

Planning law plays a significant role in the development of climate change adaptation in Australia,² as it is the area of law that regulates development and the built environment.³ It also has the capacity to respond to local pressures and determine the shape the built environment will take in the future. While local government is directly connected with the community and performs strategic and statutory functions, the State government exercises major control over planning processes and decisions.⁴ For instance, while LEPs are prepared by local government, they must be consistent with State planning instruments such as SEPPs and must be approved by the State Planning Minister.⁵

¹ *Environmental Planning and Assessment Act 1979* (NSW).

² Anita Foerster, Andrew Macintosh and Jan McDonald, 'Trade-Offs in Adaptation Planning: Protecting Public Interest Environmental Values' (2015) 27(3) *Journal of Environmental Law* 459, 462.

³ Eloise Scottford Elizabeth Fisher, Bettina Lange, *Environmental Law, Text, Cases and Materials* (Oxford University Press, 2013) 785.

⁴ Anita Foerster, Andrew Macintosh and Jan McDonald, 'Transferable Lessons for Climate Change Adaptation Planning? Managing Bushfire and Coastal Climate Hazards in Australia' (2013) 30(6) *Environmental and Planning Law Journal* 469, 476.

⁵ *Ibid* 475.

Green infrastructure is one of the tools that is responding to the mounting pressures being placed on planning law, which include population growth, increasing trends of high density living, coupled with the impacts of climate change. Urban green infrastructure is defined, in this thesis, as all vegetation in urban public areas that provides environmental, economic and social benefits. For example, the role of vegetation in promoting clean air and water, climate regulation, food provision, erosion control and places for recreation.⁶ Individual components of green infrastructure, or assets, includes: parks, streetscapes and highway verges, services and communications corridors, waterways and regional recreation areas.⁷ These components can be existing assets, or added as part of the green infrastructure network, such as urban forests, green roofs and living walls.⁸ While different countries have been attempting to define green infrastructure, some will argue that a fixed definition is problematic as the concept is evolving and moving towards socio-economic centres.⁹ In NSW, green infrastructure has no legal definition. One of the challenges is that the concept of green infrastructure encompasses a broader spectrum of infrastructure such as renewable energy, transport, water and waste systems depending on the country and this can create confusion depending on the context. For instance, green infrastructure extends to financial investment in low carbon technologies, such as low-carbon transport, renewable energy, sustainable water management and green buildings,¹⁰ which are not the focus of this paper.

Climate change is significantly shifting the way communities interact with the urban and natural environments. The current global scenario shows that the increasing greenhouse gas emissions (GHG) in the atmosphere are causing an alarming rise in global temperature.¹¹ According to the World Meteorological Organisation, '2018 is shaping up to be one of the hottest year on record, with new temperature records in many countries.'¹² The key impacts of

⁶ Commonwealth Scientific and Industrial Research Organisation, *Establishing a National Agenda for Urban Green Infrastructure* <<https://www.csiro.au/en/Research/LWF/Areas/Resilient-cities-21C/Green-infrastructure>>

⁷ Government Architect NSW, *Greener Places: Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017) 12.

⁸ Ibid.

⁹ Hannah Wright, 'Understanding Green Infrastructure: The Development of a Contested Concept in England' (2011) 16(10) *Local Environment* 1003, 1005.

¹⁰ Climate Bonds Initiative, *Green Infrastructure Investment Opportunities: Australia & New Zealand* (2018) 16.

¹¹ Intergovernmental Panel on Climate Change, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III IPCC* (Geneva, Switzerland 2015), 8; Stephen Leahy, *Climate Change impacts worse than expected, global report warns*, National Geographic (7 October 2018) <https://www.nationalgeographic.com/environment/2018/10/ipcc-report-climate-change-impacts-forests-emissions/>

¹² World Meteorological Organisation, *July Sees Extreme Weather with High Impacts* (1 August 2018) <<https://public.wmo.int/en/media/news/july-sees-extreme-weather-high-impacts>>

climate change on major Australian cities include, increasing heatwaves, changes in precipitation patterns leading to flooding and droughts, bushfires and sea level rise resulting in coastal erosion and detrimental impacts of storm surges.¹³ In the context of heatwaves, the duration, extension and frequency of extreme heat events have increased in Australia.¹⁴ Cities are particularly vulnerable, as the impact of extreme heat affects local infrastructure systems and services. One of the major problems with high temperatures in urban environments for prolonged periods, is that it exacerbates the urban heat island effect found in urban centres, especially inner-city areas, which have a high concentration of impervious surfaces.¹⁵ The urban heat island effect occurs because of increasing temperatures, combined with the decreased amount of vegetation and increased areas of dark surfaces in urban environments.¹⁶ These absorb a high amount of solar radiation during the day with the energy slowly released at night.¹⁷

Legislation and policies focused on adaptation are in various stages of development. For example, legislation in relation to the impacts of sea level rise on the coastal zone is relative well advanced, due to the high vulnerability of Australian coasts and coastal communities.¹⁸ Bushfire regulation has also been changing from a site assessment level, to a more precautionary and strategic approach centred on high-risk areas due to increased bushfire threats.¹⁹ Yet, land-use planning law and policies, focused on responding to the local impacts of the predicted escalation of the heatwaves in urban areas, are limited. Heatwaves are a serious hazard for the people and the environment. In Australia, they are considered a well-known silent killer which causes more deaths than any other extreme weather event.²⁰ Yet, Australia's approach to heatwaves to date, has been 'focused primarily on immediate reactive capacity rather than incorporating exposure reduction strategies to build long-term resilience.'²¹

¹³ National Climate Change Adaptation Research Facility, *Climate ready cities, Policy Information Brief 2*, 1.

¹⁴ Australian Government, Bureau of Metereology, *State of the Climate 2016* (2016) 8.

¹⁵ Briony A Norton et al, 'Planning for Cooler Cities: A Framework to Prioritise Green Infrastructure to Mitigate High Temperatures in Urban Landscapes' (2015) 134 *Landscape and Urban Planning* 127.

¹⁶ Climate Council of Australia, *Heatwaves: Hotter, Longer, More Often* (2014) 21.

¹⁷ Norton et al, above n 15, 128.

¹⁸ Jonathan Verschuuren and Jan McDonald, 'Towards a Legal Framework for Coastal Adaptation: Assessing the First Steps in Europe and Australia' (2012) 1(2) *Transnational Environmental Law* 355, 372.

¹⁹ Foerster, Macintosh and McDonald above n 2, 476.

²⁰ Commonwealth Scientific and Industrial Research Organisation (Cth), *The State of the Climate Report 2016* 6.

²¹ Climate Council of Australia, *The Silent Killer: Climate Change and the Health Impacts of Extreme Heat* (2016), 24.

Over the last decade, green infrastructure has been on the political agenda of countries concerned about increasing urbanisation, extreme heat and loss of extensive vegetation. Green infrastructure has proven social, cultural, environmental and economic benefits. These include reducing the urban heat island effect and improving air quality, social cohesion and climate regulation.²² Ranjha notes that ‘planning of green infrastructure refers to policies and planning activity affecting urban green infrastructure, especially through processes of land use and management and development of nature areas and elements.’²³ In countries such as Germany, the US, and Singapore, green infrastructure is well-advanced. For example, in the U.S the concept is strongly supported by the Federal government for stormwater management and is regulated under the *Clean Water Act*.²⁴ In addition, individual cities such as Ontario are passing green roofs by-laws.²⁵

In NSW, a recent policy recognises the need to promote better design and green infrastructure to improve the urban environment and community health.²⁶ *Greener Places Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion (Greener Places Policy)*, proposes the development of an interconnected network of green spaces such as the Sydney Green Grid that promotes good design and amenity and helps to respond to various challenges, including health, climate resilience and the rapid population growth.²⁷ The Sydney Green Grid initiative is an open space interconnecting network of green areas that will ‘connect town centres, public transport and major residential areas.’²⁸ The high-quality green space network has the purpose to ‘keep the city cool, encourage healthy lifestyles, enhance biodiversity and ensure ecological resilience.’²⁹

The new policy proposes statutory reforms, such as: the adoption of green infrastructure in strategic planning outcomes; consideration of green infrastructure as essential infrastructure in regional and district plans; and dedicated funding through Special Infrastructure Contributions

²² Christopher Coutts and Micah Hahn, Green Infrastructure, Ecosystem Services and Human Health, (2015) 12, *International Journal Environmental R Public Health*.

²³ Shikha Ranjha, Green infrastructure planning for sustainable and resilient urban environment (2016) *Brief for Global Sustainable Development Report*, 2.

²⁴ U.S. Environmental Protection Agency, Green Infrastructure Strategic Agenda 2013, 2.

²⁵ *Toronto Municipal Code, Chapter 492, Green roofs*, Article II, § 492-2 (A); My Plant Collection, *Green Roof Legislation, Policies and Tax Incentives* (2018) <http://myplantconnection.com/green-roofs-legislation.php>

²⁶ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 16.

²⁷ *Ibid* 16.

²⁸ Government Architect NSW, *Sydney Green Grid, Spatial Framework and Project Opportunities* 7.

²⁹ *Ibid*.

(SICS).³⁰ Overall, the policy's objectives include influencing the preparation of planning proposals and LEPs to give effect to regional and district plans, together with regular and mandatory monitoring and reporting of policy outcomes.³¹ This policy states that the adoption of green infrastructure will require the cooperation of governments in different levels.

The Greater Sydney Region is one of the fastest growing metropolises of the Western world.³² Projections show that the population is predicted to grow to 8 million in the next 40 years, of which almost half of that population will be residing West of Parramatta and a new urban corridor covering from the south west to the north west of Sydney.³³ The *Greater Sydney Region Plan, Metropolis of Three Cities* (The GSR Plan) builds a vision of three cities: Western Parkland City, Eastern Harbour City and Central River City.³⁴ The Plan establishes a 20-year plan and sets a 40-year vision 'to manage growth and change for Greater Sydney in the context of social, economic and environmental matters.'³⁵ The focus of this study is on the Greater Sydney Region. As each Sydney region is different in many respects, this study investigates the local government areas (LGA) within the Western Parkland City and Central River City. These areas have been selected because they are facing significant growth and are particularly vulnerable to the impacts of extreme heat. This research investigates whether current planning laws support the implementation of green infrastructure to support adaptation responses in vulnerable areas to extreme heat.

To investigate this topic this study first examines the role of law in adaptation responses to climate change. The focus is placed on environmental and planning law and its functions in responding to the increasing challenges of urbanisation, population growth and extreme weather events in the growth areas of Sydney. It identifies spatial planning instruments as tools available for adaptation planning, which have been particularly focused on the most vulnerable areas to the impacts of climate change, coastal and bushfire prone areas. Secondly, the research investigates concepts of green infrastructure, as illustrated through three international case study countries: US, Germany and Singapore. Each country approaches green infrastructure

³⁰ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 46.

³¹ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 46.

³² Greater Sydney Commission, *Greater Sydney Region Plan. A Metropolis of Three Cities - Connecting People* (2018) 8.

³³ Ibid.

³⁴ Ibid 6.

³⁵ Ibid.

differently. However, they have been similarly investing in urban planning and identifying the significance of urban green cover in climate adaptation. These international trends contribute an important dimension to this study, that can help to inform future directions for NSW.

Section 3 briefly describes Australia's commitment to international agreements such as the Paris Agreement and how it supports climate change adaptation in the context of cities and the built environment. It further notes the *Rio Declaration on Environment and Development* (Rio Declaration) and the principles of sustainable development, which was established under the *United Nations Conference on Environment and Development* (UNCED). It highlights Australia's commitment to the implementation of the principles of sustainable development in policies and legislation across all levels of government.

Section 4 assesses the current legal regime in NSW and the resources available in legislation that may support the implementation of green infrastructure as an adaptation tool in land-use planning. The planning regime in NSW includes regulatory instruments, such as legislation, environmental planning instruments (EPIs) and non-regulatory regimes, such as DCPs. To support this analysis, landmark cases that challenged ESD and climate change adaptation as matters of the public interest will be discussed. It is important to note that NSW does not recognise climate change adaptation under the *EPA Act*, even though there has been an increasing urgency in policies and plans to acknowledge the need to adapt to the impacts of extreme heat, especially within local government strategies, such as Penrith Council's *Cool the City Strategy 2015*.³⁶

Finally, the thesis explores the current legal approach to green infrastructure in the context of climate adaptation in NSW and the role of local government in implementing State government policies. Section 5 briefly explores the current funding proposals under the *Greener Places Draft Policy*, challenges facing the implementation of green infrastructure, such as the Green Grid. While there are multiple social, environmental and economic benefits to green infrastructure, this study acknowledges the challenges concerning its implementation. It argues that planning law in NSW requires the regulatory and non-regulatory tools to adopt a more proactive approach to climate adaptation and responses to extreme heat events, rather than the current reactive approaches, especially in the lowest socio-economic and vulnerable areas of

³⁶ Penrith City Council, *Cooling the City Strategy* (2015).

Sydney. Overall, the thesis proposes that the uptake of green infrastructure is one of the proactive measures towards climate adaptation. It concludes that green infrastructure should be regulated in accordance with the purposes of the *EPA Act*, through regulatory planning instruments such as SEPPs and non-regulatory instruments, such as DCPs to support consistency in the implementation of increased standards.

2. Methodology and limitations

The method used to investigate this cross-disciplinary study involved desktop and doctrinal research. The desktop study involved the identification of literature pertaining particularly to fields such as environmental governance and climate science. Doctrinal research is the method used to investigate the concepts, and the international and national legal framework pertaining to the topic. In this thesis, doctrinal research includes, as Hutchinson notes, investigating primary materials such as law and case law, and secondary materials, which includes commentary on the law found in textbooks and legal journals.³⁷ This ‘mixed methods’ approach, involving multiple sources of evidence, ensured high levels of confidence, in the validity of the study’s findings.³⁸

The geographical focus is the Greater Sydney Region, and in particular areas experiencing substantial development, urbanisation and are vulnerable to the impacts of extreme heat events. It was outside the scope of this study to analyse the priorities of each sub-region and its respective local government areas.

Other limitations to this study are as follows. It reviews NSW legislation only. Although it investigates international case studies, this analysis is brief and informative rather than comparative. The study involves analysing legislation in NSW and case law regarding coastal climate adaptation, even though the focus in this study is on the impacts of extreme heat on urban areas and the urban built environment. This has occurred due to the lack of applicable case law relating to the research objectives of this study. The analysis excludes, in the context of funding green infrastructure, local government rates and charges established under the *Local Government Act 1993* (NSW). It acknowledges the potential of environmental levies to implement adaptation strategies in local government areas. The study briefly reviews the

³⁷ Terry Hutchinson, *Researching and Writing in Law* (Thompson Reuters, 3rd ed, 2010), 7.

³⁸ Derek Layder, *Sociological Practice: Linking Theory and Social Research* (Sage Publications, 1998) 167-68.

funding options proposed under the *Greener Places Draft Policy* however, it is beyond the scope of this paper to investigate funding options under the *Local Government Act 1993* (NSW).

3. Climate adaptation in urban areas and the law

The IPCC estimates that ‘climate change will have profound impacts on a broad spectrum of infrastructure systems, services, the built environment and ecosystem services.’³⁹ Climate change mitigation has been at the centre of the climate debate and remains essential to minimising risks of harm. Climate mitigation involves ‘an anthropogenic intervention to reduce greenhouse gas emissions sources or enhance the sinks.’⁴⁰ Despite global efforts to stabilise greenhouse gas (GHG) emissions, significant consequences from global warming are still occurring.⁴¹ Action is required from all sectors, including policy and law reform, to plan for these future environmental changes.

Climate adaptation activities tend to be focused at a local level, as the benefits of adaption strategies are often localised.⁴² This involves ‘taking practical actions to manage risks from climate impacts, protect communities and strengthen the resilience of the economy.’⁴³ Strategies for adaptation vary, depending on the risks they seek to remedy. They involve measures to respond to issues such as sea level rise, coastal erosion, flooding, bushfires and heatwaves. Protecting urban communities from the predicted extreme temperatures, involves ensuring that the planning system provides the necessary statutory tools and strategies for urban

³⁹ Revi et al, *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Urban Areas (2014) [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 538.

Intergovernmental Panel on Climate Change, *IPCC Fourth Assessment Report: Climate Change 2007, Climate Change 2007: Working Group II: Impacts, Adaptation and Vulnerability*
https://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch18s18-1-2.html

⁴¹ Stephen Leahy, *Climate Change impacts worse than expected, global report warns*, National Geographic (7 October 2018) <https://www.nationalgeographic.com/environment/2018/10/ipcc-report-climate-change-impacts-forests-emissions/>

⁴² Jacqueline Peel and Lee Godden, ‘Planning for Adaptation to Climate Change: Landmark Cases from Australia’ (2009) *Sustainable Development Law and Policy* (9) 2, 38.

⁴³ Department of Environment and Energy, *Adapting to climate change*
<http://www.environment.gov.au/climate-change/adaptation>

planning and development.⁴⁴ These include design features in public spaces and buildings, such as passive cooling, through the inclusion of green infrastructure.

This research focuses on one aspect of adaptation measures: the development of regulatory tools to reduce the risks of the impacts of climate change, in urban areas, in the context of extreme heat events. In addition to the influence urban areas play in the rise of GHGs, urban areas are particularly impacted by climate change due to the modification of local and regional climatic conditions, which results in an Urban Heat Island (UHI) effect.⁴⁵ The UHI effect is known as the ‘difference in temperature between the built environment and the natural (surrounding) environment.’⁴⁶ For instance, ‘dark, impervious surfaces and buildings absorb solar energy which causes surface temperature in the cities to rise 10-20 degrees Celsius higher than surrounding temperatures.’⁴⁷ As the IPCC reports ‘the dense nature of large cities has a pronounced influence on anthropogenic heat emissions and surface roughness, linked to the level of wealth, energy consumption, and micro and regional climate conditions.’⁴⁸ This study focuses on ways to minimise the UHI effect in urban areas, through the inclusion of vegetation, which provides natural cooling. Additionally, these green spaces and components of nature, such as trees, assist in purifying the air, adding oxygen and assisting in the mitigation of pollution.

Aligning with international trends, most of the Australian population live in the cities.⁴⁹ The population in Australia is projected to reach 35 million by mid-century, and more than 70 percent of this growth will occur in the major cities.⁵⁰ To date, the Greater Sydney Region accounts for a population of five million and is predicted to grow by 1.7 million people by

⁴⁴ Norman, B., and N. Gurrán, 2017: ‘Adapting to long term coastal climate risk through planning approaches and instruments - CoastAdapt Information Manual 5,’ *National Climate Change Adaptation Research Facility, Gold Coast* (2nd ed, 2017), 2.

⁴⁵ Amelia Thorpe and Melissa Anne Hart, ‘Changing Climates, Changing Cities? Planning Reform and Urban Sustainability in New South Wales’ (2013) *The Australasian Journal of Natural Resources Land and Policy* (16)2, 138.

⁴⁶ Patrick E. Phelan, et al, *Urban Heat Island: Mechanisms, Implications, and Possible Remedies* (2015) *Annual Review Environment Resources* 40, 286.

⁴⁷ Office of Environment and Heritage (NSW), *Urban Green Cover in NSW, Technical Guidelines* (2015), 2.

⁴⁸ Revi above n 39, 551

⁴⁹ Department of the Environment and Energy (Cth), *Built Environment: Planning for the Future, Australia state of the environment* (2016) (Sarah Coleman) <https://soe.environment.gov.au/theme/built-environment/topic/2016/planning-future>

⁵⁰ Ibid.

2036.⁵¹ As the Australian population continues to grow and age, risks of heat related illness will increase due to urbanisation and the UHI effect.⁵²

The UHI effect remains one of the most studied climatic features of cities and the major focus of a much wider field of urban climatology.⁵³ As the U.S Environment Protection Authority (EPA) explains, ‘surface temperatures have an indirect, but significant, influence on air temperatures, especially in the canopy layer, which is closest to the surface. For example, parks and vegetated areas, which typically have cooler surface temperatures, contribute to cooler air temperatures.’⁵⁴ Livada *et al.* note that urban overheating is expected to increase in Sydney, as its population is predicted to increase by 50%, rising by over 2.1 million in the years 2011 – 2036.⁵⁵

People living in dense urban environments, the elderly, the very young and those with existing health conditions are especially vulnerable to exposure to high temperatures for a prolonged period.⁵⁶ Prolonged periods of heat, including at night, may lead to heat exhaustion.⁵⁷ Extreme heat events also aggravate pre-existing illnesses, such as cardiovascular and respiratory diseases.⁵⁸ Consequently, rising temperatures are likely to place pressure on health services as more people suffer from the effects of heat stress. Additionally, the demand for air conditioning will increase, which also contributes to the UHI effect.⁵⁹ As Hatvani-Kovacs *et al.* observe, ‘air conditioning, through the process of heat rejection, contributes to the urban heat island effect as it pumps heat into the ambient air and raises outdoor temperatures.’⁶⁰

⁵¹ NSW Department of Planning & Environment, *An act for good design* <http://www.planning.nsw.gov.au/News/2018/An-Act-for-Good-Design>

⁵² Climate Council of Australia, *Heatwaves: Hotter, longer and more often* (2014), 18.

⁵³ Coutts and Hahn above n 22.

⁵⁴ U.S. Environmental Protection Agency, *Urban Heat Island Basics.* " In: *Reducing Urban Heat Islands: Compendium of Strategies* (2008) (Draft) <https://www.epa.gov/heat-islands/heat-island-compendium>

⁵⁵ I. Livada *et al.*, ‘Time Series analysis of ambient air-temperature during the period 1970-2016 over Sydney Australia’ (2019) *Science of the Total Environment* 648, 1628.

⁵⁶ Climate Council of Australia, *The Silent Killer: Climate Change and the Health Impacts of Extreme Heat* (2016), 24.

⁵⁷ Climate Council of Australia, *Heatwaves: Hotter, longer and more often* (2014), 23.

⁵⁸ Climate Council of Australia, *The Silent Killer: Climate Change and the Health Impacts of Extreme Heat* (2016), 24.

⁵⁹ Gertrud Hatvani-Kovacs, Judy Bush, Ehsan Sharifi and John Boland, ‘Policy recommendations to increase urban heat stress resilience’ (2018) *Urban Climate* 52, 52.

⁶⁰ *Ibid.*

Legal institutions and instruments alongside technology, educational and behavioural strategies are essential tools in helping society's capacity to adapt to change.⁶¹ They are regarded as having a role in helping to build societal resilience.⁶² While there are multiple adaptation tools, the law plays a critical role in providing regulatory and non-regulatory frameworks 'to reduce the exposure and sensitivity to climate hazards and fund arrangements for adaptation costs and liability for climate impacts.'⁶³ As Godden *et al.* note 'regulation and law are part of a wider governance arrangements that guide and structure the behaviour and decision-making of actors.'⁶⁴

Planning laws are a key governance mechanism for mitigation and adaptation to climate change.⁶⁵ One of the purposes of planning legislation in NSW is to 'manage, develop and conserve the natural and artificial resources, including natural areas, cities and towns for the purposes of promoting the social and economic welfare of the community and a better environment.'⁶⁶ In NSW, a range of legal tools and instruments are available to support and control the nature of land use and development, and therefore influence the degree of exposure experienced by areas that are vulnerable to climate hazards.⁶⁷ These legal tools are defined by Macintosh *et al.* as spatial planning instruments, which can be used to influence the spatial distribution and nature of land use and development.⁶⁸ The research undertaken by Macintosh *et al.* focuses on the applicability of spatial planning instruments in the context of coastal and bushfire prone areas, due to the increasing risks of these natural hazards in Australia. It is important to note that although planning instruments have been 'available to local governments to plan adaptation, few have been developed to date, that focus on non-sea-level rise issues.'⁶⁹ Planning instruments are available in NSW to manage development control on the coasts and promote adaptation to coastal hazards, and coastal management legislation in NSW recognises the future risks of climate change on the coasts. The implementation of spatial planning

⁶¹ Jan McDonald, 'The role of law in adapting to climate change' (2011) 2 *John Wiley & Sons, Ltd*, 283.

⁶² Lee Godden et al, 'Law, Governance and Risk: Deconstructing the Public-Private Divide in Climate Change Adaptation, UNSW Law Journal (2013) 36 (1), 231.

⁶³ McDonald above n 63, 283.

⁶⁴ Godden et al above n 65, 231.

⁶⁵ Thorpe and Hart above n 45, 142.

⁶⁶ *Environmental Planning and Assessment Act 1979* (NSW) s 3.3 (a).

⁶⁷ Andrew Macintosh, Anita Foerster and Jan McDonald, 'Limp, leap or learn? Developing legal frameworks for climate change adaptation planning in Australia: Summary for policymakers' (2013) *National Climate Change Adaptation Research Facility*, Gold Coast, 1.

⁶⁸ *Ibid.*

⁶⁹ Judith Preston and Jennifer Scott, 'Meeting the climate change challenge in local government decision-making with the use of sustainable climate change adaptation modelling' (2012) 17 *Local Government Law Journal* 135, 140.

instruments to manage future risks of climate change in coastal areas would act as a model response for adaptation to guide stakeholders, such as local government and developers, in urban non-coastal adaptation planning.

Spatial planning instruments are divided into groups and classified according to the role they play within a legal framework for adaptation planning.⁷⁰ They are classified as framing instruments, fixed and flexible regulatory instruments, compulsory acquisition instruments, voluntary instruments, taxes and charges.⁷¹ Framing instruments are, ‘objective clauses in planning statutes; or objectives and principles in state and local environmental planning policies,’ such as SEPPs and principles in local development plans.⁷² Regulatory instruments are ‘legally enforceable land use activity restrictions, which determine where, what and how use and development occurs.’⁷³

Regulatory instruments are fixed when it is presumed that ‘once lawfully commenced, an existing land use will be beyond the planning system and can continue indefinitely unless intensified, expanded or abandoned.’⁷⁴ For instance, the *Coastal Management Act 2016* (NSW) regulates coastal zones and coastal management areas, such as coastal vulnerability areas, which are subject to coastal hazards.⁷⁵ The management objectives for a coastal vulnerability area centre on mitigating current and future risk from coastal hazards by considering the effects of coastal processes and climate change.⁷⁶ The role of local councils includes identifying the legal risk and liability arising from the impacts of sea level rise and mitigating such risks.⁷⁷

On the other hand, flexible regulatory instruments provide governments with the power to control land use and development, even after it has lawfully commenced, and allows a more flexible and pragmatic approach to considering uncertainty in the timing and magnitude of climate change.⁷⁸

⁷⁰ Macintosh, Foerster and McDonald, above n 70, 1.

⁷¹ Ibid.

⁷² Ibid 2.

⁷³ Ibid 3.

⁷⁴ Macintosh, Foerster and McDonald, above n 70, 3.

⁷⁵ *Coastal Management Act 2016* (NSW) s 7(1).

⁷⁶ *Coastal Management Act 2016* (NSW) s 7(2)(b).

⁷⁷ Rhett Martin, *Understanding Sustainability Law* (LexisNexis Butterworths, 2018), 112.

⁷⁸ Macintosh, Foerster and McDonald above n 70, 5.

The need for spatial planning instruments with a focus on adaptation to minimise the UHI effect is increasingly being recognised. As adaptation responses tend to be localised, state and local government agencies are expected to implement strategies that promote climate resilience and enhance the connectivity between the natural and built environments. Sustainability goals are incorporated into environmental laws, regulations and government policies, including biodiversity, planning and coastlines. However, the NSW government recognises that ‘single-issue approaches mean that balancing economic, social and environmental factors in decision-making is challenging.’⁷⁹ One way the government can deliver sustainable outcomes and promote an integrated approach, is through planning and providing green infrastructure.⁸⁰

3.1 What is green infrastructure?

The concept of green infrastructure started with fundamental changes in urban planning at the turn of the 20th century.⁸¹ The Industrial Revolution accelerated urbanisation in London and during this period, inferior urban design often resulted in poor quality housing, public health issues, a lack of open spaces for recreation and poor air quality.⁸² As a result, different models and theories of urban planning were developed to minimise the impacts of industrialisation and provide the population with healthier environments.⁸³ In the US, Frederick Law Olmsted designed Central Park in 1851, to provide clean air and decrease the physical and health risks associated with urbanisation.⁸⁴ Over the decades, different architects expanded the ideas of urbanism and stressed the importance of considering the local environment and its relationship with social concerns and town planning.⁸⁵

Modern green infrastructure has been developed to respond to different needs and to promote ecosystem assets and services, which can be grouped in three main areas: social, environmental and economic.⁸⁶ Firstly, in the social context, these ecosystem services promote human health and wellbeing, through open spaces for physical activities, social cohesion and community

⁷⁹ Greater Sydney Commission, *Greater Sydney Region Plan* (2018), 146.

⁸⁰ Ibid.

⁸¹ Symons et al, ‘Assessing the Economic Value of Green Infrastructure: Literature Review’ (2015), *Climate Change Working Paper No 23*. Victoria Institute of Strategic Economic Studies, Victoria University, Melbourne, 4.

⁸² Symons et al above 83, 3.

⁸³ Ibid 4.

⁸⁴ Theodore S. Eisenman, ‘Frederick Law Olmsted, Green Infrastructure, and the Evolving City’ (2013) *Journal of Planning History* 12(4), 290.

⁸⁵ Symons et al above n 84, 6.

⁸⁶ Ibid 8.

engagement.⁸⁷ Secondly, in the environmental context, green infrastructure incorporates water cycle modification, biodiversity conservation and climate modification through temperature reduction, shading and eva-transpiration.⁸⁸ Thirdly, in an economic context, green infrastructure improves commercial vitality, property values and the value of ecosystem services.⁸⁹

Wright argues that while varied concepts of green infrastructure differ across industry sectors, three interrelated principles appear to be consistent: connectivity, multi-functionality and “green.”⁹⁰ She notes that ‘connectivity and multi-functionality are often based on the idea that greater value is secured through establishing an interconnected network of environmental functions on different scales where natural processes work simultaneously.’ “Green,” she adds, is a more ‘implicit idea and represents the elements of green infrastructure that act as a basis for environmental improvement.’⁹¹

In the context of urban areas, green infrastructure may refer to trees, while from an engineering perspective it may involve parks, reserves, wetlands, green roofs and walls.⁹² In Australia, green infrastructure is referred as ‘a network of green spaces, natural systems and semi-natural systems including parks, rivers, bushland and private gardens that are strategically planned, designed, and managed to support good quality of life in an urban environment.’⁹³

3.1.1 Green roofs

In NSW, roofs are considered one of the main contributors to the UHI effect.⁹⁴ The City of Sydney faces increasing pressures in its central business districts (CBDs) ranging from a lack of space, the UHI effect, stormwater run-off and pollution, to competition between residential, commercial and industrial developments, and biodiversity loss. Green roofs are considered an important infrastructure-related strategy for reducing climate and UHI effects, as they cool

⁸⁷ Ibid 9.

⁸⁸ Ibid.

⁸⁹ Ibid.

⁹⁰ Hannah Wright, Understanding green infrastructure: the development of a contested concept in England (2011) *Local Government* (16) 10, 1007.

⁹¹ Ibid.

⁹² Shikha Ranjha, ‘Green infrastructure planning for sustainable and resilient urban environment’ (2016) *Brief for Global Sustainable Development Report*, 1.

⁹³ Sheryn D Pitman, Christopher B Daniels and Martin E Ely, ‘Green Infrastructure as Life Support: Urban Nature and Climate Change’ (2015) 139(1) *Transactions of the Royal Society of South Australia* 97, 139.

⁹⁴ Office of Environment and Heritage (NSW), *Urban Green Cover in NSW, Technical Guidelines* (2015), 8.

buildings through evapo-transpiration and reduce energy demands and carbon dioxide emissions.⁹⁵ Moreover, they have been used for its multi-functionality benefits as they support habitat for urban ecology and improve rainwater management.⁹⁶ Green roofs involve vegetation covering at least 30% of available rooftop space, which is not occupied by structures housing plant, equipment or stairway accesses.⁹⁷

As efficient adaptive strategies, green roofs have been used to increase urban greening and ameliorate extreme climate measures as cities are becoming more urbanised and loosing green spaces.⁹⁸ For instance, the Chicago Urban Heat Island Initiative, funded by the U.S Environmental Protection Agency aimed at ‘replacing heat-absorbing surfaces with trees, plants and shrubs to cool the air through evapotranspiration, and to reserve the warming effects of concrete surfaces associated with city development.’⁹⁹ In addition, different states in the U.S provide subsidies to offset costs of green construction, such as local government tax credits, in return for reaching certain standards, such as LEED.¹⁰⁰

Irga *et al* found that the uptake of green roof projects in Australia was higher in councils that offered policy assistance, than those that did not provide any support, or have green roof examples on public buildings.¹⁰¹ Further, the study found that the volume of projects was associated with green roofs policy frequency per city.¹⁰² The City of Sydney Council has the highest number of green roofs in Australia, with a 23% increase in total green roofs and walls since the implementation of the policy in 2014.¹⁰³ However, Irga *et al.* also found implementation of green roofs and walls has been lower in Australia comparing to other countries in America.¹⁰⁴ They suggest that this may be due to different constraining factors, including limited numbers of installation experts, and the perception that little information is available associated with the technology designed for the Australian climate.¹⁰⁵

⁹⁵ Pitman, Daniels & Ely, above n 96, 106.

⁹⁶ Julyia Litichevskaya, ‘Reviving the world wonder: Why rooftop gardens should cover urban landscapes’ (2011) 37 Rutgers Computer and Technology Law Journal, 3.

⁹⁷ City of Sydney, *Green Roofs and Walls Policy 2014*, 2.

⁹⁸ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017).

⁹⁹ Litichevskaya above n 98, 3.

¹⁰⁰ Ibid.

¹⁰¹ P.J. Irga et al, ‘The distribution of green walls and green roofs throughout Australia: Do policy instruments influence the frequency of projects?’ *Urban Forestry & Urban Greening* 24 (2017), 167.

¹⁰² P.J. Irga et al, above n 104, 167.

¹⁰³ Ibid 170.

¹⁰⁴ Ibid.

¹⁰⁵ Ibid 165.

3.1.2 Urban Forest

Urban areas in Sydney are increasing in density and losing important green corridors responsible for minimising the UHI effect, improving air quality and managing stormwater.¹⁰⁶ Urban forests are known for a range of benefits, including mitigating the urban heat island effect, reducing air pollution and regulating microclimate.¹⁰⁷ As the *City of Sydney Urban Forest Strategy* suggests, tree canopy over paved surfaces is a cost-effective measure to mitigate the UHI, manage stormwater and increase pavement longevity.¹⁰⁸

The *City of Melbourne Urban Forest Strategy* describes urban forests as ‘the science of managing trees, forests and natural ecosystems in and around urban communities to maximize social, environmental and economic benefits of trees.’¹⁰⁹ Yet, the *City of Sydney Urban Forest Strategy* recognises challenges that come with attempting to manage urban forest, including competition for physical space, climate change and the UHI effect.¹¹⁰ It notes that trees are competing with studio apartments, street parking and sometimes with the desire for ‘maintenance free’ yards.¹¹¹ Furthermore, as Phelan *et al* argue, the majority of Australia’s urban vegetation is on private residential property and is therefore supported by land-use planning policies promoting increased density within existing urban areas.¹¹²

3.2 International case studies

The paper considers the approach of three countries in relation to green infrastructure and the role of climate change adaptation in regulatory schemes.

¹⁰⁶ Leesha McKenny, *Green Square: Population under pressure as projected population swells*, Sydney Morning Herald (Sydney) (online) 07 October 2015 <https://www.smh.com.au/national/nsw/green-square-infrastructure-under-pressure-as-projected-population-swells-20151007-gk2z1o.html>; Office of Environment Heritage (NSW), *Urban Ecology Renewal Investigation Project, Summary Report Prepared for the NSW Environmental Trust* (2016) *The National Green Infrastructure Network*.

¹⁰⁷ Jason Alexandra, ‘The city as nature and the nature of the city – climate adaptation using living infrastructure: governance and integration challenges’ (2017) *Australasian Journal of Water Resources*, 66.

¹⁰⁸ City of Sydney, *Urban Forest Strategy* (2013), 1-3.

¹⁰⁹ City of Melbourne, *Urban Forest Strategy* (2011), 9.

¹¹⁰ City of Sydney, *Urban Forest Strategy* (2013), 5-1.

¹¹¹ Ibid 5-2.

¹¹² Kath Phelan, Joe Hurley and Judy Bush, ‘Land Use Planning’s Role in Urban Forest Strategies Recent Local Government Approaches in Australia’ (2018) *Urban Policy and Research*, 1.

First, the US State of California legislation requires state departments and agencies to take into account climate change adaptation in planning decisions and to respond to the effects of the urban heat island effect in urban areas. The *Public Resources Code* (PRC) emphasises the state's intention to prioritise its responses by ensuring state departments and agencies prepare for, and are ready to respond to, the impacts of climate change, such as extreme weather events, the UHI effect, habitat loss, wildfires, sea-level rise and droughts.¹¹³ In order to address climate vulnerabilities identified in the *Safeguarding California Plan*, the *PRC* requires state agencies to maximise the objectives of such as 'informing planning decisions and ensuring that state investments consider climate change impacts, as well as promote the use of natural systems and natural infrastructure, when developing physical infrastructure to address adaptation.'¹¹⁴ Although natural infrastructure may be difficult to define, the *PRC* shows commitment to certainty in investment and values the role natural infrastructure has to climate change adaptation. For the purposes of the *PRC*, "natural infrastructure" is defined as:

'The preservation or restoration of ecological systems, or utilization of engineered systems that use ecological processes, to increase resiliency to climate change, manage other environmental hazards, or both. This may include, but is not limited to, floodplain and wetlands restoration or preservation, combining levees with restored natural systems to reduce flood risk, and urban tree planting to mitigate high heat days.'¹¹⁵

The *PRC* requires state agencies to build 'resilient communities by developing urban greening projects that reduce air pollution and heat reflection in urban areas and create liveable sustainable communities in urban centres and reduce greenhouse gas emissions.'¹¹⁶ Section 41400 of the *PRC* provides: 'the California Environmental Protection Agency must work with its partners on the Climate Action Team to develop heat reduction strategies that include urban forestry, cool roofs, and sustainable or cool pavements.'¹¹⁷ Furthermore, State agencies are also required to consider the current and future impacts of climate change when planning, designing, building, operating, maintaining and investing in state infrastructure.¹¹⁸

¹¹³ *Public Resources Code*, 34 Cal Public Resources Code § 71152 (2015).

¹¹⁴ *Public Resources Code*, 34 Cal Public Resources Code § 71154 (c)(1) (2015).

¹¹⁵ 34 Cal Public Resources Code § 71154 (f) (2015).

¹¹⁶ 34 Cal Public Resources Code § 71154 (f) (2015).

¹¹⁷ 34 Cal Public Resources Code § 71400 (a) (1) (2015).

¹¹⁸ 34 Cal Public Resources Code § 71155(a) (2015).

Second, in Germany, the term ‘green infrastructure’ is supported by the idea behind the *National Green Infrastructure Concept* that ‘the conservation and improvement of ecosystems and their services are as essential to the country’s development as the maintenance and improvement of ‘grey’ infrastructure.’¹¹⁹ The components of green infrastructure in this context are primarily natural sites and near-natural sites, although engineered elements such as green-bridges, eco-ducts and green roofs may also be examples of green infrastructure ‘as long as they perform particular functions and provide ecosystem services.’¹²⁰ These natural benefit services include food, clean air and water, climate mitigation, flood prevention, recreation and pollination.¹²¹ This support for green infrastructure is part of the *EU’s Biodiversity Strategy* and has the purpose of ‘improving the protection and conservation of ecosystems and ecosystem services in the period up to 2020.’¹²²

The key legal basis for environmental conservation in Germany is the *Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatSchG)* (FNC Act).¹²³ Legislative competencies are shared between the federal government and the level of the 16 Länder (federal states), where the Länder have the right to adopt their own individual policies and legislation.¹²⁴ In the context of planning law, the FNC Act regulates the interventions in nature and landscape management. The principles of conservation of nature and of landscapes determine that the efficiency of the balance of nature shall be maintained and improved, and when affected, this balance shall be avoided or compensated for.¹²⁵ Principle 8 of the FNC Act also provides that adverse effects on climate shall be prevented, and when these effects are inevitable, they shall be compensated for, or reduced, by landscape conservation efforts.¹²⁶

¹¹⁹ Federal Agency for Nature Conservation, *Federal Green Infrastructure Concept, Nature Conservation Foundations for Plans Adopted by the German Federation* (2017), 7.

¹²⁰ Ibid 16.

¹²¹ European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *Green Infrastructure (GI) – Enhancing Europe’s Natural Capital* (2013), 2.

¹²² Federal Agency for Nature Conservation, *Federal Green Infrastructure Concept, Nature Conservation Foundations for Plans Adopted by the German Federation* (2017), 16.

¹²³ *Bundesnaturschutzgesetz, BNatSchG [Federal Nature Conservation Act]* (Germany) 21 September 1998; Biodiversity Information System for Europe, *Green Infrastructure in Germany: 1. Policy Setting* <https://biodiversity.europa.eu/countries/gi/germany>

¹²⁴ Biodiversity Information System for Europe, *Green Infrastructure in Germany: 1. Policy Setting* <https://biodiversity.europa.eu/countries/gi/germany>

¹²⁵ *Bundesnaturschutzgesetz, BNatSchG [Federal Nature Conservation Act]* (Germany) 21 September 1998, art. 2 (1), principle 1.

¹²⁶ *Bundesnaturschutzgesetz, BNatSchG [Federal Nature Conservation Act]* (Germany) 21 September 1998, art.2 (1), principle 8.

Green roofs are traditional in Berlin.¹²⁷ At the beginning of the 19th Century the city had 2,000 green roofs.¹²⁸ The Berlin government has funded green infrastructure such as courtyards, green facades and green roofs since the 1980s to reduce the green space deficits in the inner-city areas.¹²⁹ The German government has been regulating green roofs and green facades under the *German Building Code* over the last 10 years.¹³⁰ The *Federal Building Code* (*Baugesetzbuch (BauGB)*)¹³¹ provides:

§ 1 (5) Urban development plans should ensure sustainable urban development that reconciles social, economic and environmental protection requirements, also in relation to future generations [...] They should also help ensure a decent environment, to protect, and develop the natural foundations of life, to promote climate protection and adaptation, especially in urban development. When drawing up the construction plans, the following should be considered:¹³²

§ 1 (5) 7 the concerns of environmental protection, in particular: the effects on plants, water, air and climate, and the interaction between them and the landscape and diversity;¹³³ environmental impacts on humans and their health and on the population as a whole,¹³⁴

The municipalities have the responsibility to develop construction plans,¹³⁵ and adopt the development plan as a statute.¹³⁶ Green roofs and green facades are referenced as ‘other plantings’ in the content of the development plan. For instance, the *Federal Building Code* determines the content of the development plan, for urban areas to include ‘for individual areas or parts thereof, as well as for parts of building structures, except for areas designated for agricultural use or forest, which the Code lists as: a) planting trees, shrubs and other plantings, b) bindings for planting and for the maintenance of trees, shrubs and other plantings and waters.’¹³⁷

¹²⁷ Senate Department for Urban Development and Housing, *06.11 Green Roofs* (2017), 1.

¹²⁸ Ibid.

¹²⁹ Ibid.

¹³⁰ Kazmierczak, A. and Carter, J. (2010) Adaptation to climate change using green and blue infrastructure. A database of case studies, 3.

¹³¹ *Baugesetzbuch* [Federal Building Code] (Germany) (*‘BauGB’*).

¹³² *Baugesetzbuch* [Federal Building Code] (Germany) § 1 (5) (*‘BauGB’*).

¹³³ *BauGB* § 1 (5) 7 (a).

¹³⁴ *BauGB* § 1 (5) 7 (c).

¹³⁵ *BauGB* § 2 (1).

¹³⁶ *BauGB* § 10 (1).

¹³⁷ *BauGB* § 9 (25).

The city of Stuttgart is one example of how green infrastructure has been applied in land-use planning and transport in Germany. Strategic planning in Stuttgart is ‘directed towards the improvement of essential linkages between green spaces and places of employment and living.’¹³⁸ Further, all new buildings have installed green roofs since 1993, as they improve building’s energy performance, the UHI effect and air quality.¹³⁹ Green roof technologies are also applied in the public transport system as in ‘trains, buses, train stations, bus stops and rail road tracks.’¹⁴⁰

Third, Singapore is the well-known “City in the Garden.”¹⁴¹ The government of Singapore invests heavily in green infrastructure to respond to water stresses, mitigate the urban heat island effect and improve loss of green space and biodiversity.¹⁴² Different spatial planning instruments in Singapore integrate the concept of green infrastructure in land use planning and development. The Urban Redevelopment Authority (URA) is Singapore’s national planning authority and the body responsible for planning and enhancing Singapore’s built environment.¹⁴³ URA introduced the *Landscaping for Urban Spaces and High Rises (LUSH)* program in 2009 to implement new and existing initiatives that encourage more skyrise greenery in private developments,¹⁴⁴ as well as a skyrise greening scheme made up of incentives and requirements.¹⁴⁵ As Irga *et al* note, the *Skyrise Incentive Scheme (SIGS)* funds up to 50% of the costs of green roofs installation and aims to reduce costs barriers to industries.¹⁴⁶

The purpose of *LUSH* includes mitigating the UHI effect and improving air quality through the plant’s transpiration and dust particles filtration.¹⁴⁷ The *Landscape Replacement Policy for Strategic Areas* requires developers to replace greenery lost from the site due to development

¹³⁸ Reeman Mohammed Rehan, ‘Cool city as a sustainable example of heat island management case study of the coolest city in the world’ (2016) *Housing and Building National Research Center*, 12, 193.

¹³⁹ Ibid.

¹⁴⁰ Ibid 195.

¹⁴¹ Vivienne Skinner et al, *Time’s Up: Making Green Infrastructure Count* (2017), 79.

¹⁴² Ibid.

¹⁴³ Alice Christudason, *Optimisation of Land Use through Innovative Legislation in Singapore* 1
<<http://www.ura.gov.sg/>>.

¹⁴⁴ Urban Redevelopment Authority, *Landscaping for Urban Spaces and High-Rises (LUSH) 2.0 Programme: Landscape Replacement Policy for Strategic Areas*, Circular to Professionals Institutes (12 June 2014)
<https://www.ura.gov.sg/Corporate/Media-Room/Media-Releases/pr17-77>

¹⁴⁵ Ibid

¹⁴⁶ Irga et al above n 104, 167.

¹⁴⁷ Ibid.

with greenery in other areas within development.¹⁴⁸ The total size of replaced landscaped areas must be at least equivalent in size to the development site area.¹⁴⁹ These replacement areas may be on the ground, rooftops or mid-level sky terraces. It requires at least 40 percent of the replacement area to have greenery in the form of landscaping, roof gardens, sky terraces or planter boxes, while the remaining areas may be designed as community facilities, such as playgrounds and water features.¹⁵⁰

The most recent *LUSH 3.0* seeks to further enhance the quality of greenery in developments as well as encourage more sustainable features.¹⁵¹ The changes include counting vertical greenery and extensive rooftops towards the Landscape Replacement Area requirements; encourage rooftops to be used for sustainability- related features and setting Green Plot Ratio (GnPR) Standards for private developments to safeguard sufficient density of greenery.¹⁵²

The GnPR is a planning and design tool used in Singapore, defined as ‘the average leaf area index (LAI) of the greenery of a site.’¹⁵³ This tool allows a three-dimensional quantification of greenery on a site using the Leaf Area Index (LAI).¹⁵⁴ The objectives of GnPR include identifying impacts of various levels of green infrastructure on capital and maintenance costs and developing recommendations and landscape guidelines for implementing optimal levels of GnPR within the urban design framework.¹⁵⁵ It may be used as a regulatory tool to ensure the design of buildings and precincts accommodates any loss in ecological value.¹⁵⁶ The developer can comply with the green plot ratio through different greening methods, such as combining areas reserved for planting and installing green roofs.¹⁵⁷

Singapore’s *Parks and Tree Act* provides a legal framework regarding the ‘planting, maintenance and conservation of trees and plants within national parks, reserves, tree conservation areas, heritage road green buffers and other specified areas for matter that are

¹⁴⁸ Ibid.

¹⁴⁹ Ibid.

¹⁵⁰ Ibid.

¹⁵¹ Urban Redevelopment Authority, *Updates to the Landscaping for Urban Spaces and High-Rises (LUSH) Programme: LUSH 3.0*, Circulars to Professional Institutes (09 November 2017).

¹⁵² Ibid.

¹⁵³ Dr David Ho Kim Hin, ‘To Develop a Landscape Guidelines for Application of Green Plot Ratio in Singapore’ *National University of Singapore* (2014), 1.

¹⁵⁴ Ibid.

¹⁵⁵ Hin above n 156, 1.

¹⁵⁶ Skinner et al, above n 144, 63.

¹⁵⁷ Ibid.

connected.¹⁵⁸ The Act requires that all premises or building plans requiring approval from the Commissioner of Building Control must have a planting area that conforms to prescribed dimensions.¹⁵⁹ The occupier of the premises is responsible for maintaining the planting area, either wholly or to the extent specified by the Commissioner.¹⁶⁰ The Minister has the power to prescribe different dimensions of planting areas specific to the class of a premises, for the purpose of enhancing greenery and promoting the use of trees and plants as important elements of streetscapes and landscapes.¹⁶¹

Examples from the US, Germany and Singapore demonstrate how other countries consider the impacts of climate change in state infrastructure and urban planning. It suggests that regulating green infrastructure as an adaptation strategy through land-use planning is already being utilised in different countries. While the motivation behind each implementation strategy differ, they recognise the adverse effects of development on local climate and the urgent need to compensate with additional landscape conservation and greenery in other areas within development.

4. International Frameworks and Australia

The *United Nations Conference on Environment and Development* (UNCED) was a landmark conference in the development of strategies to achieve sustainable development, which acknowledged the need to decrease greenhouse gas emissions and the threat of the impacts of climate change. One of the documents adopted was the *Rio Declaration*. The *Rio Declaration* sets out 27 guiding principles for sustainable development and includes influential principles such as intra- and intergenerational equity, polluter-pays and the precautionary principle, which has shaped environmental law and policy worldwide.¹⁶²

The concept of sustainable development was adopted in international law and policy as an important influence informing decision making in response to environmental degradation,

¹⁵⁸ *Parks and Trees Act* (Singapore, cap 216, 2006).

¹⁵⁹ *Parks and Trees Act* (Singapore, cap 216, 2006) s 23 (1).

¹⁶⁰ *Parks and Trees Act* (Singapore, cap 216, 2006) s 25 (25).

¹⁶¹ *Parks and Trees Act* (Singapore, cap 216, 2006) s 23 (3).

¹⁶² Lyster et al, *Environmental and Planning Law in New South Wales* (The Federation Press, 4th ed, 2016) 24. Legislation recognising the principles of ESD in decision making include: *Environmental Protection and Biodiversity Conservation Act 1999* (Cth), *Water Act 2007* (Cth), *Protection of Environment Administration Act 1991* (NSW), *Protection of the Environment Operations Act 1997* (NSW), *Biodiversity Conservation Act 2016* (NSW),

population growth and climate change. Sustainable development was first defined by the World Commission on Environment and Development (WCED) in the *Our Common Future Report* as ‘development that meet the needs of the present, without compromising the ability of future generations meeting their own needs.’¹⁶³

In 1992, Australian Federal, State and Territory, and local governments agreed to develop the *Intergovernmental Agreement on the Environment* (IGAE), which recognises ecologically sustainable development (ESD) in decision making.¹⁶⁴ The IGAE provides for adopting ESD as a basis for sound environmental practices and procedures: ‘it is required (for) the effective integration of environmental and economic considerations in decision making processes in order to improve community well-being and to benefit future generations.’¹⁶⁵

In the same year, the Council for Australian Governments adopted the *National Strategy for Ecologically Sustainable Development*.¹⁶⁶ It defined ESD “as using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.”¹⁶⁷ This concept has been widely adopted at all levels of government through environmental policies and legislation.

At the same time, global climate change was first identified as a concern, when it was discussed at the 1992 *United Nations Conference on Environment and Development* (UNCED).¹⁶⁸ In response to concerns about increasing GHGs and the potential impacts of climate change, the *United Nations Framework Convention on Climate Change* (UNFCCC) was adopted at this Conference.¹⁶⁹ The main purpose of the UNFCCC is to help ‘achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropocentric interference with the climate system.’¹⁷⁰ More than 20 years later, the *Fifth*

¹⁶³ World Commission on Environment and Development, *Our Common Future Report* UN Doc A/42/427 (October 1987).

¹⁶⁴ Department of the Environment and Energy (Cth), *Intergovernmental Agreement on the Environment* (1st May 1992).

¹⁶⁵ Department of the Environment and Energy (Cth), *Intergovernmental Agreement on the Environment* (1st May 1992), s 3.3.

¹⁶⁶ Department of Environment and Energy (Cth), *National Strategy for Ecologically Sustainable Development* (1992) See: <http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy-part1>

¹⁶⁷ Department of Environment and Energy (Cth), *National Strategy for Ecologically Sustainable Development* (1992) See: <http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy-part1>

¹⁶⁸ Lyster et al, above n 165, 233.

¹⁶⁹ Ibid.

¹⁷⁰ Lyster et al, above n 165, 236.

IPCC Assessment Report alerts about the future climate risks and impacts if anthropogenic greenhouse gas emissions continue to increase.¹⁷¹

In 2016, the Australian government committed to the *Paris Agreement* goal to limit the temperature increase to 1.5 °C above pre-industrial levels,¹⁷² and reduce emissions to 26-28 per cent on 2005 levels by 2030.¹⁷³ The *Paris Agreement*, and its associated *Kyoto Protocol*, are the main international mechanisms to date that aim at strengthening the global response to threats presented by climate change. They do so in the context of sustainable development, including increasing the ability of state parties to adapt to the impacts of climate change and foster resilience.¹⁷⁴ This goal includes ‘adaptation of enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change, with a view to contributing to sustainable development and ensuring adequate response in the context of the Paris Agreement’s temperature goal.’¹⁷⁵

Adaptation to climate change has become an essential aspect of policy reform and urban planning.¹⁷⁶ For example, the Australian Government adopted the *National Climate Change Adaptation Framework* (NCCARF) to build an understanding of the country’s adaptive capacity to reduce vulnerabilities in key sectors, namely health and infrastructure.¹⁷⁷ The NCCARF states:

Adaptation is the main way to deal with the unavoidable impacts of climate change. It is a mechanism to manage risks, adjust economic activity to reduce vulnerability and to improve business certainty.¹⁷⁸

¹⁷¹ Intergovernmental Panel on Climate Change, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III IPCC* (Geneva, Switzerland 2015), 8.

¹⁷² Australian Government, Department of the Environment and Energy, *Paris Agreement* <http://www.environment.gov.au/climate-change/government/international/paris-agreement>

¹⁷³ Australian Government, Department of the Environment and Energy, *Australia’s 2030 climate change target* (2015) <http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target>

¹⁷⁴ *Paris Agreement*, opened for signature 12 December 2015 (entered into force 4 November 2016) art. 2 (b).

¹⁷⁵ *Paris Agreement*, opened for signature 12 December 2015 (entered into force 4 November 2016) art. 7 (1).

¹⁷⁶ National Climate Change Adaptation Research Facility, *National Climate Change Adaptation Framework* (2007) 6 <https://www.nccarf.edu.au/sites/default/files/Australian-Government-2007a.pdf>

¹⁷⁷ National Climate Change Adaptation Research Facility, *National Climate Change Adaptation Framework* (2007) 6 <https://www.nccarf.edu.au/sites/default/files/Australian-Government-2007a.pdf>

¹⁷⁸ National Climate Change Adaptation Research Facility, *National Climate Change Adaptation Framework* (2007)3 <https://www.nccarf.edu.au/sites/default/files/Australian-Government-2007a.pdf>

In 2015, Australian Government released the *National Climate Resilience and Adaptation Strategy (The Strategy)*.¹⁷⁹ The Strategy identifies the roles and responsibilities for climate change in Australia. It states that State and Territory Governments have the responsibility to ensure ‘appropriate regulatory and market frameworks are in place and deliver adaptation responses in areas of policy and regulation that are within the jurisdiction of the state.’¹⁸⁰ It determines that one of the roles of the State government is to ‘manage risks through new state planning, property and environmental policy and legislation to ensure an appropriate environment for effective adaptation by asset owners or providers of both private and public infrastructure.’¹⁸¹

The recent *IPCC Global Warming of 1.5 C Special Report* suggests a wide range of adaptive options are available to reduce the risks of climate change, and focuses on their applicability across different sectors, including natural and managed ecosystems, the risks to sea level rise and urban areas.¹⁸² Importantly, the report highlighted green infrastructure and sustainable land use and planning as adaptation options in urban areas.¹⁸³ The avenues suggested by the report demonstrate increasing concern about the risks of climate change in urban areas by virtue of the urban heat island effect, for example, and the importance of adopting green infrastructure for climate adaptation in land use and planning. There is an ever-growing host of international and domestic instruments supporting mitigation and adaptation measures such as green infrastructure.

4.1 Ecological Sustainable Development and the law

The principles of ESD were recognised in Australian federal legislation with the enactment of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).¹⁸⁴ The EPBC Act provides the legal framework to protect and manage matters of national environmental significance in Australia, such as nationally threatened species, world heritage

¹⁷⁹ Australian Government, *National Climate Resilience and Adaptation Strategy* (2015).

¹⁸⁰ Australian Government, *National Climate Resilience and Adaptation Strategy, Roles and responsibilities for Climate Change Adaptation in Australia* (2015), 6.

¹⁸¹ *Ibid* 7.

¹⁸² Intergovernmental Panel on Climate Change, *Global warming of 1.5 C, Summary for Policy Makers*, approved at the First Joint Session of Working Groups I, II and III of the IPCC, and accepted by the 48 Session of the IPCC, Incheon, Republic of Korea (6 October 2018), 33.

¹⁸³ Intergovernmental Panel on Climate Change, *Global warming of 1.5 C, Summary for Policy Makers*, approved at the First Joint Session of Working Groups I, II and III of the IPCC, and accepted by the 48 Session of the IPCC, Incheon, Republic of Korea (6 October 2018), 33.

¹⁸⁴ *Environmental Protection and Biodiversity Conservation Act 1999* (Cth).

properties and water resources. The EPBC Act was enacted after the landmark *Tasmanian Dam* case in the High Court.¹⁸⁵ Gibbs CJ held:

‘a law that gives effect to an international agreement within Australia will be a valid exercise of the power conferred by s 51 (xxix) if the agreement is with respect to a matter which can itself be described as an external affair, and that any subject matter may constitute an external affair provided that the manner in which it is treated involves in some way a relationship with other countries or with persons or things outside Australia.’¹⁸⁶

The purposes of the *EPBC Act* include promoting ecologically sustainable development,¹⁸⁷ and assist in the co-operative implementation of Australia’s international environmental responsibilities.¹⁸⁸ To date, no provisions under the *EPBC Act* require the Minister to consider the impacts of climate change in activities that are likely to affect the environment or when approving a development regulated under the Act.

5. Climate adaptation and planning law in NSW

Traditionally, the common law has ruled land-use in Australia where the emphasis is on the protection of private property rights rather than on the protection of public rights and interests.¹⁸⁹ Although traditional common law causes of action are still alive in the use and management of land, the implementation of a statutory regime for environmental planning law has advanced the regulation of land-use in the public interest, not readily achievable under the common law.¹⁹⁰ As Ireland observes, ‘one presumption of statutory interpretation that regularly gives rise to rarely balanced issues in environmental and planning law, is the general presumption that legislation does not interfere with vested property interests unless parliamentary intention is manifested to this effect.’¹⁹¹ Further, he also notes that the modern approach to statutory interpretation is contextual and purposive.¹⁹² This means that the main objective of statutory interpretation is to construe the language of the relevant provision so it

¹⁸⁵ *Commonwealth v Tasmania* [1983] HCA 21.

¹⁸⁶ *Commonwealth v Tasmania* [1983] HCA 21, 95.

¹⁸⁷ *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) s 3 (1) (b).

¹⁸⁸ *Environmental Protection and Biodiversity Conservation Act 1999* (Cth) s 3 (1) (e).

¹⁸⁹ Lyster et al, above n 165, 2.

¹⁹⁰ Clifford Ireland, ‘Should private property rights trump the public interest in renewal of the urban environment?’ (2009) *Local Government Law Journal* 86, 86.

¹⁹¹ *Ibid* 88.

¹⁹² *Ibid* 87.

is consistent with the language and purpose of the whole statute.¹⁹³ This purposive approach has facilitated the achievement of the objects of environmental planning legislation and the interpretation of the public interest requirement under the *EPA Act*, which includes provision of land for public purposes and ESD.¹⁹⁴

The drivers of change in the planning system in the 1970s involved a system driven by complexity.¹⁹⁵ Historically, land-use and planning decisions were made under a system dominated by economic rationality.¹⁹⁶ The Wran government proposed a simplified system with the enactment of the *EPA Act*, while recognising the importance of community involvement in development assessments and considering the public interest in decision making processes.¹⁹⁷ With the adoption of a new planning system, the need to consider the environment in land use and development was also strong, although not a priority.¹⁹⁸ As Chief Justice McClellan from the Land and Environment Court of NSW observes: ‘The inclusion of the word “environment” was not incidental. It reflected that all aspects of the built and natural environment including projects undertaken by government were later controlled by an Act of Parliament.’¹⁹⁹

The *EPA Act* came into effect in 1979 to implement a system of planning and development control in NSW. It introduced environmental planning instruments (EPIs), comprehensive environmental assessments and for the first time, the increasing opportunity for public participation in environmental planning and assessment.²⁰⁰ Further, it recognises the need for environmental consideration in decision making, while giving the Minister considerable discretion to make environmental planning instruments.²⁰¹ The *EPA Act* has the purpose, among other things,

¹⁹³ Ibid 87.

¹⁹⁴ Tayanah O'Donnell and Louise Gates, ‘Getting the balance right: A renewed need for the public interest test in addressing coastal climate change and sea level rise’ (2013) 30 *Environmental Planning and Law Journal* 220, 229.

¹⁹⁵ Lyster et al, above n 165.

¹⁹⁶ Robyn Bartel, Paul McFarland and Colin Hearfield, ‘Taking a de-binarised envirosocial approach to reconciling the environment vs economy debate: lessons from climate change litigation for planning in NSW, Australia’ (2014), 72.

¹⁹⁷ Lyster et al, above n 165, 60.

¹⁹⁸ Ibid.

¹⁹⁹ Peter McClellan, ‘The Land and Environment Court of NSW’ (swearing In Speech of Chief Judge, 35 August 2003) *National Environmental Law Review* (2003) 3, 27.

²⁰⁰ *Environmental Planning and Assessment Act 1979* (NSW) s 1.3(j).

²⁰¹ Lyster et al, above n 165, 63.

‘to promote the social and economic welfare of the community and a better environment by the proper management, development and conservation of the State’s natural and other resources.’²⁰²

The *EPA Act* also has the purpose to promote ESD by integrating relevant environmental, economic and social considerations in to decision-making.²⁰³ Decisions made under the *EPA Act* require the consent authority to protect, restore and enhance the quality of the environment in NSW, having regard to the need to maintain ESD.²⁰⁴ Importantly, it encourages the sharing of responsibility for environmental planning and assessment between the different levels of government in the State.²⁰⁵

The application of the principles of ESD as one of the objects of the *EPA Act* remains strongly at the discretion of the administrator. . Criticisms involve the extent by which the principles of ESD are applied when the matter arises, such as in biodiversity loss and climate change cases. NSW Land and Environment Court Chief Justice Preston notes:

‘Legislation that incorporates ESD typically describes ESD in general terms, it is operated as a standard of conduct or behaviour, as a standard of methodology of decision-making or as a standard of outcome or result.’²⁰⁶

The principles of ESD are ‘utilised by many other NSW Acts, where the object is to ameliorate the impact of government or private actions on the natural or built environment.’²⁰⁷

The legislation references core principles of ESD such as the precautionary principle and intergenerational equity.²⁰⁸ The precautionary principle is based on Principle 15 of the Rio Declaration, which states: ‘if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.’²⁰⁹

²⁰² *Environmental Planning and Assessment Act 1979* (NSW) s 1.3 (a).

²⁰³ *Environmental Planning and Assessment Act 1979* (NSW) s 1.3 (b).

²⁰⁴ *Protection of the Environment Administration Act 1991* (NSW), s 6 (1)(a)

²⁰⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 1.3(i).

²⁰⁶ The Hon. Justice Brian Preston SC, ‘The Judicial Development of Ecologically Sustainable Development (2016) *Environment in Court*,’ *IUCNAEL Colloquium 2016*, 22 June 2016, Oslo, Norway, 6.

²⁰⁷ *BGP Properties Pty Ltd v Lake Macquarie City Council* [2004] NSWLEC 399.

²⁰⁸ *Protection of the Environmental Administration Act 1991* (NSW) s 6 (2) (a).

²⁰⁹ *Ibid.*

The principle of inter-generational equity is based on the presumption that ‘the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.’²¹⁰ This principle received judicial attention in the case *Taralga Landscape Guardians Inc v Minister for Planning*, which involved the construction of 62 wind turbines in the local rural community of Taralga, NSW.²¹¹ In his judgement, Preston CJ understood the principle of intergenerational equity to be a key consideration:

The attainment of intergenerational equity in the production of energy involves meeting at least two requirements. The first requirement is that the mining of and the subsequent use in the production of energy of finite, fossil fuel resources need to be sustainable. Sustainability refers not only to the exploration and use of the resource but also to the environment in which the exploration takes place and which may be affected. The objective is not only to extend the life of the finite resources and the benefits yielded by exploration and use of the resources to future generations, but also to maintain the environment, including the ecological processes on which life depends, for the benefit of future generations. The second requirement is, as far as practicable, to increasingly substitute energy resources that result in less greenhouse gas emissions for energy sources that result in more greenhouse gas emissions, thereby reducing the cumulative and long-term effects caused by anthropogenic climate change.²¹²

His Honour balanced community concerns surrounding the local amenity and environment against the broader public good concerning global impacts of climate change caused by greenhouse gases.²¹³ Preston CJ held that ‘the overall public benefits outweigh any private disbenefits either to the Taralga community or specific landowners.’²¹⁴

The *EPA Act*’s most recent 2017 amendment introduced two new objectives to ESD. While making decisions under the *EPA Act*, the consent authority is to promote good design and amenity of the built environment,²¹⁵ and to promote the proper construction and maintenance of buildings, including the protection of the health and safety of their occupants.²¹⁶ These new

²¹⁰ *Ibid* s 6 (2) (b).

²¹¹ (2007) 161 LGERA.

²¹² *Taralga Landscape Guardians Inc v Minister for Planning* (2007) 161 LGERA [74].

²¹³ David Farrier and Paul Stein, *The Environmental Law Handbook* (5th ed, 2011), 414.

²¹⁴ *Taralga Landscape Guardians Inc v Minister for Planning* (2007) 161 LGERA [352].

²¹⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 1.3 (g).

²¹⁶ *Environmental Planning and Assessment Act 1979* (NSW) s 1.3 (h).

provisions are important considering the future legal dimensions associated with the uptake of climate change adaptation and green infrastructure.

Land use planning in NSW is regulated by environmental planning instruments and involves three main aspects of environmental protection: strategic planning, development control and environmental assessment.²¹⁷ Environmental planning legislation includes strategic and statutory planning, which have the purpose of regulating land-use planning and managing environmental impacts of development at a state, local or development-specific level.²¹⁸ Development for the purposes of the *EPA Act* include the use and subdivision of land, the erection of a building, carrying out of a work and any other activities that may be controlled by an environmental planning instrument.²¹⁹

Part 3 of the *EPA Act* sets out the framework for strategic planning, which is then delivered through various environmental planning instruments. Environmental planning instruments (EPIs), such as state environmental planning policies (SEPPs) and local environmental plans (LEPs), are created to achieve the EPA's objectives. They are statutory documents that determine how land is to be used and to control development.²²⁰ EPIs must be reviewed periodically by the relevant authorities 'for the purposes of ensuring that the objects of the *EPA Act* are having regard to changing circumstances as may be relevant and achieved to the maximum extent possible.'²²¹ As Ireland notes, 'as environmental regulation concerns land-use activities on land across an entire jurisdiction, it needs a content and flexibility that goes beyond what can be achieved by Acts of Parliament alone.'²²² In NSW, this content and flexibility in the environmental regulatory regime is provided through the system of interconnected EPIs.²²³ The *EPA Act* determines the categories of development which may require consent, assessment or prohibition of environmental impacts. These categories are provided under Part 4 and Part 5 of the *EPA Act*. They represent an essential aspect of development assessment and consent in NSW and sets out the requirements for environmental impact assessments (EIA) of any activity that is likely to significantly affect the environment, including State Significant Infrastructure (SSI).

²¹⁷ Gerry Bates, *Environmental Law in Australia* (LexisNexis Butterworths Australia, 9th ed, 2016) 263.

²¹⁸ *Ibid* 341.

²¹⁹ *Environmental Planning and Assessment Act 1979* (NSW) s 1.5 (1).

²²⁰ EDO NSW, *LEPs and SEPPs, Planning, Development and Heritage Factsheet* (2013)

²²¹ *Environmental Planning and Assessment Act 1979* (NSW) s.73.

²²² Ireland above n 195, 87.

²²³ *Ibid*.

Part 4 is particularly important for matters regarding climate change adaptation, as it sets out the framework for development assessment and consent and classifies the requirements of developments that may require consent, or are prohibited.²²⁴ The consent authority, often the Minister for Planning, is required to consider a range of relevant matters in decision making for development applications under Part 4. For instance, the Minister is required to consider in decision making processes environmental planning instruments and the likely impacts of development, including environmental impacts, on both natural and built environments, and the social and economic impacts in the locality.²²⁵ Development Control Plans (DCPs) are also a matter for consideration, although they are implemented by the Council and are not mandatory. While the consent authority must consider a DCP, decisions should not require excessive standards if the development complies with any aspect of the development and development application.²²⁶ Moreover, the consent authority is, when appropriate, required to be flexible if aspects of the development do not comply with the standards. Developers are encouraged to find alternative solutions to achieve the objects of the standards.²²⁷

Public interest is among the relevant matters the Minister is required to consider under Part 4. Over the last decade, several cases relevant to climate change mitigation and adaptation have been interpreted as a public interest matter, even though climate change is not referred under the *EPA Act*. The problem is, as Ghanem and Ruddock note, ‘the current NSW planning framework does not adequately incorporate the consideration of the potential effects of climate change nor does it mandate measures to adapt to climate change impacts under the *Environmental Planning and Assessment Act 1979* (NSW) (*EPA Act*).’²²⁸

Cases have tested the consideration of the principles of ESD in development assessments involving climate change risks as matters of the public interest. For instance, the case *Walker v Minister for Planning*²²⁹ challenged the approval of a concept plan under Part 3A (now repealed) of the *EPA Act* for residential subdivision and retirement village at Sandon Point.²³⁰

²²⁴ *Environmental Planning and Assessment Act 1979* (NSW) Part 4, Division 4.1.

²²⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 4.15 (1) (b)

²²⁶ *Environmental Planning and Assessment Act 1979* (NSW) s 4.15 (3A)(a)

²²⁷ *Environmental Planning and Assessment Act 1979* (NSW) s 4.15 (3A)(b)

²²⁸ Robert Ghanem and Kirsty Ruddock, ‘Are New South Wales’ planning laws climate-change ready?’ (2011)

28 *Environmental and Law Planning Journal* 17, 17.

²²⁹ (2008) 157 LGERA 124.

²³⁰ *Walker v Minister for Planning* (2008) 157 LGERA 124.

The case raised community opposition due to its potential environmental impacts, as the proposed development was to be built in flood-prone coastal land.²³¹ One line of argument was that the Minister had failed to apply the principles of ESD when deciding to approve the proposal.²³² Justice Biscoe held that the answer to these questions may be found in the subject matter, scope and purpose of the *EPA Act*.²³³ His honour found that a climate change flood risk may be considered an aspect of the public interest that potentially had a direct bearing on the justice of the decision.²³⁴ While ESD is not referred in s 79C (s 4.15) of the *EPA Act*, the Land and Environment Court has determined that principles of ESD are matters of the public interest and must be considered in decision making when the issue arises.²³⁵ However, the *Walker* decision was overturned by the Court of Appeal, which said that ‘one difficulty with the view that failure to consider ESD principles renders void a Minister’s decision, is that the encouragement of ESD is just one of the many objects set out in s 5 of the *EPA Act*.’²³⁶ Hodgson JA held:

The “mandatory” requirement that the Minister have regard to the public interest does not of itself make the condition of validity mandatory, that the Minister have regard to any aspect of the public interest, such as one or more of the principles of. Whether or not it is mandatory to have regard to one or more of the principles of ESD must depend on statutory construction.”²³⁷

The majority ruled that it was not mandatory to have regard to one or more principles of ESD as a matter of statutory construction of Part 3A of the *EPA Act*.²³⁸ However, as the majority agreed, ‘the principles of ESD are likely to come to be so plainly an element of the public interest, in relation to most if not all decisions, that failure to consider them will become strong evidence of failure to consider the public interest, [...] and thus become capable of avoiding decisions.’²³⁹

²³¹ EDONSW, *Walker v Minister for Planning* (November 2007) <https://www.edonsw.org.au/walker>

²³² *Ibid*

²³³ *Walker v Minister for Planning* (2008) 157 LGERA 124, 129.

²³⁴ *Ibid.*

²³⁵ *Ibid.*

²³⁶ *Minister for Planning v Walker* [2008] NSWCA 224, 52.

²³⁷ *Minister for Planning v Walker* [2008] NSWCA 224, 44.

²³⁸ *Minister for Planning v Walker* [2008] NSWCA 224, 56.

²³⁹ *Minister for Planning v Walker* [2008] NSWCA 224, 56.

In the *Bulga Milbrodale Progress Association Inc v Minister for Planning and Infrastructure and Warkworth Mining Ltd*,²⁴⁰ the Chief Justice Preston observed:

“It is not necessary in these proceedings to determine whether the principles of ESD are mandatory relevant considerations in their own right, and it is sufficient to conclude that as an aspect of the public interest they may be taken into account in cases where issues relevant to the principles of ESD arise.”²⁴¹

Part 5 of the *EPA Act* establishes the framework for development and assessment of infrastructure critical to the state. This is important, since it requires assessment of a project’s environmental impact. Section 5.5 requires the determining authority to examine and take into account, to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity.²⁴² In *Parks and Playgrounds Movement Inc v Newcastle City Council*,²⁴³ Biscoe J said: ‘The mandatory duty under s 111 (s 5.5) is to be applied reasonably and with practicality. The duty is to consider to the fullest extent reasonably practicable, matters that will or are likely to affect the environment.’²⁴⁴

As a decision making-tool under Part 5, EIAs assess the potential environmental impact of a project in order to determine whether a project can go ahead, and, if so, under what conditions.²⁴⁵ The purpose of an EIA includes documenting and disclosing the extent of environmental impacts of an activity, while allowing public discussion on development proposals.²⁴⁶ EIAs are usually applied to development approval applications that signal the potential for environmental harm, and to activities that have significant environmental impacts, but do not require development approval.²⁴⁷

Categories of development under Part 5 do not require consent, although they require government approval, by or on behalf of a public authority.²⁴⁸ For example, the Minister’s

²⁴⁰ *Mining Ltd* [2013] NSWLEC 48, 57.

²⁴¹ *Bulga Milbrodale Progress Association Inc v Minister for Planning and Infrastructure and Warkworth Mining Ltd* [2013] NSWLEC 48, 59.

²⁴² *Environmental Planning and Assessment Act 1979* (NSW), s 5.5(1).

²⁴³ *Parks and Playgrounds Movement Inc v Newcastle City Council* [2010] NSWLEC 231

²⁴⁴ *Parks and Playgrounds Movement Inc v Newcastle City Council* [2010] NSWLEC 231, 158.

²⁴⁵ Elizabeth Fisher, Bettina Lange, Eloise Scottford, *Environmental Law, Text, Cases and Materials* (2013) Oxford University Press, 845.

²⁴⁶ Lyster et al, above n 165, 143.

²⁴⁷ Bates, above n 220, 408.

²⁴⁸ Lyster et al, above n 165, 147.

approval is required if a person wants to carry out a development that is classified as ‘State Significant Infrastructure’ (SSI).²⁴⁹ This includes development for the purpose of railways, roads, electricity transmission, pipelines, stormwater management systems, water supply systems, public parks or reserves management and soil conservation works.²⁵⁰ Together with the development proposal, the Planning Secretary is to prepare environmental assessment requirements concerning the infrastructure,²⁵¹ which must require an environmental impact statement (EIS) prepared by the proponent.²⁵²

Section 5.7 of the *EPA Act* states that a determining authority shall not carry out an activity, or grant an approval in relation to a prescribed activity, that is likely to significantly affect the environment unless an environmental impact statement has been fully examined and considered.²⁵³ An activity may include, the use of land, subdivision of land, erection of a building and carrying out of a work.²⁵⁴ It does not include exempt developments or others carried out in compliance with a development control order.²⁵⁵

EISs are required under Part 4 and Part 5 of the *EPA Act* if an activity is likely to affect the environment.²⁵⁶ For the purposes of the *EPA Act*, the environment includes all aspects of the surroundings of humans whether affecting any human as an individual, or, in his or her social groupings.²⁵⁷ An EIS should contain a detailed analysis and a statement of the objectives about the development, activity or infrastructure and an analysis of the feasible alternatives, including the consequences of not the carrying out of the development, activity or infrastructure.²⁵⁸ The reasons for justifying the development, activity or infrastructure must have regard to the biophysical, economic and social considerations, including the principles of ESD.²⁵⁹ Therefore, the scope of the EIS is to support the assessment of development application and determine the potential risks and impacts of climate change. In the context of assessing the impacts of urban heat and development in areas vulnerable to extreme heat, mapping could be

²⁴⁹ *Environmental Planning and Assessment Act 1979* (NSW) s 5.14(1).

²⁵⁰ *Environmental Planning and Assessment Act 1979* (NSW) s 5.11.

²⁵¹ *Environmental Planning and Assessment Act 1979* (NSW) s 5.16(1).

²⁵² *Environmental Planning and Assessment Act 1979* (NSW) s 5.16(2).

²⁵³ *Environmental Planning and Assessment Act 1979* (NSW) s 5.7 (1)(a).

²⁵⁴ *Environmental Planning and Assessment Act 1979* (NSW) s 5.1 (a)-(d).

²⁵⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 5.1 (i) and (j).

²⁵⁶ Lyster et al, above n 165, 146.

²⁵⁷ *Environmental Planning and Assessment Act 1979* s 1.4 (1).

²⁵⁸ *Environmental Planning and Assessment Regulation 2000* (NSW), Schedule 2, s 7(1).

²⁵⁹ *Environmental Planning and Assessment Regulation 2000* (NSW), Schedule 2, s 7(1)(f).

one of the assessment tools to identify areas that require stronger adoption of green infrastructure alongside other development.

5.1 The relationship between planning law and climate change adaptation

The *IPCC Fifth Assessment* indicates that resilience to extreme weather for urban dwellers is strongly influenced by factors such as ‘the quality of buildings, the effectiveness of land use planning and the quality and coverage of key infrastructure and services.’²⁶⁰ The relationship between planning law and climate change adaptation is directly related to how development, and the use of land, is regulated. This is because climate change adaptation strategies require action to manage local impacts, such as sea level rise, flooding, bushfires and extreme heat events.²⁶¹ ²⁶² In Australia, these factors are largely regulated by state and local government, which ultimately determine the scale of the country’s adaptation to climate change.²⁶³ Peel and Osofsky note the concentration of state control over land use planning, and the delegation of decision-making powers to local government, are essential aspects of the localised nature of action on climate adaptation in Australia.²⁶⁴ In the context of developing green infrastructure in urban areas, state and local government mechanisms for implementation at a local level are essential.

While the *EPA Act* does not recognise climate change adaptation, there is a growing body of jurisprudence concerning development in coastal areas and the application of ESD. Peel and Godden argue that most of the decisions rely on ‘the principles of ecologically sustainable development to interpret planning laws in a way that supports the implementation of adaptation measures.’²⁶⁵ For example, in *Aldous v Greater Taree City Council*,²⁶⁶ the applicant argued that the development consent under Part 4 was to be considered invalid because the council failed to take in to consideration the principles of ESD, in particular the principles of

²⁶⁰ Revi et al, *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Urban Areas (2014) [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 538.

²⁶¹ Peel and Godden, above n 41, 38.

²⁶² Revi et al above n 39, 548.

²⁶³ Foerster, Macintosh and McDonald above n 4, 475.

²⁶⁴ Jacqueline Peel and Hari M. Osofsky, ‘Sue to Adapt?’ (2015), *Forthcoming in Minnesota Law Review*, 33.

²⁶⁵ Peel and Godden above n 41, 38.

²⁶⁶ (2009) 167 LGRA 13.

intergenerational equity and the precautionary principle.²⁶⁷ The applicant argued that the local council was obliged to consider ESD as a public interest consideration under s79C (s 4.15) in the context of climate change induced coastal erosion.²⁶⁸ The case involved the validity of the consent of a development to construct a new dwelling on a beachfront property in Old Bar, which was granted by the Greater Taree City Council to the second respondent.²⁶⁹ Biscoe J assessed the 4th IPCC Report and different Australian government reports concerned about the impacts of climate change on the Australian coasts, and held that the council was ‘obliged to take into account the principles of ESD and, in particular, climate change induced erosion, by reason of the council’s mandatory obligation under s 79C of the EPA Act to take into consideration the public interest.’²⁷⁰ His Honour held that the Council did not fail to do so.²⁷¹

Over the past decade, evidence of the growing momentum in terms of the law responding to adaptation and climate change can be seen in the jurisprudence of cases concerning climate change adaptation. In NSW, climate change cases have mostly challenged the interpretation and use of the principles of ESD in development applications and decision-making processes. In NSW, the courts have interpreted the application of ESD principles in decision making on cases concerning the environment, the impacts of development for future generations and the impacts of climate change on coastal areas. Court decisions have established a link between the principles of ESD and EIAs, providing direction in investigating ‘the adequacy of environmental assessments and potential global warming impacts.’²⁷²

5.2 Environmental planning instruments and Development Control Plans

This section describes the role of environmental planning instruments and DCPs in regulating development and infrastructure in the GSR. The following mechanisms available in the planning system are essential to the development of climate change adaptation strategies and improved standards such as green infrastructure. As it was previously observed, spatial planning instruments are currently available to respond to other natural hazards, such as sea level rise. These instruments have a formal hierarchy and are applied in a manner to avoid

²⁶⁷ *Aldous v Greater Taree City Council and Another* (2009) 167 LGERA 13, 23.

²⁶⁸ Bates, above n 220, 273.

²⁶⁹ *Aldous v Greater Taree City Council and Another* (2009) 167 LGERA 13, 1.

²⁷⁰ *Aldous v Greater Taree City Council v Another* (2009) 167 LGERA 13, 40.

²⁷¹ *Aldous v Greater Taree City Council v Another* (2009) 167 LGERA 13, 40.

²⁷² Martin, above n 77, 114.

inconsistency between them. Although LEPs are developed by the relevant planning authority, which may be the Council,²⁷³ the Minister for Planning still retains major power to approve proposed local instruments. A similar approach applies to DCPs, which the Minister has the power to make determinations in development applications where the Minister considers beneficial to the public interest, having regards to the matters of significance for state or regional environmental planning.²⁷⁴

5.2.1. State Environmental Planning Policies

Section 3.29 of the *EPA Act* provides that a SEPP may be made by the Governor with respect to any matter that, in the opinion of the Minister, is of state or regional environmental planning significance, or of environmental planning significance to a district of any area of the State or any part of the GSR.²⁷⁵ Bates argues that ‘the advantage of a state planning is that implementation of the government’s objectives is not left to the discretion of individual local councils, which might vary in their commitment to the objectives of plans and apply a diverse range of different approaches and standards to their realisation.’²⁷⁶ He further suggests that ‘state-wide planning enables the government to coordinate a response to matters of environmental concern and require a uniform and consistent approach from state to local government, applying common standards throughout the state.’²⁷⁷

Different SEPPs were introduced to regulate development, infrastructure and environmental protection in the State over the decades. For example, *SEPP Infrastructure* (2007) and *SEPP (Regional and State Significant development)* 2011 have the purpose to control infrastructure that is essential, considered critical and of great extension.²⁷⁸ State Significant Infrastructure (SSI) and State Significant Development (SSD) are regulated by the *SEPP (State and Regional Development)* 2011. The SEPP identifies development that is of State significance or of Critical State Significant Infrastructure (CSSI).²⁷⁹ SSI in NSW includes major transport and services that have a wider impact to more than just one local area, such as road and rail infrastructure, pipelines, water storage, and treatment plants. SSI is also identified in a development proposal

²⁷³ Lyster et al, above n 165, 63.

²⁷⁴ *Environmental Planning and Assessment Act 1979* (NSW) s 3.29(2).

²⁷⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 3.29(2).

²⁷⁶ Bates, above n 220, 347.

²⁷⁷ Ibid.

²⁷⁸ *SEPP (Regional and State Significant development)* 2011.

²⁷⁹ *State Environmental Planning Policy - SEPP (State and Regional Development)* 2011, s 3(b).

if it is over a certain size, located in a sensitive environmental area or would exceed a particular capital investment.²⁸⁰ The Minister for Planning may declare an infrastructure project to be CSSI if the Minister believes that the infrastructure is essential for the State for economic, environmental or social reasons.²⁸¹

The growing housing development in Sydney growth areas, such as under the *Greenfield Housing Code* are regulated by *SEPP (Exempt and Complying Development Code) 2008*. Greenfield growth focuses in the north and south-west ‘Growth Centres.’²⁸² The *Greenfield Housing Code* was included in the SEPP to simplify and coordinate development standards to suit market demand, housing types and lot sizes and achieve faster housing approvals.²⁸³ The purpose of the SEPP is to provide detailed assessment processes for development that complies with specified development standards.²⁸⁴ For instance, the SEPP has three key purposes: firstly the instrument sets out exempt and complying development codes that have State-wide application;²⁸⁵ secondly it identifies in the exempt development codes, types of development that are of minimal impact to the environment and may be carried out without development consent, such as air conditioning, verandas and decks.²⁸⁶ Thirdly it identifies in complying development codes, types of development that may be carried out in accordance with a complying development certificate,²⁸⁷ such as the erection of a 1 or 2 storey house.²⁸⁸

One of the main concerns with the use of SEPP’s for the development of housing, has been that they are designed to speed up the development assessment process.²⁸⁹ This may lead to higher environmental impacts and lack of consideration regarding green spaces and other green infrastructure in general such as tree canopies. While the NSW government is offering a “free tree” per house, residential design may lead to less front setback available and lead no room for tree canopies. Bartel *et al.* argue that land releases, greenfield infill and streamlined

²⁸⁰ NSW Government, Planning & Environment, *State Significant Infrastructure* (2018) <https://www.planning.nsw.gov.au/Assess-and-Regulate/Development-Assessment/Planning-Approval-Pathways/State-Significant-Infrastructure>

²⁸¹ *Environmental Planning and Assessment Act 1979* (NSW) s 5.13.

²⁸² Martin, above n 77, 240.

²⁸³ NSW Government, Planning & Environment, *Greenfield Housing Code* (2018) <https://www.planning.nsw.gov.au/policy-and-legislation/housing/greenfield-housing-code>

²⁸⁴ *State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008*, s 1.3.

²⁸⁵ *State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008*, s 1.3 (a).

²⁸⁶ *State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008*, s 1.3 (b).

²⁸⁷ *State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008*, s 1.3 (c).

²⁸⁸ *State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008*, s 3.1(1) (a).

²⁸⁹ Ghanem and Ruddock above n 233, 33.

development assessment are perceived as the solution, even though this is likely to generate further issues, such as limiting the land available for alternative uses and leaving more fundamental price pressures untreated.²⁹⁰

Another concern is the lack of assessment regarding cumulative impacts of development. Environmental groups have responded to the NSW government's Discussion Paper, "*Options for Low Rise Medium Density Housing as Complying Development*" with concerns that it does not address the potential cumulative impacts of multiple complying developments in a specific area adequately.²⁹¹ It further suggests that large areas could be developed by a single developer without any consideration of the overall impacts of such development, including tree clearing.²⁹² As EDO NSW notes, 'complying development should be low-impact in order to justify the exemption from assessment and determination by local councils.'²⁹³

The only SEPP regulating water, energy efficiency and GHG emissions in residential buildings, is the *Building Sustainability Index (BASIX)*.²⁹⁴ The BASIX SEPP requires developments to have regard for design quality principles, which aim to reduce the consumption of mains-supplied potable water, or reduce emissions of GHG's, in the use of the building or in the use of the land on which the building is situated,²⁹⁵ or to improve the thermal performance of the building.²⁹⁶ It has been argued that this sustainability standard mechanism hasn't been effective as the scope and requirements of the SEPP have not been updated between 2006 and 2016 and the majority of NSW energy-related emissions remain outside the scope of BASIX.²⁹⁷ Parker stated the need to amend BASIX to give direction to councils and developers about how buildings should meet the ground.²⁹⁸ He said that 'while a range of controls address the quality of apartment design and improving their internal amenity, NSW planning legislation does not provide clear design requirements for the point at which buildings meet the street.'²⁹⁹

²⁹⁰ Bartel, McFarland and Hearfield above n 195, 79.

²⁹¹ EDO NSW, *Submission on Options for Low Rise Medium Density Housing as Complying Development* (February 2016), 7.

²⁹² Ibid 7.

²⁹³ Ibid.

²⁹⁴ *State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004*.

²⁹⁵ *Environmental Planning and Assessment Regulation 2000* (NSW), s154A (3)(a).

²⁹⁶ *Environmental Planning and Assessment Regulation 2000* (NSW), s154A (3)(b).

²⁹⁷ Nari Sahukar, 'The Role of Planning Laws and Development Control Systems in Reducing Greenhouse Gas Emissions: Analysis from New South Wales, Australia' (2018) *Springer*, 76.

²⁹⁸ New South Wales, Parliamentary Debates, Legislative Assembly, *Environmental Planning and Assessment Bill 2017* (8 August 2017) (Jamie Parker, MP)

²⁹⁹ Ibid.

The positive outcomes expected from BASIX would benefit from the development of green infrastructure, which would be considered in the design process.

5.2.2 Local Environmental Plans

Local government plays an essential role in environmental planning regulation.³⁰⁰ Local Councils may develop Local Environmental Plans (LEPs) ‘for the purposes of environmental planning in each local government area as the local plan-making authority determines.’³⁰¹ LEPs may be applied to all or part of the LGA and guide local government decisions by allocating land use in categories, also known as zones. LEPs have the purpose to determine conditions on land use. Therefore, the consent authority cannot grant consent to a development unless the same authority is of the opinion that the activity is consistent with the objectives of the zone in which the activity is proposed to be carried out.³⁰²

Zoning is an essential aspect of the LEPs. Each category of land use has different objectives, indicating the purpose of land, while also listing developments that are permitted with consent, without consent, or prohibited.³⁰³ In *BGP Properties Pty Ltd v Lake Macquarie City Council*,³⁰⁴ McClellan CJ has held that the more specific the zoning, the more confined the range of permissible uses, the greater the weight which must be attributed to achieving the objects of the planning instrument which the zoning reflects.³⁰⁵ This could be an efficient tool to respond to climate change adaptation strategies and determine the appropriate development consent in vulnerable areas.

Historically, LEPs were inconsistent, as each local council had different criteria for zoning and its objectives and permissible uses. A Standard Instrument for preparing LEPs was introduced in 2006 to achieve consistency and efficiency.³⁰⁶ The LEP Standard Instrument provides a Dictionary of standard definitions relating to land uses and they are grouped into categories, such as Metropolitan Centre, High, Medium or Low Density, Infrastructure, Commercial,

³⁰⁰ Ireland above n 195, 86.

³⁰¹ *Environmental Planning and Assessment Act 1979* (NSW), s 3.31 (1).

³⁰² Preston, Brian J, *Climate Change Litigation in the Land and Environment Court of New South Wales and Other Courts*, ACPECT 2009 *Conference* (19-21 August 2009, Environment Court, Christchurch, New Zealand), 8; *Sydney Local Environmental Plan 2012* (NSW) s 2.3 (2).

³⁰³ EDO NSW, *Planning Development and Heritage Factsheet, LEPs and SEPPs Factsheets*, 1.

³⁰⁴ [2004] NSWLEC 399.

³⁰⁵ *BGP Properties Pty Ltd v Lake Macquarie City Council* [2004] NSWLEC 399, 117.

³⁰⁶ Peel and Godden above n 41, 82.

Residential, Public Recreation, Environmental Protection, Environmental Management.³⁰⁷ LEPs play a key role in development control and protection of open spaces.³⁰⁸ Moreover, they are also important for adaptation as they may be designed to respond to the impacts of climate change in local areas. For example, LEPs may address new zones to respond to risks in areas that are vulnerable to the impacts of climate change in coastal areas. In NSW, local governments are required to consider coastal hazards when assessing a development application.

The City of Sydney LGA is one of the fastest growing areas in Australia and highly urbanised.³⁰⁹ The *Sydney Local Environmental Plan (Sydney LEP)* applies to how the proposed development addresses matters, including environmental impacts, sustainable design, overshadowing and solar access, visual and acoustic privacy, noise, wind and reflectivity.³¹⁰ One of the purposes is promote the principles of ESD.³¹¹ Under the *Sydney LEP*, green roofs may be considered as an integral part of the building design³¹² as it allows minor architectural roof features to exceed the roof size and height limits.³¹³ As a condition, the Council should not grant consent to such development unless the consent authority is satisfied that the architectural roof feature comprises a decorative element on the uppermost portion of a building, is not an advertising structure, does not include floor space area, nor is capable of modification to include floor space area.³¹⁴

5.2.3 Development Control Plans

A Development Control Plan (DCP) has the principal purpose of providing the conditions of consent on behalf of the consenting authority (the Council) as an instrument to guide developers. The DCP has three main purposes: to give effect to the aims of the applicable EPI, to facilitate development that is permissible under any such instrument, and to achieve the objectives of land zones under an EPI.³¹⁵ The objective of the DCP is to deliver the highest

³⁰⁷ *Standard Instrument, Principal Local Environmental Plan 2016* (NSW), Land Use Table, Directions 5.

³⁰⁸ EDO NSW, *Planning Development and Heritage Factsheet, LEPs and SEPPs Factsheets*, 1.

³⁰⁹ City of Sydney, 'The City at glance' (16 January 2018)

³¹⁰ <https://www.cityofsydney.nsw.gov.au/learn/research-and-statistics/the-city-at-a-glance>

³¹¹ *Sydney Local Environmental Plan 2012* (NSW) s 6.21 (4) (d) (vii).

³¹² *Sydney Local Environmental Plan 2012* (NSW) s 6.21(4) (d) (viii).

³¹³ *Sydney Local Environmental Plan 2012* (NSW) s 5.6 (1) (c).

³¹⁴ *Sydney Local Environmental Plan 2012* (NSW) s 5.6 (1) (a).

³¹⁵ *Sydney Local Environmental Plan 2012* (NSW) s. 5.6 (3) (a).

³¹⁵ Lyster et al, above n 165, 83.

standard of architectural, urban and landscape design.³¹⁶ Reference to green roofs are generally found in DCPs. For instance, consent is required for a development proposing an architectural roof feature that exceeds, or causes a building to exceed, the height limits set by the DCP.³¹⁷

Although DCPs are important tools to support EPIs and help achieve the objectives of the zones under LEPs, they are not determinative, so the relevant consent authority is not required to strictly follow the standards under the DCP. In *Zhang v Canterbury City Council*,³¹⁸ his Honour held that ‘whilst it was necessary for the DCP to be considered as a “fundamental element” or a “focal point” of the decision-making process, the DCP was not “determinative.”’³¹⁹ While DCPs remain a fundamental element in the consideration of any development application as adopted in *Zhang v Canterbury City Council*³²⁰, the amended s 79 C (3A(b) of the *EPA Act* requires the consent authority to allow reasonable solutions that are alternative to the solutions embodied in a particular standard that also achieves the objects of the standard.³²¹ In the case *Bellenger v Randwick City Council*,³²² Preston CJ held that requiring the consent authority to allow reasonable alternative solutions did not mean that the consent authority could not still refuse development consent to a development that proposes reasonable alternative solutions.³²³

5.3 The role of local government

Local government plays an important role in the protection of local communities and the environment. It has the responsibility to provide community health, recreation, education and information services and environmental protection.³²⁴ Moreover, local government has a range of functions relating to urban planning, land use and the provision and maintenance of public spaces and assets.³²⁵ Despite local Council being directly involved with decisions made at the local level and with the development of public amenities and open spaces, it may lack adequate resources and training to implement long-term adaptation strategies. Thus, developing

³¹⁶ *Sydney Local Environmental Plan 2012* (NW) s 6.21(1).

³¹⁷ *Sydney Local Environmental Plan 2012* (NSW) s 5.6 (2).

³¹⁸ (2001) 51 NSWLR 589.

³¹⁹ *Zhang v Canterbury City Council* (2001) 51 NSWLR 589, 75.

³²⁰ (2001) 51 NSWLR 589

³²¹ *Bellenger v Randwick City Council* [2017] NSWLEC 1; Greg Weeks and Linda Pearson, ‘Planning and Soft Law’ (2017) 24 *Australian Journal of Administrative Law*, 15.

³²² [2017] NSWLEC 1

³²³ *Bellenger v Randwick City Council* [2017] NSWLEC 1

³²⁴ Office of Environment and Heritage, *Minimising the impacts of extreme heat: A guide for local government* (2016), 4.

³²⁵ *Ibid.*

adequate planning mechanisms to support compliance with increased standards and appropriate funding for local government is essential.

As Preston and Scott observe, ‘local governments are largely responsible for the implementation of adaptation strategies so effective policies are needed to increase investment and foster creativity and innovation in addressing climate change issues’.³²⁶ Councils have the function of providing goods, services and facilities, and carry out activities, appropriate to the current and future needs within its local community and of the wider public, subject to relevant legislation.³²⁷

The *Local Government Act 1993* (NSW) (LGA Act) determines that ‘an application must be made by the person seeking to carry out an activity for which the council’s approval is required.’³²⁸ In determining an application, local councils must take into consideration the principles of ESD in determining an application³²⁹ and seek to give effect to the applicant’s objectives to the extent to which they are compatible with the public interest.³³⁰ Public interest matters in the context of the *LGA Act* (NSW) include protection of the environment³³¹ and the protection of public health, safety and convenience.³³²

One of the concerns with the adequate implementation of adaptation measures is that it often requires action from local governments due to the localised impacts of climate change. McDonald and Styles argue that traditional approaches to environmental planning regulation may be failing to respond to the uncertainties of the impacts of climate change or acting as barriers to effective adaptation.³³³ One of the reasons may be due to the difficulty in predicting the future environmental impacts of climate change, and the relative costs and benefits of different approaches to adaptation.³³⁴ Verschuuren and McDonald argue that ‘the experience

³²⁶ Preston and Scott, above n 72, 140.

³²⁷ *Local Government Act 1993* (NSW) s 24.

³²⁸ *Ibid* s 78.

³²⁹ *Ibid* s 89(1) (c).

³³⁰ *Ibid* s 89(2) (b).

³³¹ *Local Government Act 1939* (NSW) s 89(3) (a).

³³² *Local Government Act 1939* (NSW) s 89(3) (b).

³³³ Jan McDonald and Megan C Styles, ‘Legal Strategies for Adaptive Management under Climate Change’ (2014) 26 *Journal of Environmental Law*, 27.

³³⁴ *Ibid*.

in Australia highlights the balance between legislative safeguards against intergenerational liability for poor planning decisions and protection of existing property rights.’³³⁵

The *LGA Act* requires local councils to consider financial investment in responsible and sustainable infrastructure for the benefit of the local community.³³⁶ Local infrastructure contributions are regulated under s 94 of the *EPA Act* and are levied for ‘essential works’ for public purposes including open spaces, stormwater management and other public facilities,³³⁷ although they cannot be levied solely for environmental purposes.³³⁸

While making decisions that will affect the community and the environment, councils must consider intergenerational equity, including ensuring that policy decisions are made after their financial effects on future generations have been identified.³³⁹ For instance, in *Lake Macquarie City Council v Hammersmith Management Pty Ltd* [2003] NSWCA 313, the Court of Appeal held that the requirement to pay a contribution to enable the acquisition of a conservation corridor was imposed under s 94 contributions. Conditions under section 94 (s.7.11) also include tree planting,³⁴⁰ bushland and environment works,³⁴¹ and park acquisition and embellishment.³⁴²

The *EPA Act* allows consent authorities to impose conditions for contributions towards the provision or improvement of amenities and services. Section 7.11 provides that if a consent authority, which is often the Council, is satisfied that a development will, or is likely to, require the demand for public amenities and public services within the area, the consent authority may grant the development consent subject to conditions.³⁴³ The conditions include the dedication of land free of cost, or the payment of a monetary contribution.³⁴⁴ For instance, the Council may impose, as a condition of development consent, a requirement that the applicant pay a levy of the percentage, authorised by a contribution plan, of the proposed cost of carrying out the

³³⁵ Verschuuren and McDonald, above n 18, 375

³³⁶ *Local Government Act 1939* (NSW) s 8B(b).

³³⁷ Skinner et al, above n 144.

³³⁸ Ibid.

³³⁹ *Local Government Act 1939* (NSW), s 8B(d)(i).

³⁴⁰ *Valiant Timber and Hardware Co Pty Ltd v Blacktown City Council* (2005) 144 LGERA 355.

³⁴¹ *Long v Hornsby Shire Council* [2007] NSWLEC 267.

³⁴² *Meriton Apartments Pty Ltd v Ku-ring-gai Council* (2006) 152 LGERA 301.

³⁴³ *Environmental Planning and Assessment Act 1979* (NSW) s 7.11 (1).

³⁴⁴ *Environmental Planning and Assessment Act 1979* (NSW) s 7.11 (1) (a) and (b).

development.³⁴⁵ This fixed levy condition cannot be imposed in relation to the same development, together with the conditions under section 7.11.³⁴⁶

6. Green Infrastructure in NSW – Planning for climate adaptation

The Greater Sydney Region is increasing in density and losing important green corridors that minimise the UHI effect.³⁴⁷ While it is true that Sydney has green spaces of great significance, urbanisation and habitat fragmentation is creating a disconnection, which otherwise would contribute to people's quality of life, as they promote several ecosystem services such as shading and cooling, air filtering, water cleansing and habitat for wildlife.³⁴⁸ In this context, adaptation planning for urban areas means acting to reduce the adverse consequence of extreme weather events,³⁴⁹ while exploiting beneficial opportunities that contribute to the population's well-being and security of assets.³⁵⁰ Planning for climate adaptation in urban areas has the potential to mitigate the UHI effect and improve people's quality of life, if developed strategically and interconnected with different eco-corridors. Bambrick *et al.* suggest an optimal planning for adaptation:³⁵¹

‘If the approach to adaptation planning considers the complexities of a city as a system it could incorporate complementary strategies to reduce greenhouse gas emissions (mitigation) and to minimise and respond to the health impacts of inevitable warming already in place set by past emissions (adaptation).’

³⁴⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 7.12 (1).

³⁴⁶ *Environmental Planning and Assessment Act 1979* (NSW) s 7.12 (2).

³⁴⁷ Leesha McKenny, ‘Green Square: Population under pressure as projected population swells’ (Sydney Morning Herald) (Sydney) (online) 07 October 2015 <https://www.smh.com.au/national/nsw/green-square-infrastructure-under-pressure-as-projected-population-swells-20151007-gk2z1o.html>; The National Green Infrastructure Network, *Urban Ecology Renewal Investigation Project, Summary Report Prepared for the NSW Environmental Trust* (2016)

³⁴⁸ Pitman, Daniels and Ely, above n 95, 98.

³⁴⁹ National Climate Change Research Facility, ‘What does climate change mean for Australia?’ <https://www.nccarf.edu.au/content/adaptation>

³⁵⁰ Intergovernmental Panel on Climate Change, *Global warming of 1.5 C, Summary for Policy Makers*, approved at the First Joint Session of Working Groups I, II and III of the IPCC, and accepted by the 48 Session of the IPCC, Incheon, Republic of Korea (6 October 2018), 19.

³⁵¹ Hilary Jane Bambrick *et al.*, ‘Climate Change and Health in the Urban Environment: Adaptation Opportunities in Australian Cities,’ *Asia-Pacific Journal of Public Health* (2011) 23(2), 715.

Adopting green infrastructure for climate change includes ‘functioning as a risk buffer’ and ‘managing risks or uncertainties created by anthropogenic activities.’³⁵² Matthews *et al.* suggest that defining green infrastructure as a necessity, emphasises the strategic benefits of urban green elements whereby ‘the infrastructure approach elevates urban greening to a higher level of importance, linking it to key socio-economic imperatives, such as local economic development and reduction of health care expenditure.’³⁵³

The following sections explore the opportunities for green infrastructure in growing areas in Sydney. It firstly investigates Western Sydney LGA approaches to climate change adaptation and resilience due to its rapid population growth and climate vulnerabilities. It then evaluates how the NSW planning regime can consider green infrastructure as essential infrastructure in future development, especially at a local level. This evaluation is supported by the complex proposal for the implementation of the Sydney Green Grid, which will require a stronger partnership between state and local governments in terms of regulation, management and finance considering the magnitude of the initiative. It argues that a regulatory reform and the amendment of spatial planning instruments, such as LEPs are necessary for local governments to successfully implement the Sydney Green Grid and adopt strategies to ameliorate the impacts of extreme heat events at a local level.

The Greater Sydney Commission (the Commission) is playing an important role in the development of the Greater Sydney Region (GSR). The *Greater Sydney Commission Act 2015* (NSW) leads the metropolitan planning in the GSR.³⁵⁴ The Commission has significant discretion as the relevant strategic planning authority, as it establishes a regime for the regional and district planning in NSW.³⁵⁵ The objectives of the Commission include; to promote orderly development in the GSR having regard to the principles of ESD,³⁵⁶ to encourage development that is resilient and consider natural hazards,³⁵⁷ and to support ongoing improvement in productivity, liveability and environmental quality.³⁵⁸

³⁵² Tony Matthews, Alex Y. Lo, Jason A. Byrne, ‘Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners,’ *Landscape and Urban Planning* 138 (2015), 158.

³⁵³ *Ibid* 156.

³⁵⁴ *Greater Sydney Commission Act 2015* (NSW), s 9(1).

³⁵⁵ *Environmental Planning and Assessment Act 1979* (NSW), s 3.3 (3).

³⁵⁶ *Greater Sydney Commission Act 2015* (NSW), s 9 (b).

³⁵⁷ *Greater Sydney Commission Act 2015* (NSW), s 9 (e).

³⁵⁸ *Greater Sydney Commission Act 2015* (NSW), s 9 (f).

The NSW government policy *Greener Places* supports the vision of the GSR Plan of an interconnected network of green spaces and incorporates green infrastructure practices and components in strategic planning rather than on an ad-hoc basis.³⁵⁹ While the policy lacks regulatory force, it may influence new developments and decision-making. The problem with lack of regulatory force is that it gives a level of flexibility and discretion to government agencies, business and the community to decide whether to consider green infrastructure in land use and development, which may potentially undermine successful outcomes.

The development of a green infrastructure network includes ‘linking greenspaces at multiple scales, whilst addressing groundwater, surface water, and air movement systems.’³⁶⁰ Overcoming the challenges of implementing green infrastructure requires strategic planning and the participation of a wide range of stakeholders, such as governments, the private sector and the broader community. These measures include regulatory change, education regarding the value of green infrastructure, the incorporation of green infrastructure in strategic planning and financing. In the latest report *Cities: Planning for our growing population*, the Australian government recommends the need to focus on ‘maintaining and enhancing green infrastructure and the public realm to ensure they remain liveable.’³⁶¹ The report suggests that successful outcomes may be achieved through different means, such as ‘a combination of taxation, planning incentives, and policy and regulatory reforms, including upgrading and expanding existing green and public spaces, creating new spaces, and making better use of existing assets.’³⁶²

The Sydney Green Grid is one of the key policy directives under the GSR Plan. The initiative is ‘a network of high-quality green areas that connects town centres, public transport networks and major residential areas in Sydney, which will be managed by more than 42 different public authorities.’³⁶³ The Sydney Green Grid is therefore a ‘green infrastructure, design-led strategy that includes a wide range of open spaces: from national, regional and local parks through the harbour, ocean beaches, wetlands, rivers and creeks, to playgrounds, golf courses and

³⁵⁹ Government Architect NSW, *Sydney Green Grid, Spatial Framework and Project Opportunities* (2017), 11.

³⁶⁰ Clive Davies and Raffaele Laforteza, ‘Urban Green Infrastructure in Europe: Is greenspace planning and policy compliant?’ *Land Use Policy* (2017) 69, 94.

³⁶¹ Australian Government, Infrastructure Australia, *Future Cities: Planning for our growing population, List of Recommendations* (2018), 112.

³⁶² *Ibid.*

³⁶³ Department of the Environment and Energy (Cth), *Australia State of the Environment 2016*, Built Environment: Planning for the Future (2016) (Sarah Coleman) <https://soe.environment.gov.au/theme/built-environment/topic/2016/planning-future>

cemeteries.’³⁶⁴ This complex and challenging green infrastructure initiative is composed of a combination of four of the essential grids: the hydrological grid, the ecological grid, the recreational grid and agricultural grid.³⁶⁵ They establish Sydney’s geographic and urban landscape and provide an interconnected network of green spaces across the six districts in the GSR.³⁶⁶ While it is outside of the scope of this study to comment about the four grids, it is important to note that the principles of the ecological grid include adapting to climate extremes, improving air quality and increasing urban greening with street trees, green roofs and walls and water sensitive urban design.³⁶⁷

As communities of each district have different lifestyle needs, a ‘one size fits all’ approach to open space, landscape, and infrastructure is considered inadequate. Therefore ‘the methodology of the Green Grid is to identify and create a site-specific open space planning approach that responds to local character and needs.’³⁶⁸ This approach delegates much of the responsibility to deliver the plans for the Sydney Green Grid to local councils. The plan is proposed to be delivered through ‘land use planning and infrastructure investment mechanisms such as development control plans, agreements for dual use of open space and recreational facilities, direct investment in open space, and other funding mechanisms such as local development contributions and voluntary planning agreements.’³⁶⁹ This is critical to local government authorities as they have the role to ‘deliver services to the community through local services in the most cost-efficient manner’.³⁷⁰ In addition, local governments are directly involved with the preparation and approval of local infrastructure contribution plans which are subject to regulations.³⁷¹ Therefore, implementing regulatory and non-regulatory instruments that support compliance with development and land-use, forms part of their core responsibilities.

³⁶⁴ Government Architect NSW, *Sydney Green Grid, Spatial Framework and Project Opportunities* (2017), 7.

³⁶⁵ Ibid, 11.

³⁶⁶ Ibid.

³⁶⁷ Government Architect NSW, *Sydney Green Grid, Spatial Framework and Project Opportunities* (2017), 11.

³⁶⁸ Ibid 12.

³⁶⁹ Greater Sydney Commission NSW, South District Plan, *Increasing urban tree canopy cover and delivering Green Grid connections, Planning Priority S15* (2017) <https://www.greater.sydney/south-district-plan/sustainability/city-its-landscape/increasing-urban-tree-canopy-cover-and>

³⁷⁰ Preston and Scott above n 72, 138.

³⁷¹ *Environmental Planning and Assessment Act 1979* (NSW) s 7.18 (1).

The policy *Greener Places* supports the Sydney Green Grid as it was developed to guide the planning design and delivery of green infrastructure in NSW.³⁷² To achieve the purposes of the policy, the government suggests green infrastructure ‘needs to be as essential infrastructure at the outset of the design process from strategy, through the concept design, construction and maintenance.’³⁷³ This means planning strategically to create an urban ecosystem network of green spaces, including parks and open spaces, such as urban trees, squares and waterways.³⁷⁴ To support this approach, three manuals are being developed to describe the operational processes to implement the policy, which are focused on recreation, habitat and ecological health and climate adaptation and resilience.³⁷⁵ Although the implementation of spatial instruments requiring the adoption of green infrastructure in public and private lands may appear challenging, the idea to increase urban green space and improve climate extremes is achievable and realistic. For instance, the policy suggests practices like planting trees and introducing green roofs, as a way of improving air quality and reducing temperatures in urban areas.³⁷⁶ This approach involves co-ordinated planning and the design of green cover strategies, including street trees, green walls and roofs, reflecting one of the ecological grid principles.³⁷⁷

While green infrastructure is not the only approach to climate adaptation and resilience, the concept has proven to offer many long-term and sustainable benefits. Tree canopies are known to provide shading and cooling, contributing to the surface temperature reduction of around 15 degrees Celsius.³⁷⁸ One of the criticisms regarding the policy is that it does not have any effect on the preservation or enhancement of vegetation such as trees in private open spaces.³⁷⁹ One study suggests that a significant vegetation asset is being lost from residential properties alone, due to medium and high density development trends.³⁸⁰ Therefore, one way of preserving and enhancing vegetation on private property includes, as Total Environmental Centre suggests, is

³⁷² Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 10.

³⁷³ Ibid 5.

³⁷⁴ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 5.

³⁷⁵ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 24.

³⁷⁶ Ibid 16.

³⁷⁷ Ibid 40.

³⁷⁸ Low Carbon Living, *Guide to Urban Cooling Strategies*, 20.6.

³⁷⁹ Total Environmental Centre (TEC), *Submission to Greener Places* (February 2018), 6.

³⁸⁰ Ibid.

‘strengthening local planning controls to discourage clearing and requiring minimum areas of landscaping and optimal tree planting in residential areas.’³⁸¹

Overall, the NSW green infrastructure policy and the GSR Plan reflect, in theory, a commitment to ESD and a commitment to promoting good design and amenity of the environment, as objects of the *EPA Act*. The question remains, how can the current environmental and law planning regime support the implementation of green infrastructure in land-use planning and development to respond to extreme heat events more pro-actively?

Local government is at the forefront of planning for climate change adaptation, even though funding for climate change, policies and programs may lack consistency in relation to strategies for heatwave response.³⁸² In addition, the level of awareness and consensus pertaining to heatwaves as climate hazards differ between LGAs. These variations, or lack of cohesion, may inhibit resident’s adaptive capacity and engagement.³⁸³ For instance, Zografos *et al.* note that the media has been a source of information for residents, which ‘informs about short-term coping solutions rather than long-term adaptive solutions, such as changes to housing environment or institutional arrangements.’³⁸⁴

As Preston CJ said in *Hub Action Group Inc v Minister for Planning*:³⁸⁵

“In order to achieve sustainability... hortatory statements of principle and aspirational goals are insufficient; the grand strategy must be translated into action. This involves not only institutionalising the principles of ecologically sustainable development in policies and laws, but also ensuring that functions under those policies and laws are exercised in a way so as to promote and implement the principles of ecologically sustainable development. This involves good governance.”³⁸⁶

³⁸¹ Ibid.

³⁸² Christos Zografos, Isabelle Anguelovski and Maria Grigorova, ‘When exposure to climate change is not enough: Exploring heatwave adaptive capacity of a multi-ethnic, low income urban community in Australia,’ *Urban Climate* (2016) 17, 257.

³⁸³ Ibid.

³⁸⁴ Ibid 258.

³⁸⁵ (2008) 161 LGERA 136.

³⁸⁶ *Hub Action Group Inc v Minister for Planning* (2008) 161 LGERA 136, 2.

While government strategies and policies are important in supporting the uptake of green infrastructure, EPIs are essential to ensure compliance, management and funding for green infrastructure more consistently.

6.1. Western Sydney and the impacts of extreme heat

Western Sydney deserves attention for two main reasons: extreme heat and population growth. In January 2018, Penrith was the hottest place on the planet at 47.3 degrees Celsius.³⁸⁷ The NSW government reported that the temperature in Western Parkland Region currently has 21 average annual days over 35 degrees Celsius, compared to 11 days in Central River City and three days in the Eastern Harbour City.³⁸⁸ Livada *et al.* note, ‘development areas in Sydney, expanding towards inland, will be highly exposed to climate change and already show an increasing trend of peak in summer temperatures.’³⁸⁹ Secondly, population in Sydney West is ‘expected to have an addition 63,400 people by 2063 and ‘is anticipated to see the largest addition increase in population due to the long-term development of the proposed Badgery’s Creek airport.’³⁹⁰ For instance, the LGAs with the strongest population growth associated with the proposed airport development include Penrith, Blue Mountains, Blacktown, Wollondilly and Camden.³⁹¹

Hotspot mapping is one of the tools used to identify and treat localised urban heat risk.³⁹² Studies show that urban heat is a common occurrence across suburbs in Western Sydney, and ‘hotspots appeared in areas with high proportions of sealed surfaces, such as roads, roofs and footpaths.’³⁹³ For instance, commercial areas are found to be much hotter than reserves, recreational areas and surface water with sealed surfaces covering up to 90% surface in hotspot areas.³⁹⁴ Potential risks for heatwaves, as Hatvani-Kovacs *et al* note, depend on the level of exposure that is influenced by the microclimate, the intensity of a heatwave and the level of

³⁸⁷ Yasmin Parry, *How Western Sydney is tackling the mysterious ‘heat island’ effect behind rising temperatures?* ABC News (Sydney) (online) 1 March 2018 <https://www.abc.net.au/news/2018-03-01/how-western-sydney-is-tackling-the-heat-island-effect/9361156>

³⁸⁸ Greater Sydney Commission, *Greater Sydney Region Plan, Metropolis of Three Cities – connecting people* (2017), 143.

³⁸⁹ I. Livada, *et al* above n 57, 1628.

³⁹⁰ Western Sydney Airport, *Environmental Impact Statement, Section 37 Social and Economic*, 37.3.2 Population redistribution and housing, 138

³⁹¹ *Ibid.*

³⁹² Local Government NSW, *Office of Environment and Heritage, Adapting to urban heat events: by mapping vulnerability hot spots* (May 2016),

³⁹³ *Ibid.*

³⁹⁴ *Ibid.*

UHI effects.³⁹⁵ Therefore, mapping may be beneficial as an assessment tool for climate vulnerability, and may help inform the public about hotspots, or when to use cool refuges. Cool refuges are public spaces and buildings such as shopping centres able to maintain thermal comfort even during heatwaves.³⁹⁶

A study undertaken by Western Sydney University revealed that urban heat is likely to become a major, future liveability issue for Western Sydney.³⁹⁷ For example, the study found several hotspots with land surface temperatures exceeding 45 degrees Celsius.³⁹⁸ Far from the cooling sea breezes of the coasts, Western Sydney can be 10 degrees hotter than the Sydney harbourside.³⁹⁹ This research investigated how residents in areas with the greatest concentration of low-income households such as Penrith, Cranebrook and St. Marys, cope with the heat during summer months.⁴⁰⁰ As Penrith is considered an Urban Growth Area, a significant number of trees have been lost due to new housing development.⁴⁰¹ Furthermore, the study reports that 'Sydney has the second highest proportion of hard surface in the country, and Western Sydney has the highest proportion of grass-bare ground in NSW.'⁴⁰² While grass-bare ground is better than hard concrete surfaces and has benefits in terms of managing stormwater and ground temperature, it does not support liveability nor increase the amenity as open public environments due to lack of shade, toilets or water stations.⁴⁰³ Grass-bare grounds could be seen as an opportunity for potential planting trees compared to other areas in Sydney with higher proportions of hard surface while at the same time increasing the cooling effects and promoting liveability.

The *Cooling the City Strategy* was developed to respond to the impacts of urban heat through maximizing community awareness, encouraging green infrastructure and identifying ways to adapt to existing projects and activities that will help cooling the Penrith LGA.⁴⁰⁴ The strategy supports adaptation to extreme heat, as Penrith LGA is already experiencing high temperatures

³⁹⁵ Hatvani-Kovacs et al, above n 61, 54.

³⁹⁶ Ibid.

³⁹⁷ Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (October 2016), 1.

³⁹⁸ Ibid.

³⁹⁹ Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (October 2016), 1.

⁴⁰⁰ Ibid.

⁴⁰¹ Ibid 4.

⁴⁰² Ibid 8.

⁴⁰³ Ibid.

⁴⁰⁴ Penrith City Council, *Cooling the City Strategy* (2015), 6.

and the effects of the UHI effect.⁴⁰⁵ Green infrastructure is one of the strategies found to assist with managing the urban heat and adapt to the local impacts of climate change. The Council proposes that the strategies can be implemented through policies and regulations such as DCPs, tree and landscape rules and standards and comprehensive plans and design guidelines.⁴⁰⁶ This example demonstrates the need for planning law in NSW to regulate green infrastructure more adequately.

Penrith's LEP seeks 'to ensure that development incorporates the principles of sustainable development through the delivery of balanced social, environmental and economic outcomes,' and that development is designed in a way that assists in reducing and adapting to the likely impacts of climate change.'⁴⁰⁷ In deciding whether to grant consent for development, the consent authority must have regard to the principles of sustainable development as they relate to a "whole of building". For example, the Council needs to consider energy and water conservation, greenhouse gas emissions reduction and water reuse in a development application.⁴⁰⁸

Furthermore, Penrith's DCP also illustrates the Council's commitment to sustainability. The Council developed the *Sustainable Penrith Program* which 'commits the Council to apply the principles of sustainability in all of its operations.'⁴⁰⁹ Although not legally binding, DCPs provide government agencies with the power to control land use and development.⁴¹⁰ This flexible characteristic does not prevent new and innovative development to Council, if the principles and objectives of the DCP can be addressed in the development application.⁴¹¹ If unable to comply with all the development controls, the proposed development needs to 'justify how non-compliance will be addressed in other ways to satisfy the Plan's principles.'⁴¹²

Penrith Council is committed to the implementation of climate change strategies by 'requiring drought resistant planting and landscaping' and 'requiring that the design of dwellings aims to minimise their vulnerability to extreme weather events and bushfires.'⁴¹³ Furthermore, *Penrith*

⁴⁰⁵ Ibid 18.

⁴⁰⁶ Ibid 20.

⁴⁰⁷ *Penrith Local Environmental Plan 2010* (NSW) s 1.2 (2) (h).

⁴⁰⁸ *Penrith Local Environmental Plan 2010* (NSW) s 7.4.

⁴⁰⁹ *Penrith Development Control Plan 2014*, B DCP Principles, 1.1.1, 2.

⁴¹⁰ *Penrith Development Control Plan 2014*, B DCP Principles, 1.1.4, 2.

⁴¹¹ *Penrith Development Control Plan 2014*, B DCP Principles, 1.1.4, 2.

⁴¹² *Penrith Development Control Plan 2014*, B DCP Principles, 1.1.4, 2.

⁴¹³ *Penrith Development Control Plan 2014*, B DCP Principles, Principle 4.

DCP 2014 encourages green infrastructure components in different forms, including through design principles and landscape design. For example, opportunities to incorporate green roofs as an important architectural element of a building are included in the Building Form section of the Plan.⁴¹⁴

Despite this Council's intention to promote the principles of sustainability through DCPs and respond to the impacts of climate change in the built environment, research shows that 'the commons' are still suffering from the impacts of extreme heat.⁴¹⁵ The Western Sydney University report refers to the word 'commons' as something, 'which is made, cared for, and shared by a community, including biophysical, resources, material infrastructures, socio-cultural practices, and knowledge.'⁴¹⁶ In Western Sydney, the major recreational sites for children was found to be the mall and fast food restaurants, such as McDonalds, where they have access to amenities such as toilets and air-conditioning.⁴¹⁷ Moreover, some areas in Penrith were found to be too hot to walk in the streets during summer months.⁴¹⁸ Therefore, the question is whether the current approaches have been implemented efficiently and are able to combat the local impacts of extreme heat events.

Another example, located in Western Sydney, is Blacktown City Council. *Blacktown's LEP 2015* does not encourage the application of ESD principles in decision making, nor the adoption of climate adaptation strategies to build resilience to climate change. Despite this, the LEP does seek to 'minimise risk to the community by restricting development in sensitive areas that are subject to flooding and other hazards.'⁴¹⁹

In 2015, the Council developed a *Responding to Climate Change Strategy*.⁴²⁰ The commitments of the strategy include to assist community with reducing GHG emissions and build resilience to climate change.⁴²¹ The priorities include; working with government to achieve best practice reductions in urban heat impacts through planning instruments, increasing

⁴¹⁴ *Penrith Development Control Plan 2014*, C1 Site Planning and Design Principles, 1.2.3 (g)(ii).

⁴¹⁵ Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (2016), 8.

⁴¹⁶ Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (2016), 8.

⁴¹⁷ *Ibid.*

⁴¹⁸ *Ibid* 4.

⁴¹⁹ *Blacktown Local Environmental Plan 2015 (NSW)* s 1.2 (e).

⁴²⁰ Blacktown City Council, *Responding to Climate Change Strategy* (2015).

⁴²¹ *Ibid* 29.

urban canopy cover and providing climate refuges from extreme heat for vulnerable residents.⁴²² In partnership with the state government, Blacktown Council implemented a project called *Cool Streets Blacktown Pilot Project*, which was developed to reduce rising urban heat, which was identified as one of the risks in the *Blacktown Community Strategic Plan*.⁴²³ The research undertaken in this project has found that the implementation of approaches, such as street trees, could reduce carbon dioxide almost by seven times and reduce electricity bills.⁴²⁴ The initiative was developed through a participatory decision-making process that enabled community decision making surrounding how to cool their neighbourhood.⁴²⁵

while proactive approaches are preferred, reactive approaches are also necessary to support the responses to extreme heat events. Emergency responses to extreme heat events are essential as they are involved in the preparations for an emergency, including communication, health and transport services.⁴²⁶ In response to the immediate need for a reactive response, the NSW government has developed the *Heatwave SubPlan* ‘to detail the control and coordination arrangements for aspects of the preparation for, response to, and immediate recovery from a heatwave.’⁴²⁷

Although reactive responses to extreme heat events are important, they should not prevent a more proactive approach to strategic planning and help adapt to long-term impacts of extreme weather events. Zografos *et al.* argue that while councils have the responsibility to develop and implement strategies to minimise the effects of extreme heat, no guidance is provided on how to achieve the SubPlan objectives, causing inaction and lack of a comprehensive response to heatwaves in NSW LGA’s.⁴²⁸ Thus, it could be argued that it is essential to develop the law, together with adaptation guidelines and communication strategies to inform local councils and increase the community’s adaptive capacity to respond to extreme heat events.⁴²⁹

⁴²² Ibid.

⁴²³ Government Architect NSW, *Case Studies* (2017)

<https://www.governmentarchitect.nsw.gov.au/resources/case-studies/2017/11/cool-streets-blacktown>

⁴²⁴ Ibid.

⁴²⁵ Government Architect NSW, *Case Studies* (2017)

<https://www.governmentarchitect.nsw.gov.au/resources/case-studies/2017/11/cool-streets-blacktown>

⁴²⁶ NSW Government, *State Heatwave Subplan: A Subplan of the NSW State Emergency Management Plan* (March 2018), 4.

⁴²⁷ Ibid 1.

⁴²⁸ Zografos, Anguelovski and Grigorova, above n 379, 257.

⁴²⁹ Hatvani-Kovacs et al, above n 62, 55.

7. Green infrastructure, funding and the law

The future inclusion of green infrastructure in planning law in NSW, as an adaptation response, will not succeed, unless it is supported by strategic policy and implementation layers. One such critical ‘layer’ involves financial models to provide the required funding resources, some of which have a legal basis, for example section 11.7 (s 94) of the *EPA Act*. This section briefly outlines the important role funding plays in the implementation of green infrastructure at a local level, in the context of land - use and development. It provides an overview of the some of the options available and as proposed by the *Greener Places Draft Policy*.

Funding is especially important to local government, as a lack of financial resources has been identified as a barrier to the implementation of green infrastructure.⁴³⁰ It is important to note that investment in green infrastructure worldwide involves a broader scope than introducing vegetation to improve the quality of the urban environment and reduce the costs of ‘grey infrastructure.’⁴³¹ Investment in green infrastructure, in another context, extends to investing in renewable energy, sustainable transport, waste management and water.⁴³² For instance, the Canada Infrastructure Bank is investing 5 billion in green infrastructure projects, which also includes investment in projects that reduce GHG emissions, provide clean and safe water systems, and promote renewable power.⁴³³ In addition, Climate Bonds refers to green infrastructure investment and funding opportunities in four key sectors: low-carbon transport, renewable energy, and sustainable water management and green buildings.⁴³⁴ Although they are relevant to climate adaptation, it is outside the scope of this thesis to investigate the above mentioned green infrastructure funding opportunities.

The successful implementation of green infrastructure involves the cooperation of the public sector, developers, business and the wider community.⁴³⁵ This cooperation depends on the

⁴³⁰ Zografos, Anguelovski and Grigorova, above n 379, 257; The Greater Sydney Commission, *Infrastructure aligns with project growth – growth infrastructure compact*, Objective 2 <https://www.greater.sydney/metropolis-of-three-cities/infrastructure-and-collaboration/city-supported-infrastructure-0>

⁴³¹ Government of Melbourne, *Urban Forest Strategy, Making a great city greener 2012-2032*, 6.

⁴³² Green Infrastructure Canada, *Investing in Green Infrastructure* (20 September 2018) <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html>

⁴³³ Infrastructure Canada, *Canada Infrastructure Bank* (30 August 2018) <https://www.infrastructure.gc.ca/CIB-BIC/index-eng.html>

⁴³⁴ Climate Bonds Initiative, *Australia & New Zealand GIIO Report* (2018), 16.

⁴³⁵ Government of Melbourne, *Urban Forest Strategy, Making a great city greener 2012-2032*, 58.

adoption and implementation of appropriate spatial planning instruments that incorporate green infrastructure, coupled with funding mechanisms. As the *City of Melbourne, Urban Forest Strategy 2012 – 2032* suggests, sustainable urban development is supported with resilience and connectivity while ‘creating urban communities where both the current and present needs of future generations are met.’⁴³⁶ It notes that the on-going support by the public is essential to achieving funding stability. Providing a strong cost benefit analysis for the urban forest, helps ensure that ‘it remains competitive as a high value land use amongst hard infrastructure and transport.’⁴³⁷

Financial incentives facilitate investment in strategies for adaptation planning and green infrastructure in many countries. For example, the U.S Federal government has invested in the regulation and funding of green infrastructure for three main reasons: stormwater management, reducing the UHI effect and lowering building energy demands.⁴³⁸ Different states in the U.S., such as New York, offer tax credit and abatement schemes for the installation of green roofs that include at least 50% of a building’s roof space.⁴³⁹ Moreover, many local governments in the U.S fund green infrastructure and stormwater management programs through the General Fund, which is primarily resourced through income and property taxes.⁴⁴⁰

In the Greater Sydney Region, public submissions in response to the *Draft Policy Greener Places* have supported the need for more resources to support Councils as they implement elements of green infrastructure.⁴⁴¹ The *Draft Policy* proposes that funding for green infrastructure would come from different sources, including mechanisms available under the *EPA Act*.⁴⁴² These include local infrastructure contributions under s. 7.11 (s 94) of the *EPA*

⁴³⁶ Ibid.

⁴³⁷ Ibid.

⁴³⁸ Environmental Protection Agency (U.S), *Integrating Green Infrastructure into Federal Regulatory Programs* <https://www.epa.gov/green-infrastructure/integrating-green-infrastructure-federal-regulatory-programs>

⁴³⁹ My Plant Connection, *Green Roof Legislation, Policy and Tax Incentives* (2018) <http://myplantconnection.com/green-roofs-legislation.php> ; NYC Department of Finance, *Green Roof Tax Abatement* <https://www1.nyc.gov/site/finance/benefits/landlords-green-roof.page>

⁴⁴⁰ Georgetown Climate Center, *Green Infrastructure Kit, Government Financing* <https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html>

⁴⁴¹ Western Sydney Regional Organisation of Councils Ltd, *Letter the Government Architect of NSW, Response to the Draft Greener Places Policy* (23 February 2018); City of Parramatta, *Letter to the Government Architect NSW*.

⁴⁴² Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 50.

Act, Special Infrastructure Contributions (SICS), Voluntary Planning Agreements (VPAs) and grant programs.⁴⁴³

The *EPA Act* allows consent authorities, such as local Councils, to seek contributions towards the provision or improvement of amenities and services.⁴⁴⁴ Section 7.11 of the *EPA Act* provides that the consent authority may grant the development consent, subject to conditions, if satisfied a development will, or is likely to, require the demand for public amenities and public services within the area.⁴⁴⁵ Conditions include the dedication of land free of cost, or the payment of a monetary contribution.⁴⁴⁶ For instance, a Council is required to develop a contributions plan if it seeks contributions under s.7.11 of the *EPA Act*, to ‘establish a relationship between the expected types of development in the area and the demand for public amenities and services to meet the demand for development related infrastructure.’⁴⁴⁷

Submissions to the *Greener Places Draft Policy* recommends standard rates to be applied to the embellishment and management of open areas, such as green links and bio-corridors, following best practice.⁴⁴⁸ In this sense, for local infrastructure contributions to be efficient in the development and management of green infrastructure, the essential works list as referred in the *Local Infrastructure Contribution Practice Note*,⁴⁴⁹ could be amplified to recognise other elements of green infrastructure, which would minimise the impacts of development and optimise environmental, social and economic values on public lands.

Another option includes funding through special infrastructure contributions (SIC). The Minister for Planning may determine SIC which are made for the provision, extension and augmentation of public amenities or public services, affordable housing, transport or other infrastructure relating to land, funding of recurrent expenditure of the same matters, and the conservation or enhancement of the natural environment.⁴⁵⁰ The Minister has a high level of

⁴⁴³ Ibid.

⁴⁴⁴ *Environmental Planning and Assessment Act 1979* (NSW) s 7.11.

⁴⁴⁵ *Environmental Planning and Assessment Act 1979* (NSW) s 7.11 (1).

⁴⁴⁶ *Environmental Planning and Assessment Act 1979* (NSW) s 7.11 (1) (a) and (b).

⁴⁴⁷ Department of Planning and Environment, *Local Infrastructure Contributions – Practice Note* (January 2018), 8.

⁴⁴⁸ Lendlease Communities (Australia), *Letter to Government Architect NSW, Government Architect NSW Draft Greener Places Policy* (26 February 2018).

⁴⁴⁹ Department of Planning and Environment, *Local Infrastructure Contributions – Practice Note* (January 2018).

⁴⁵⁰ *Environmental Planning and Assessment Act 1979* (NSW) s 7.22(1).

discretion to determine the level and nature of development contributions to be imposed as conditions for the provision of infrastructure in relation to a particular development or class of development.⁴⁵¹ For instance, a new SIC for the *Western Sydney Infrastructure Contribution* was created due to the higher rate of growth.⁴⁵² The proposed scheme will provide \$1.5 billion in developer funding in the next 30 years to new and upgraded infrastructure in the North West Growth Area, including open space and conservation, bridges, roads and planning.⁴⁵³

Planning agreements are voluntary, made between planning authorities and the developer who has sought a change to an EPI.⁴⁵⁴ In addition, planning agreements may be made by the person who makes or proposes to make a development application for a complying development certificate or is associated with the developer.⁴⁵⁵ Although voluntary agreements are similar to development contributions, they differ in the sense that voluntary contributions may be applied more broadly and ‘do not need to demonstrate a direct relationship between development and new infrastructure demand.’⁴⁵⁶ Under voluntary planning agreements, developers are required to dedicate land free of cost, pay a monetary contribution and/or provide any other material public benefit to be used towards a public purpose.⁴⁵⁷ A public purpose could include, as Bates suggests, ‘the conservation and enhancement of the natural environment and monitoring the planning impacts of development.’⁴⁵⁸

The NSW government also provides a wide range of financial grants to fund the delivery of green infrastructure. Such programs are funded by all levels of government, including the NSW Environmental Trust.⁴⁵⁹ These funds are invested in a broad range of activities including on-ground work, research and community education.⁴⁶⁰ For instance, they have been dedicated in the past, to addressing identified climate change risks and vulnerabilities in NSW councils.⁴⁶¹ Relevant case studies include “Safeguarding communication infrastructure against extreme

⁴⁵¹ *Environmental Planning and Assessment Act 1979* (NSW) s 7.23 (1).

⁴⁵² NSW Department of Planning and Environment, *North West Growth Area Special Infrastructure Contribution* (12 October 2018).

⁴⁵³ *Ibid.*

⁴⁵⁴ *Environmental Planning and Assessment Act 1979* (NSW), s 7.4 (1).

⁴⁵⁵ *Environmental Planning and Assessment Act 1979* (NSW), s 7.4 (1).

⁴⁵⁶ Skinner et al, above n 144, 42.

⁴⁵⁷ *Environmental Planning and Assessment Act 1979* (NSW), s 7.4 (1).

⁴⁵⁸ Bates above n 220, 392.

⁴⁵⁹ Skinner et al, above n 144, 46.

⁴⁶⁰ *Ibid.*

⁴⁶¹ Local Government NSW, *Building Resilience to Climate Change*, <https://www.lgnsww.org.au/policy/climate-change/building-resilience>

heat” developed by Albury Council and “Adapting roads to climate change” developed by Manly Council.⁴⁶²

In a study by Manly Council, it was noted that many councils were looking into increasing tree cover to combat the UHI effect and aide community health impacts as an adaptation measure. However, the Council noted that an increase in tree cover may also incur detrimental consequences. For example, the impacts of windstorms causing tree fall events were noted as a potential major cause of disruption, damage and ‘clean-up’ costs for councils.⁴⁶³ To manage conflicting interests, the study proposed investigating the opportunities for different tree species for both canopies needs and wind gust survival. It found that researching how different tree species withstand wind speeds, drought, extreme heat and other extreme weather events can contribute to more resilient urban forests.⁴⁶⁴

Overall, the NSW planning regime provides different mechanisms to support funding for green infrastructure. One of the problems with some of the mechanisms is that they are ‘artificially and unhelpfully restricted.’⁴⁶⁵ Thus, law reform is necessary to regulate funding for the development and management of green infrastructure at a local and regional levels, together with the development of other models of funding that may help local government to implement the concept more strategically. The successful adoption of climate adaptation strategies, such as green infrastructure, depends on the efficient use of these resources and the collaboration among stakeholders such as the public sector, developers and the community.

8. Challenges and opportunities

The evidence presented shows green infrastructure is a positive adaptation option in urban areas. This section reviews opportunities for green infrastructure and some of the challenges in planning law in NSW. Of particular importance, is the need to plan for extreme heat events in areas of increased population growth, including in low-socio economic LGAs.⁴⁶⁶ These areas

⁴⁶² Local Government NSW and Office of Environment and Heritage (NSW), *Adapting roads to climate change* (May 2016).

⁴⁶³ Local Government NSW and Office of Environment and Heritage (NSW), *Adapting roads to climate change* (May 2016).

⁴⁶⁴ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 50.

⁴⁶⁵ Skinner et al, above n 144, 53.

⁴⁶⁶ Hannah Jane and Brown, *Green Infrastructure: Fostering Equity*, U.S Green Building Council (14 October 2016) <https://www.usgbc.org/articles/green-infrastructure-fostering-equity>

also tend to be the locations where Greater Sydney residents are generally most exposed to heat risks.⁴⁶⁷

Considering adaptation to climate change under a regulatory regime supports implementation of green infrastructure in the future, and helps foresee a sustainable environment and improve resilience in urban areas.⁴⁶⁸ Despite evidence showing that the design of an urban environment can mitigate climate change related risks, such the UHI effect,⁴⁶⁹ further work is required by the state government to support local government in strengthening legal instruments and their implementation.⁴⁷⁰

Furthermore, it is important for the state government to ensure legislation and environmental planning decisions are appropriate to ‘facilitate successful mitigation and adaptation.’⁴⁷¹ As the *EPA Act* makes no reference to climate change,⁴⁷² many cases before the LEC find that ‘the requirement to consider the public interest in s 79C of Pt 4 requires the consideration of the principles of ecologically sustainable development, which would consequently involve climate change impacts.’⁴⁷³

Thorpe and Hart suggest, that ‘the potential impacts of climate change on planning proposals, and of planning proposals on climate change, are mandatory considerations for planning authorities in NSW.’⁴⁷⁴ However, the application of ESD is still highly discretionary, since the concept’s language is perceived as vague and ambiguous.⁴⁷⁵ As Dwyer and Taylor suggest, ‘ESD cannot be achieved if one does not possess a sufficient degree of knowledge about how to achieve it.’⁴⁷⁶ The new purpose of the *EPA Act*, ‘to promote good design and amenity of the built environment,’ may change the current approach to ESD in decisions involving land-use

⁴⁶⁷ Parliament of Australia, *Current and Future Impacts of Climate Change Report, Chapter 4: Urban and Coastal Planning* (2018), 52

⁴⁶⁸ Ibid.

⁴⁶⁹ Ibid 53.

⁴⁷⁰ Parliament of Australia, *Current and Future Impacts of Climate Change Report, Chapter 4: Urban and Coastal Planning* (2018), 52.

⁴⁷¹ Parliament of Australia, *Current and Future Impacts of Climate Change Report* (2018), 181.

⁴⁷² Sahukar above n 297, 67.

⁴⁷³ Ghanem and Ruddock above n 233, 28; *Aldous v Greater Taree Council* (2009) 167 LGERA 13.

⁴⁷⁴ Thorpe and Hart above n 45, 144.

⁴⁷⁵ Australian Panel of Experts on Environmental Law, *The Foundations of Environmental Law: Goals, Objects, Principles and Norms* (2017) 23.

⁴⁷⁶ Guy J Dwyer and Mark P Taylor, ‘Moving from consideration to application: The uptake of principles of ecologically sustainable development in environmental decision-making in New South Wales’ (2013) 30 *Environmental and Planning Law Journal* 185, 187.

and the expansion of urban areas. For example, it may facilitate the integration of the social, environmental and economic impacts in decision-making processes in the context of climate adaptation in urban areas. As Preston J notes, ESD includes viewing its principles as part of a package and not in isolation.⁴⁷⁷

Although proposals to adopt a more comprehensive approach to green infrastructure in the Greater Sydney Region are positive and promising, there are challenges in implementation, especially at a local level. The *Current and Future Impacts of Climate Change Report (the CFICC Report)* highlighted the need for legislation: ‘there is currently no legislation, standards or guidelines that provide a minimum standard for managing the urban heat island effect.’⁴⁷⁸ Other barriers to implementation include the lack of appropriate planning mechanisms to support local government, expert knowledge and community awareness regarding the benefits of urban forests.⁴⁷⁹

The *CFICC Report* suggests that ‘public spaces in greenfield development will need to provide greenery to address urban heat.’⁴⁸⁰ It further argues that ‘housing affordability has decreased block sizes in new developments and large trees are not the best cohabitant of houses.’⁴⁸¹ Critics have argued that legislation surrounding the lack of protection of ‘existing green spaces and/or trees or of future assets under green infrastructure’ is weak.⁴⁸² This is especially due to the increasing population growth pressures and “fast-track” coded complying development to support affordable housing.⁴⁸³

Hotspot mapping may help identify hotspots that are vulnerable to heat and ensure green spaces and elements of green infrastructure are adopted as part of the strategic plan and codes in greenfield development. In addition, planning for adaptation may include approaches similar to those in Singapore. Singapore adopts the green plot ratio, which ‘codify landscape controls to set minimum areas or establish percentages of site that must be dedicated to landscaping,

⁴⁷⁷ Preston, Brian J, ‘The Judicial Development of the Precautionary Principle’ (2018) 35 *Environmental Planning and Law Journal* 123, 126.

⁴⁷⁸ Parliament of Australia, *Current and Future Impacts of Climate Change Report, Chapter 4: Urban and Coastal Planning* (2018), 53.

⁴⁷⁹ Ibid.

⁴⁸⁰ Ibid.

⁴⁸¹ Ibid 54.

⁴⁸² Total Environment Centre, *Submission to Greener Places* (February 2018), 3.

⁴⁸² Ibid.

⁴⁸³ Ibid.

including additional conditions zones suitable for canopy trees or to integrate green walls/or roofs.⁴⁸⁴

While urban forests have many benefits, including the capacity to mitigate the UHI effect, they should be planned adequately to avoid risks to people's safety and property. The *Western Sydney Report* notes: 'while people want public amenities with shade, they are concerned about the impact of trees on the footpath, road and amenities.'⁴⁸⁵ Stronger legal instruments and enforcement would help 'local government to understand when it is appropriate to retain trees and work to minimise the risks.'⁴⁸⁶ Additional approaches include strategic planning, including the selection of appropriate species of trees that can 'reduce damage to roads, footpaths and buildings and minimise risk of injuries.'⁴⁸⁷

In this sense, it is preferred that planning and investing in green infrastructure are considered essential assets in strategic planning,⁴⁸⁸ which requires it to be considered as an integral part of future development as proposed by the *Greener Places Draft Policy*.⁴⁸⁹ This is particularly important to growing areas in Sydney, such as Western Sydney, which is developing at an accelerated pace in response to housing demands.

Green infrastructure may be costly to the government, developers and the community, as there are no adequate incentives and planning instruments to help build green infrastructure in the long-term. However, this short-sighted perspective of development is changing in countries where governments are concerned about implementing green infrastructure to support long-term mitigation and adaptation to the impacts of climate change.⁴⁹⁰ Bates argues 'while initial capital costs may be more expensive than the "business as usual" option, once the "payback" period is achieved, ongoing operating costs may well become cheaper than the alternative.'⁴⁹¹

⁴⁸⁴ Total Environmental Centre (TEC), *Submission to Greener Places* (February 2018), 24.

⁴⁸⁵ Yasmin Parry, *How Western Sydney is tackling the mysterious 'heat island' effect behind rising temperatures?* ABC News (Sydney) (online) 1 March 2018; Western Sydney University, *Cooling the Commons, Pilot Research Report* (2016).

⁴⁸⁶ AECOM, *Green Infrastructure: A Vital Step to Brilliant Australian Cities* (2017) 21.

⁴⁸⁷ Ibid.

⁴⁸⁸ Total Environment Centre, *Submission to Greener Places* (February 2018), 3.

⁴⁸⁹ Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (2017), 10.

⁴⁹⁰ Environment Protection Agency (U.S), *Green Infrastructure Collaborative* <https://www.epa.gov/green-infrastructure/green-infrastructure-collaborative> ;

⁴⁹¹ Bates, above n 220, 281.

Planning law in NSW provides the regulatory instruments by which planning for adaptation and green infrastructure can be implemented. Despite green infrastructure being considered one of GSR's priorities due to its social, environmental and economic benefits, no provisions under the *EPA Act* have been determined to support the appropriate regulation. An alternative mechanism may be through EPIs as they are developed to achieve the objects of legislation,⁴⁹² and can be tailored to improve the environment and control development.⁴⁹³

9. Conclusion

This research has presented the scientific evidence highlighting the urgent need for the law to consider the impacts of climate change in urban areas, especially in localities that are environmentally and socially vulnerable to extreme heat events. The predicted changes to climatic patterns present unprecedented challenges to the law and its role in aiding adaptive responses to protect communities and nature. The benefits of green infrastructure mitigating the urban heat island effect were found in this study to have many positive attributes. For example, green infrastructure can promote: biodiversity conservation, air quality, community health and well-being and stormwater management.⁴⁹⁴ This study has examined green infrastructure as one of a range of adaptation options and focused on the rapidly growing areas of Greater Sydney Region and has demonstrated its value.

Land use planning in NSW is changing due to increasing pressures of population growth and development. The impacts of a changing climate exacerbate these pressures, especially in vulnerable areas, so strategic planning plays an important role in decreasing vulnerabilities.⁴⁹⁵ Planning law has evolved over decades, and currently provides mechanisms through which adaptation options, such as green infrastructure, may be implemented. Yet, this investigation has identified that the *EPA Act* does not refer to climate change adaptation and mitigation.

The impacts of climate change in Australia, especially on coastal areas, have been interpreted by domestic and international courts in the context of ESD, with consensus that climate change

⁴⁹² Ibid 344.

⁴⁹³ *Environmental Planning and Assessment Act 1979* (NSW) s 3.14 (1)(a)(b).

⁴⁹⁴ Coutts and Hahn, above n 22.

⁴⁹⁵ Hannah Jane and Brown, *Green Infrastructure: Fostering Equity*, U.S Green Building Council (14 October 2016) <https://www.usgbc.org/articles/green-infrastructure-fostering-equity>

adaptation and ESD are matters of the public interest.⁴⁹⁶ The discussion remains in relation to the weight it receives in relation to other matters for consideration under the *EPA Act*.

While planning law does not have a green infrastructure legal framework, adequate EPIs may influence the development of green infrastructure and enforce the diverse and complex system required to implement its components. For instance, elements of green infrastructure could be recognised as essential infrastructure through a proposed future green infrastructure SEPP, as determined under the *EPA Act*. This SEPP could facilitate implementation across urban forests, eco-corridors, green spaces and green roofs. Additionally, the proposed extension of the current regulatory framework would determine increased standards, ongoing monitoring and funding. Furthermore, one of the purposes of a proposed green infrastructure SEPP would be to integrate ESD principles in to decision making processes in order to respond to the impacts of climate change in urban areas.

Non-regulatory instruments provide guidance to local government, businesses and the wider community through the implementation of green infrastructure within LGAs vulnerable to climate hazards. Flexible instruments, such as DCPs, could also be expanded to facilitate the adequate implementation of elements of green infrastructure locally and strengthen local development controls.⁴⁹⁷

This research has identified the need for improvements in the NSW regulatory system, for example to support the measures proposed by the *GSR Plan* and *Green Infrastructure Draft Policy*. This development requires the NSW government to work collaboratively with different stakeholders, including local government, business and the wider community. For the concept to be widely accepted and implemented, it is necessary to understand that the benefits of building green infrastructure will outweigh the costs in the long-term concerning different sectors, including energy, water and health.⁴⁹⁸ Further, benefits of green infrastructure include investing in the wellbeing of future generations.

⁴⁹⁶ Thorpe and Hart, above n 45, 144; *Aldous v Greater Taree City Council v Another* (2009) 167 LGERA 13, 40.

⁴⁹⁷ Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (October 2016), 1.

⁴⁹⁸ AECOM, *Green Infrastructure: A vital step to Brilliant Australian cities, A brilliant cities report* (2017), 17.

This study has found that it is important for planning law in NSW to regulate green infrastructure strategically. This can be modelled current approaches to adaptation in bushfire-prone and coastal areas through a combination of legislation, EPIs and guidelines. This includes the integration of green infrastructure as proposed under the *GSR Plan* and *Greener Places* policy as a climate adaptation measure.

This research has found that investment in green infrastructure requires a stronger recognition from government of the economic, social and environmental benefits for the wider community. This approach requires the principles of ESD to be considered as a key aspect in decision-making processes, especially the principles of intra- and inter-generational equity, as the outcomes are focused on ameliorating the impacts of urban development for present and future generations.

Overall, the successful development of green infrastructure depends on whether strong legal instruments are in place. While strategies are important to respond to adaptation issues, they lack the necessary regulatory force for implementation and assessment. This research has identified the critical need for NSW planning law to recognise both proactive and reactive responses to assist adaptation to the impacts of climate change.

10. Bibliography

1. Books

Bates, Gerry, *Environmental Law in Australia* (LexisNexis Butterworths Australia, 9th ed, 2016)

Farrier, David and Paul Stein, *The Environmental Law Handbook* (Redfern Legal Centre Publishing, 5th ed, 2011)

Fisher, Elizabeth, Bettina Lange, Eloise Scottford, *Environmental Law, Text, Cases and Materials* (Oxford University Press, 2013)

Hutchinson, Terry, *Researching and Writing in Law* (Thompson Reuters, 3rd ed, 2010)

Layder, Derek, *Sociological Practice: Linking Theory and Social Research* (Sage Publications, 1998)

Lyster, Rosemary, Zada Lipman, Nicola Franklin, Linda Pearson and Graeme Wiffen, *Environmental and Planning Law in New South Wales*, (The Federation Press, 4th ed, 2016)

Martin, Rhett, *Understanding Sustainability Law* (LexisNexis Butterworths, 2018)

Scottford, Eloise Elizabeth Fisher, Bettina Lange, *Environmental Law, Text, Cases and Materials* (Oxford University Press, 2013)

2. Treaties

Paris Agreement opened for signature 16 February 2016 (entered into force 4 November 2016)

UN General Assembly, *United Nations Conference on Environment and Development, Earth Summit* UN Doc A/CONF 151/26 (Vol.1) (Rio de Janeiro, 3-14 June 1992)

United Nations Framework Convention on Climate Change opened for signature 9 May 1992 1771 UNTS 107 (entered into force 21 March 1994)

World Commission on Environment and Development, *Our Common Future Report* UN Doc A/42/427 (October 1987)

3. Journal Articles

Alexandra, Jason, 'The city as nature and the nature of the city – climate adaptation using living infrastructure: governance and integration challenges' (2017) *Australasian Journal of Water Resources*, 66

Bambrick, Hilary Jane, Anthony Guy Capon, Guy Bruce Barnett, R. Matthew Beaty and Anthony John Burton, 'Climate Change and Health in the Urban Environment: Adaptation Opportunities in Australian Cities' (2011) 23(2) *Asia-Pacific Journal of Public Health*

Bartel, Robyn, Paul McFarland and Colin Hearfield, 'Taking a de-binarised envirosocial approach to reconciling the environment vs economy debate: lessons from climate change litigation for planning in NSW, Australia' (2014)

Christudason, Alice, 'Optimisation of Land Use through Innovative Legislation in Singapore' *National University of Singapore*

Coutts, Christopher and Micah Hahn, Green Infrastructure, Ecosystem Services and Human Health (2015) 12 *International Journal Environmental R Public Health*

Davies, Clive and Raffaele Laforteza, 'Urban Green Infrastructure in Europe: Is greenspace planning and policy compliant?' (2017) *Land Use Policy* 69

Dwyer, Guy J and Mark P Taylor, 'Moving from consideration to application: The uptake of principles of ecologically sustainable development in environmental decision-making in New South Wales' (2013) 30 *Environmental and Planning Law Journal* 185

Eisenman, Theodore S., 'Frederick Law Olmsted, Green Infrastructure, and the Evolving City' (2013) *Journal of Planning History* 12(4)

Foerster, Anita, Andrew Macintosh and Jan McDonald, 'Trade-Offs in Adaptation Planning: Protecting Public Interest Environmental Values' (2015) 27(3) *Journal of Environmental Law* 459

Foerster, Anita, Andrew Macintosh and Jan McDonald, 'Transferable Lessons for Climate Change Adaptation Planning? Managing Bushfire and Coastal Climate Hazards in Australia' (2013) 30(6) *Environmental and Planning Law Journal* 469

Ghanem, Robert and Kirsty Ruddock, 'Are New South Wales' planning laws climate-change ready?' (2011) 28 *Environmental and Law Planning Journal* 17

Godden, Lee, Francine Rochford, Jacqueline Peel, Lisa Caripis and Rachel Carter, 'Law, Governance and Risk: Deconstructing the Public-Private Divide in Climate Change Adaptation' (2013) 36 (1) *UNSW Law Journal*

Hatvani-Kovacs, Gertrud, Judy Bush, Ehsan Sharifi and John Boland, 'Policy recommendations to increase urban heat stress resilience' (2018) *Urban Climate* 52

Hin, David Ho Kim, 'To Develop a Landscape Guidelines for Application of Green Plot Ratio in Singapore' *National University of Singapore*

Ireland, Clifford, 'Should private property rights trump the public interest in renewal of the urban environment?' (2009) *Local Government Law Journal* 86

Irga, Peter et al, 'The distribution of green walls and green roofs throughout Australia: Do policy instruments influence the frequency of projects?' (2017) *Urban Forestry & Urban Greening* 24

Kazmierczak, Aleksandra. and Jeremy Carter, 'Adaptation to climate change using green and blue infrastructure. A database of case studies' (2010) *The University of Manchester*

Litichevskaya, Juliya, 'Reviving the world wonder: Why rooftops gardens should cover landscapes?' (2011) *Rutgers Computer and Technology Law Journal* (37) 58

Livada, I, A. Synnefa, S. Haddad, R. Paolini, S. Garshasbi, G. Ulpiani, F.Fiorito, K. Vassilakopoulou, P. Osmond, M. Santamouris, 'Time Series analysis of ambient air-temperature during the period 1970-2016 over Sydney Australia' (2019) *Science of the Total Environment* 648

Macintosh, Andrew, Anita Foerster and Jan McDonald, 'Limp, leap or learn? Developing legal frameworks for climate change adaptation planning in Australia: Summary for policymakers' (2013) *National Climate Change Adaptation Research Facility*, Gold Coast

Matthews, Tony, Alex Y. Lo, Jason A. Byrne, 'Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners' (2015) *Landscape and Urban Planning* 138

McDonald, Jan and Megan C Styles, 'Legal Strategies for Adaptive Management under Climate Change' (2014) 26 *Journal of Environmental Law*, 27

McDonald, Jan, 'The role of law in adapting to climate change' (2011) 2 *John Wiley & Sons, Ltd*

McClellan, Peter, 'The Land and Environment Court of NSW' (swearing In Speech of Chief Judge Peter McClellan, 35 August 2003) *National Environmental Law Review* (2003) 3

Norton, Briony A. et al, 'Planning for Cooler Cities: A Framework to Prioritise Green Infrastructure to Mitigate High Temperatures in Urban Landscapes' (2015) 134 *Landscape and Urban Planning* 127

O'Donnell, Tayanah and Louise Gates, 'Getting the balance right: A renewed need for the public interest test in addressing coastal climate change and sea level rise' (2013) 30 *Environmental Planning and Law Journal* 220

Peel, Jacqueline and Hari M. Osofsky, 'Sue to Adapt?' (2015) *Forthcoming in Minnesota Law Review*

Peel, Jacqueline and Lee Godden, 'Planning for Adaptation to Climate Change: Landmark Cases from Australia' (2009) *Sustainable Development Law and Policy* (9) 2

Phelan, Kath, Joe Hurley and Judy Bush, 'Land Use Planning s Role in Urban Forest Strategies Recent Local Government Approaches in Australia' (2018) *Urban Policy and Research*

Phelan, Patrick E. et al, *Urban Heat Island: Mechanisms, Implications, and Possible Remedies*, *Annual Review Environment Resources* (2015) 40

Pitman, Sheryn D, Christopher B Daniels and Martin E Ely, 'Green Infrastructure as Life Support: Urban Nature and Climate Change' (2015) 139(1) *Transactions of the Royal Society of South Australia* 97

Preston, Brian J, 'Climate Change Litigation in the Land and Environment Court of New South Wales and Other Courts,' ACPECT 2009 Conference (19-21 August 2009, Environment Court, Christchurch, New Zealand)

Preston, Brian J, 'The Judicial Development of Ecologically Sustainable Development' (2016) Environment in Court, IUCNAEL Colloquium 2016 (22 June 2016, Oslo, Norway, 6)

Preston, Brian J, 'The Judicial Development of the Precautionary Principle' (2018) 35 *Environmental Planning and Law Journal* 123

Preston, Judith and Jennifer Scott, 'Meeting the climate change challenge in local government decision-making with the use of sustainable climate change adaptation modelling' (2012) 17 *Local Government Law Journal* 135

Sahukar, Nari, 'The Role of Planning Laws and Development Control Systems in Reducing Greenhouse Gas Emissions: Analysis from New South Wales, Australia' (2018) *Springer*.

Symons, John et al, 'Assessing the Economic Value of Green Infrastructure: Literature Review' (2015) *Climate Change Working Paper No 23. Victoria Institute of Strategic Economic Studies*, Victoria University, Melbourne

Thorpe, Amelia and Melissa Anne Hart, 'Changing climates, changing cities? Planning reform and urban sustainability in New South Wales,' *The Australasian Journal of Natural Resources Law and Policy* (2013) 16 (2)

Verschuuren, Jonathan and Jan McDonald, 'Towards a Legal Framework for Coastal Adaptation: Assessing the First Steps in Europe and Australia' (2012) 1(2) *Transnational Environmental Law* 355

Weeks, Greg and Linda Pearson, 'Planning and Soft Law' (2017) 24 *Australian Journal of Administrative Law*

Wright, Hannah, 'Understanding Green Infrastructure: The Development of a Contested Concept in England' (2011) 16(10) *Local Environment* 1003

Zografos, Christos, Isabelle Anguelovski and Maria Grigorova, 'When exposure to climate change is not enough: Exploring heatwave adaptive capacity of a multi-ethnic, low income urban community in Australia' (2016) *Urban Climate* 17

4. Legislation

Blacktown Local Environmental Plan 2015

Coastal Management Act 2016 (NSW)

Environmental Planning and Assessment Act 1979 (NSW).

Environmental Planning and Assessment Regulation 2000 (NSW)

Environmental Protection and Biodiversity Conservation Act 1999 (Cth)

Federal Building Code, Baugesetzbuch (BauGB) (Germany)

Federal Nature Conservation Act (Bundesnaturschutzgesetz, BNatSchG) (Germany) (1998)
Federal Nature Conservation Act (Gesetz über Naturschutz und Landschaftspflege) (Germany) (1998)
Greater Sydney Commission Act 2015 (NSW)
Local Government Act 1993 (NSW)
Parks and Trees Act, Chapter 216 (Singapore) (2005)
Penrith Development Control Plan 2014
Penrith Local Environmental Plan 2010
Protection of the Environmental Administration Act 1991 (NSW)
Public Resources Code, 34 Cal Public Resources Code (2015)
SEPP (Regional and State Significant development) 2011
Standard Instrument, Principal Local Environmental Plan 2016 (NSW)
State Environmental Planning Policy - SEPP (Exempt and Complying Development Code) 2008
State Environmental Planning Policy - SEPP (State and Regional Development) 2011
State Environmental Planning Policy (Building Sustainability Index: BASIX) 2004
Sydney Local Environmental Plan 2012

5. Cases

Aldous v Greater Taree City Council and Another (2009) 167 LGERA 13
Bellenger v Randwick City Council [2017] NSWLEC 1
BGP Properties Pty Ltd v Lake Macquarie City Council [2004] NSWLEC 399
Bulga Milbrodale Progress Association Inc v Minister for Planning and Infrastructure and Warkworth Mining Ltd [2013] NSWLEC 48
Commonwealth v Tasmania [1983] HCA 21
Gippsland Coastal Board v South Gippsland Shire Council SC & Ors (No 2) [2008] VCAT 1545
Hub Action Group Inc v Minister for Planning (2008) 161 LGERA 136
Long v Hornsby Shire Council [2007] NSWLEC 267
Meriton Apartments Pty Ltd v Ku-ring-gai Council (2006) 152 LGERA 301
Minister for Planning v Walker [2008] NSWCA 224
Parks and Playgrounds Movement Inc v Newcastle City Council [2010] NSWLEC 231

Taralga Landscape Guardians Inc v Minister for Planning (2007) 161 LGERA

Valiant Timber and Hardware Co Pty Ltd v Blacktown City Council (2005) 144 LGERA 355

Walker v Minister for Planning (2008) 157 LGERA 124

Zhang v Canterbury City Council (2001) 51 NSWLR 589

6. Reports

AECOM, *Green Infrastructure: A Vital Step to Brilliant Australian Cities* (2017)

Australian Government, Infrastructure Australia, *Future Cities: Planning for our growing population* Report (February 2018)

Australian Government, Bureau of Metereology, *State of the Climate 2016* (2016)

Australian Panel of Exterts on Environmental Law, *The Foundations of Environmental Law: Goals, Objects, Principles and Norms* (2017)

Blacktown City Council, *Responding to Climate Change Strategy* (2015)

Climate Bonds Initiative, *Green Infrastructure Investment Opportunities Australia & New Zealand GIIO Report* (August 2018)

City of Melbourne, *Urban Forest Strategy: Making a Great City Greener 2012 – 2032* (2011)

City of Sydney, *Urban Forest Strategy* (February 2013)

City of Sydney, *Green Roofs and Walls Policy* (April 2014)

Climate Council of Australia, *Heatwaves: Hotter, longer and more often* (2014)

Climate Council of Australia, *The Silent Killer: Climate Change and the Health Impacts of Extreme Heat* (2016)

Commonwealth, Senate, Environment and Communications References Committee, *Current and Future Impacts of Climate Change on Housing, Buildings and Infrastructure* (August 2018)

Cox R., O'Donnell T., Norman N., Ware D., Tomlinson R., Rouse T., Leitch A. *National Climate Change Adaptation Research Plan for settlements and infrastructure*, National Climate Change Adaptation Research Facility (Update 2017)

Department of the Environment and Energy (Cth), *Built Environment: Planning for the Future, Australia State of the Environment 2016* (2016) (Sarah Coleman)

Department of Infrastructure, Regional Development and Cities, Western Sydney Airport, *Environmental Impact Statement* (2016)

European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: *Green Infrastructure (GI) – Enhancing Europe-s Natural Capital* (2013)

Federal Agency for Nature Conservation, *Federal Green Infrastructure Concept*, Nature Conservation Foundations for Plans Adopted by the German Federation (March 2017)

Greater Sydney Comission (NSW), *Greater Sydney Region Plan. A Metropolis of Three Cities - Connecting People* (March 2018)

Intergovernmental Panel on Climate Change, *Global warming of 1.5 C, Summary for Policy Makers*, approved at the First Joint Session of Working Groups I, II and III of the IPCC, and accepted by the 48 Session of the IPCC, Incheon, Republic of Korea (6 October 2018)

Intergovernmental Panel on Climate Change, *Climate Change 2014: Synthesis Report, Contribution of Working Groups I, II and III IPCC* (Geneva, Switzerland 2015)

Local Government NSW and Office of Environment and Heritage (NSW), *Adapting roads to climate change* (May 2016)

Local Government NSW and Office of Environment and Heritage (NSW), *Adapting to urban heat events: by mapping vulnerability hot spots* (May 2016)

Low Carbon Living, Guide to Urban Cooling Strategies (Paul Osmond and Ehsan Sharifi) (July 2017)

Office of Environment and Heritage (NSW), *Minimising the impacts of extreme heat: A guide for local government* (2016)

Office of Environment and Heritage (NSW), *Technical Guidelines for Urban Green Cover in NSW* (2015)

Office of Environment and Heritage (NSW), *Urban Ecology Renewal Investigation Project, Summary Report Prepared for the NSW Environmental Trust* (2016) The National Green Infrastructure Network

Government Architect NSW, *Greener Places – Establishing an Urban Green Infrastructure for New South Wales, Draft for Discussion* (October 2017)

Government Architect NSW, *Sydney Green Grid, Spatial Framework and Project Opportunities* (23 March 17)

Penrith City Council, *Cool the City Strategy* (August 2015)

Rehan, Reeman Mohammed, ‘Cool city as a sustainable example of heat island management case study of the coolest city in the world’ (2016) *Housing and Building National Research Center*

Revi, A., D.E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R.B.R. Kiunsi, M. Pelling, D.C. Roberts, an W. Solecki, Urban areas. In: *Climate Change 2014: Impacts, Adaptation, and*

Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA 2014)

Ranjha, Shikha, 'Green infrastructure planning for sustainable and resilient urban environment' (2016) *Brief for Global Sustainable Development Report*

Norman, Barbara, and Nicole Gurrán, 'Adapting to long term coastal climate risk through planning approaches and instruments' Information Manual 5, CoastAdapt (National Climate Change Adaptation Research Facility, Gold Coast 3rd ed, 2018)

Parry, M.L. et al (eds), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007 Impacts, Adaptation and Vulnerability* (Cambridge University Press, 2007)

Skinner, Vivienne and Chris Twitchen Kate Freney, Alex Lawrie, 'Time's Up: Making Green Infrastructure Count,' *UNSW Research for Evidence Based Policy* (2017)

United States Environmental Protection Agency, *Green Infrastructure Strategic Agenda* (2013)

United States Environmental Protection Agency, *Reducing Urban Heat Islands: Compendium of Strategies*, Urban Heat Island Basics, Draft (2008)

Western Sydney University, Institute for Culture and Society, *Cooling the Commons: Pilot Research Report* (October 2016)

7. Website/Others

Biodiversity Information System for Europe, *Green Infrastructure in Germany: 1. Policy Setting* <https://biodiversity.europa.eu/countries/gi/germany>

City of Sydney, *The City at a Glance* (16 January 2018) <https://www.cityofsydney.nsw.gov.au/learn/research-and-statistics/the-city-at-a-glance>

Commonwealth of Australia, State of the Environment 1016: Livability: Urban Amenity (Built Environment) (2016) <https://soe.environment.gov.au/theme/built-environment/topic/2016/livability-urban-amenity>

Commonwealth Scientific and Industrial Research Organisation, *Establishing a National Agenda for Urban Green Infrastructure* <<https://www.csiro.au/en/Research/LWF/Areas/Resilient-cities-21C/Green-infrastructure>>

Department of Environment and Energy (Cth), *National Strategy for Ecologically Sustainable Development* (1992) See: <http://www.environment.gov.au/about-us/esd/publications/national-esd-strategy-part1>

Department of the Environment and Energy (Cth), *Intergovernmental Agreement on the Environment* (1st May 1992) <http://www.environment.gov.au/about-us/esd/publications/intergovernmental-agreement>

Department of the Environment and Energy (Cth), *Paris Agreement* <http://www.environment.gov.au/climate-change/government/international/paris-agreement>

Department of the Environment and Energy (Cth), *Australia's 2030 climate change target* (2015) <http://www.environment.gov.au/climate-change/publications/factsheet-australias-2030-climate-change-target>

Department of the Environment and Energy (Cth), *National Climate Resilience and Adaptation Strategy* (2015)

Department of Environment and Energy (Cth), *Adapting to climate change* <http://www.environment.gov.au/climate-change/adaptation>

Department of Planning and Environment (NSW), *State Significant Infrastructure* (24 September 2018) <https://www.planning.nsw.gov.au/Assess-and-Regulate/Development-Assessment/Planning-Approval-Pathways/State-Significant-Infrastructure>

Department of Planning and Environment (NSW), *Greenfield Housing Code* (17 July 2018) <https://www.planning.nsw.gov.au/policy-and-legislation/housing/greenfield-housing-code>

Department of Planning & Environment (NSW), *North West Growth Area Special Infrastructure Contribution* (12 October 2018) <https://www.planning.nsw.gov.au/Policy-and-Legislation/Infrastructure/Infrastructure-Funding/Special-Infrastructure-Contributions-SIC/Western-Sydney-Growth-Area-Special-Infrastructure-Contribution/North-West-Growth-Area-Special-Infrastructure-Contribution>

EDO NSW, 'Submission on Options for Low Rise Medium Density Housing as Complying Development' (February 2016)

EDO NSW, *LEPs and SEPPs*, Planning, Development and Heritage Factsheet (January 2013)

EDONSW, *Walker v Minister for Planning* (November 2007) <https://www.edonsw.org.au/walker>

Georgetown Climate Center, *Green Infrastructure Kit, Government Financing* <https://www.georgetownclimate.org/adaptation/toolkits/green-infrastructure-toolkit/government-financing.html>

Government Architect NSW, *Case Studies* (2017) <https://www.governmentarchitect.nsw.gov.au/resources/case-studies/2017/11/cool-streets-blacktown>

Greater Sydney Commission, South District Plan, *Increasing urban tree canopy cover and delivering Green Grid connections, Planning Priority S15* (2017) <https://www.greater.sydney/south-district-plan/sustainability/city-its-landscape/increasing-urban-tree-canopy-cover-and>

Greater Sydney Commission, *Infrastructure aligns with project growth – growth infrastructure compact* (2017) <https://www.greater.sydney/metropolis-of-three-cities/infrastructure-and-collaboration/city-supported-infrastructure-0>

Green Infrastructure Canada, *Investing in Green Infrastructure* (20 September 2018) <https://www.infrastructure.gc.ca/plan/gi-iv-eng.html>

United Nations, *World's population increasingly urban with more than half living in urban areas* (10 July 2014) <http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html>

Infrastructure Canada, *Canada Infrastructure Bank* (30 August 2018) <https://www.infrastructure.gc.ca/CIB-BIC/index-eng.html>

IPART, *Local Infrastructure Contributions – Practice Note* (January 2018) <https://www.ipart.nsw.gov.au/files/sharedassets/website/shared-files/local-government-contribution-plans-review-of-plans-review-process-and-policy/practice-notes/local-infrastructure-contributions-practice-note-january-2018.pdf>

Leahy, Stephen, *Climate Change impacts worse than expected, global report warns*, National Geographic (7 October 2018) <https://www.nationalgeographic.com/environment/2018/10/ipcc-report-climate-change-impacts-forests-emissions/>

Letter from City of Parramatta to the Government Architect NSW, *Draft Green Infrastructure Policy, Greener Places* (26 February 2018) https://majorprojects.accelo.com/public/4c88be80bac6389d1bd61603bed1596d/247124_SW%20submission%20on%20GI%20final.pdf

Letter from Lendlease Communities (Australia) to Government Architect NSW, *Government Architect NSW Draft Greener Places Policy* (26 February 2018) https://majorprojects.accelo.com/public/831b3aaab9c41e60d49471c9b3a8ca88/247226_Lendlease%20submission_Greener%20Places%20Policy.pdf

Letter from Western Sydney Regional Organisation of Councils Ltd to the Government Architect of NSW, *Response to the Draft Greener Places Policy* (23 February 2018) https://majorprojects.accelo.com/public/6318e5be497df0e3e9c290994b6b0914/247122_Response%20to%20NSW%20Draft%20Greener%20Places%20Policy.pdf

Local Government NSW, *Building Resilience to Climate Change* <https://www.lgnsw.org.au/policy/climate-change/building-resilience>

McKenny, Leesha, *Green Square: Population under Pressure as Projected Population Swells*, Sydney Morning Herald (Sydney) 07 October 2015 (online) <https://www.smh.com.au/national/nsw/green-square-infrastructure-under-pressure-as-projected-population-swells-20151007-gk2z1o.html>

My Plant Connection, *Green Roof Legislation, Policy and Tax Incentives* (2018) <http://myplantconnection.com/green-roofs-legislation.php>

National Climate Change Adaptation Research Facility, *Roles and responsibilities for Climate Change Adaptation in Australia* (2012) <https://www.nccarf.edu.au/sites/default/files/18-dccee-2012.pdf>

National Climate Change Adaptation Research Facility, *National Climate Change Adaptation Framework* (2007) <https://www.nccarf.edu.au/sites/default/files/Australian-Government-2007a.pdf>

National Climate Change Research Facility, *What does climate change mean for Australia?* <https://www.nccarf.edu.au/content/adaptation>

New South Wales, Parliamentary Debates, Legislative Assembly, *Environmental Planning and Assessment Bill 2017* (8 August 2017) (Jamie Parker, MP)

New South Wales Government, *State Heatwave Subplan: A Subplan of the NSW State Emergency Management Plan* (March 2018)

Norman, B., *Climate ready cities, Policy Information Brief 2* (2016) National Climate Change Adaptation Research Facility, Gold Coast

NYC Department of Finance, *Green Roof Tax Abatement* <https://www1.nyc.gov/site/finance/benefits/landlords-green-roof.page>

Parry, Yasmin, *How Western Sydney is tackling the mysterious 'heat island' effect behind rising temperatures?* ABC News (Sydney) (online) 1 March 2018

United States Environmental Protection Agency, *Green Infrastructure Collaborative* <https://www.epa.gov/green-infrastructure/green-infrastructure-collaborative>

Poulet, Peter, *An Act for Good Design*, NSW Government Architect, Department of Planning & Environment (27 February 2018) <http://www.planning.nsw.gov.au/News/2018/An-Act-for-Good-Design>

Saulwick, Jacob, *The system is broken, now is the time to fix it* Sydney Morning Herald (Sydney) (online) 31 August 2016 <https://www.smh.com.au/national/nsw/the-planning-system-is-broken-now-is-the-time-to-fix-it-20160831-gr56jp.html>

Senate Department for Urban Development and Housing (Berlin), *06.11 Green Roofs* (Edition 2017) http://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/e_text/ek611.pdf

Total Environmental Centre, *Submission to Greener Places* (February 2018) https://majorprojects.accelo.com/public/ea298dbd16cab39e7ef16ed490b1e88/242768_TEC%20submission%20final%20report_050218.pdf

United States Environmental Protection Agency, *Integrating Green Infrastructure into Federal Regulatory Programs* <https://www.epa.gov/green-infrastructure/integrating-green-infrastructure-federal-regulatory-programs>

Jane, Hannah and Brown, *Green Infrastructure: Fostering Equity*, U.S Green Building Council (14 October 2016) <https://www.usgbc.org/articles/green-infrastructure-fostering-equity>

United Nations, *World's population increasingly urban with more than half living in urban areas* (10 July 2014) <http://www.un.org/en/development/desa/news/population/world-urbanization-prospects-2014.html>

United Nations, *Sustainable Development Goals* (2015) <https://sustainabledevelopment.un.org/?menu=1300>

United Nations, *Sustainable Development Knowledge Platform* <https://sustainabledevelopment.un.org/sdg11>

Urban Redevelopment Authority, *Enhanced LUSH to take urban greenery to new heights, Circular to Professionals Institutes* (09 November 2017) <https://www.ura.gov.sg/Corporate/Media-Room/Media-Releases/pr17-77>

Urban Redevelopment Authority, *Landscaping for Urban Spaces and High-Rises (LUSH) 2.0 Programme: Landscape Replacement Policy for Strategic Areas*, Circular to Professionals Institutes (12 June 2014) <https://www.ura.gov.sg/Corporate/Media-Room/Media-Releases/pr17-77>

Urban Redevelopment Authority, *Updates to the Landscaping for Urban Spaces and High-Rises (LUSH) Programme: LUSH 3.0, Circulars to Professional Institutes* (09 November 2017) <https://www.ura.gov.sg/Corporate/Guidelines/Circulars/dc17-06>

World Meteorological Organisation, *July Sees Extreme Weather with High Impacts* (1 August 2018) <https://public.wmo.int/en/media/news/july-sees-extreme-weather-high-impacts>