

An aerial photograph of the Macquarie Park Innovation Precinct. The image shows a dense cluster of modern, multi-story office buildings and residential-style structures, interspersed with green spaces and trees. A major road, likely the M2, runs diagonally through the center of the precinct. The surrounding area is a mix of urban development and natural forest.

Sustainability Framework

Macquarie Park Innovation Precinct Stage 1 Masterplan and Rezoning

Revision 02, July 2023

Document information

Report title: Sustainability Framework
Project name: Macquarie Park Innovation Precinct Stage 1 Masterplan and Rezoning
Project number: 1733
Digital file name: 1733_Macquarie Park - Sustainability Framework_rev01
Digital file location: 1733 Macquarie Park Innovation Precinct/10 Outgoing/10.1 Sustainability Framework

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Revisions

No	Date	Approved
00	17/03/2023	SM
01	07/06/2023	BR
02	14/07/2023	SM

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Executive summary

This Sustainability Framework (Framework) sets out the key sustainability ambitions for Macquarie Park Innovation Precinct (MPIP), and an approach to embed environmental, social, and economic sustainability into the Macquarie Park Structure Plan.

This report is structured into four key sections which develop the narrative and provide the evidence base for its application.

Section 01: Context

Describes the purpose of this framework as providing guidance to all future infrastructure investment and property development in the area across all stages of the project lifecycle from planning and design, to construction and operation. The methodology for establishing the evidence-base for future decision making and synthesising it into a MPIP - specific Sustainability Vision (Vision) and Framework for delivery.

Provides a background summary of sustainability in the study area at diminishing scales from Greater Sydney to the North District, City of Ryde Council (Council) local government area and to the locality.

Section 02: Sustainability Strategy

Establishes the sustainability context in which MPIP operates, and includes an exploration of:

- physical, environmental and social aspects of the region
- the public policy framework at local, state, Commonwealth, and global levels
- the property and real estate development environment
- emerging sustainability research on the urgency and scale of change required to address pressing socio-environmental challenges
- benchmark projects with aspects relevant to MPIP

Introduces MPIP overarching Vision and proposes a series of Sustainability Themes (Themes) that reflect organisational ambitions, statutory requirements, industry and public expectations, and sustainability challenges in the built environment. The seven themes outlined are:

- Connected with Country
- Climate Positive
- Resilient and Adaptable
- Bioiverse and Regenerative
- Integrated Mobility
- Healthy and Inclusive
- Innovative Community

To structure a delivery approach, this Sustainability Strategy builds on the Themes and for each describes:

- **Ambition** | what will MPIP do for sustainability
- **Rationale** | why this is critical to delivering a successful and sustainable place
- **Principles** | fundamental outcomes which represent positive achievement
- **Benchmarks** | quantifiable indicators which align with existing policies or frameworks

- **Opportunities** | potential actions to deliver sustainability across the development lifecycle
- **Supports** | specific frameworks or policies that it contributes to or facilitates

It concludes with a summary of key findings which synthesises the recurring attributes of sustainable development projects and organisations.

Implementation

Strategic initiatives of the strategy are delivered throughout stages of the project lifecycle. Each Theme addresses the opportunities by stage. For example, planning, design and operational delivery.

The strategy seeks to provide opportunities that are aligned with global ambition, are holistic and can be implemented incrementally.

Specific objectives have been addressed within planning controls to support the design guide for delivery by DPE. These controls will address development of the study area.

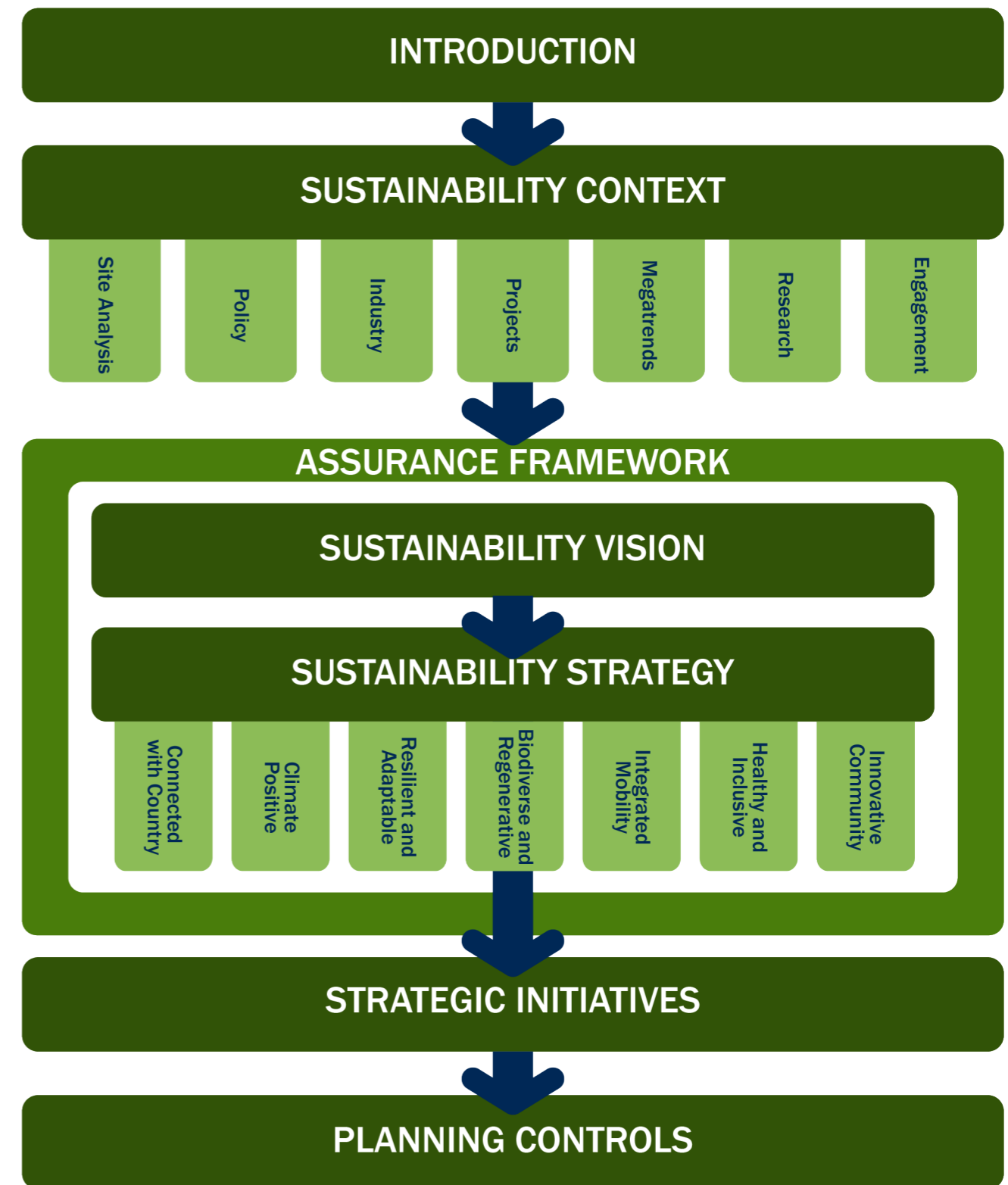


Figure 1.1 MPIP Structure Plan Framework document structure (Source: Atelier Ten)

01 CONTEXT

1.1 Purpose and Approach

1.1.1 Purpose

This Framework marks the beginning of a considered and coordinated approach to the implementation of sustainability in the MPIP. It is designed to guide all future infrastructure investment and property development in the area across all stages of the project lifecycle from planning and design, to construction and operation.

This document represents the outcome of a research and engagement process designed to direct its efforts to areas most meaningful to the overarching goal to become 'Australia's innovation engine.'

1.1.2 Approach

This framework documents an approach to sustainability that incorporates two discrete exercises conducted in succession.

The first exercise is designed to explore the current context of sustainability relevant to this particular organisation in this place. It puts MPIP into context, and provides an evidence-base for future decision making. This initial research piece (as shown) includes:

- **Site** | contextual analysis of physical and environmental conditions in the study area
- **Policy** | statutory and regulatory planning framework in which the organisation operates
- **Projects** | benchmark projects with aspects relevant to MPIP
- **Research** | emerging research on how society and the natural environment impact each other
- **Engagement** | meetings and workshops with relevant Government organisations and stakeholders

The second exercise synthesises this research into a MPIP-specific Vision and Framework for delivery. This Framework builds on the Design Principles proposed in the Urban Design Report and for each describes:

- **Ambition** | what will MPIP do for sustainability
- **Rationale** | why this is critical to delivering a successful and sustainable place
- **Principles** | fundamental outcomes which represent positive achievement
- **Benchmarks** | quantifiable indicators which align with existing policies or frameworks
- **Opportunities** | potential actions to deliver sustainability across the development lifecycle
- **Supports** | specific frameworks or policies that it contributes to or facilitates



Figure 1.1 Evidence base supporting sustainability ambition and vision (Source: Atelier Ten)

1.2 Background

1.2.1 The Study Area

MPIP is the largest non-CBD office market in the country and the fourth largest employment centre in Greater Sydney. The area is home to over 180 large international and 200 small businesses, Macquarie University and Hospital, and Macquarie University Incubator. The aim for the new innovation precinct is to create a better place, improve connectivity and ways for people to share ideas and technology.

The MPIP Place Strategy considers the 350 hectares of land within the study area. It also strives to create a place for people, in recognition of Wallumattagal Country. The framework informs planning for new open spaces and links, active transport and greater connectivity, as well as 20 000 jobs; bringing life and activity day and night.

1.2.2 Greater Sydney Innovation Districts

The Greater Cities Commission is leading the delivery and coordination of four innovation districts in Sydney: Tech Central, Westmead, Central Coast and MPIP. Through the involvement of government and non-government stakeholders these innovation precincts “will act as catalysts for broader economic growth.”

A “collaborative one government approach” will unlock the high productivity of places through bringing together many stakeholders to address complex urban issues. The various districts will complement each other utilising their social, economic and sustainability benefits.

1.2.3 A Metropolis of three cities

Greater Sydney will be transformed into a metropolis consisting of 3 cities: Western Parkland City, Central River City, and Eastern Harbour City. MPIP is located in the North District of the Eastern Harbour City and is apart of the Eastern Economic Corridor.

The Metropolis will be a “collaborative city” of healthy and resilient communities that are culturally rich and diverse. There will be a greater supply of housing and more diverse/affordable housing. Open space and heritage areas will be conserved and enhanced with increased accessibility for all. Biodiversity and waterways will be protected and healthier, with urban bushland and public open space enhanced. An increased urban tree canopy cover and implementing the Green Grid will “link parks, walking paths and bushland” to each other. The metropolis will work towards 70% reduction of emissions by 2035 and contribute to net zero emissions by 2050.

The new Metropolis plan aims to rebalance economic and social opportunities across Greater Sydney, as the population is projected to rise by 8 million people over the next 40 years.

1.2.4 Six Cities Region

The Six Cities Region is a network of connected cities that support each other whilst leveraging each others unique character and strengths. The cities comprise of the future Metropolis of Three Cities

as well as Lower Hunter and Greater Newcastle City, Central Coast City, Illawarra-Shoalhaven City.

The region will ensure digital connectivity in nanoseconds and ensure that people and goods can move across the region in 90 minutes. In each city jobs will be 30 minutes from people’s homes, with vibrant local centres and neighbourhoods that can meet daily needs in a 15 minute walk. The aspirations and knowledge from First Nations people are recognised and embedded in planning for the region’s future.

Social sustainability will also be intrinsic to the development of the region, with the vision including more sustainable and affordable housing that can adapt to “changing needs over time.” Communities and cities will drive Sydney towards net zero emissions and mitigate climate related risks. Social infrastructure will be accessible and attractive with town centres embracing more experience based mix uses. Ensuring housing is located near public transport hubs, such as the Metro, and in locations that provide a “high quality of life”.

The NSW Government’s Net Zero Plan Stage 1: 2020-2030 creates a pathway to a low-carbon state by 2050. Low and zero emission vehicles are key to the transition to clean and quiet mobility. Renewable energy will ensure transport, homes and businesses are sustainable and climate-proofed cities. A circular economy in these cities will transform urban systems and create efficiency of resources. Emissions will have more than halved by 2050, and NSW will play a leadership role in the global region for the transition to a net zero economy.

Establishing partnerships with representatives of First Nations communities, Aboriginal Community Controlled Organisations, traditional custodians, and Local Aboriginal Land Councils, the Commission will ensure First Nations perspectives inform and influence all its planning and decision-making processes. The commission will also create a First Nations Advisory Panel “to advise on regional strategic planning.”

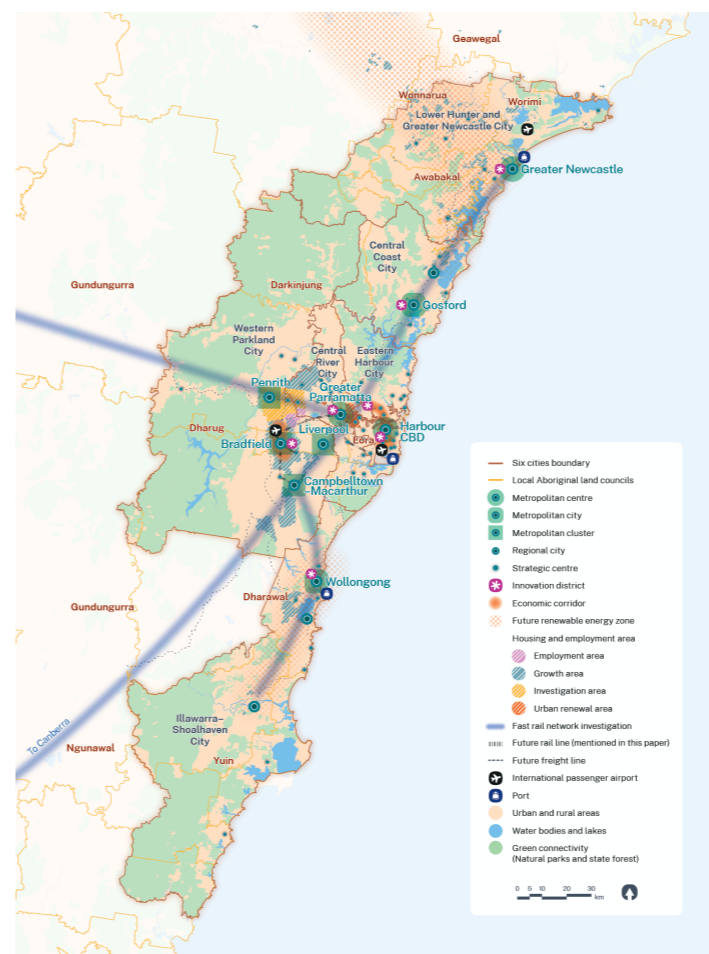


Figure 1.2 Six Cities Region (Source: GSC)

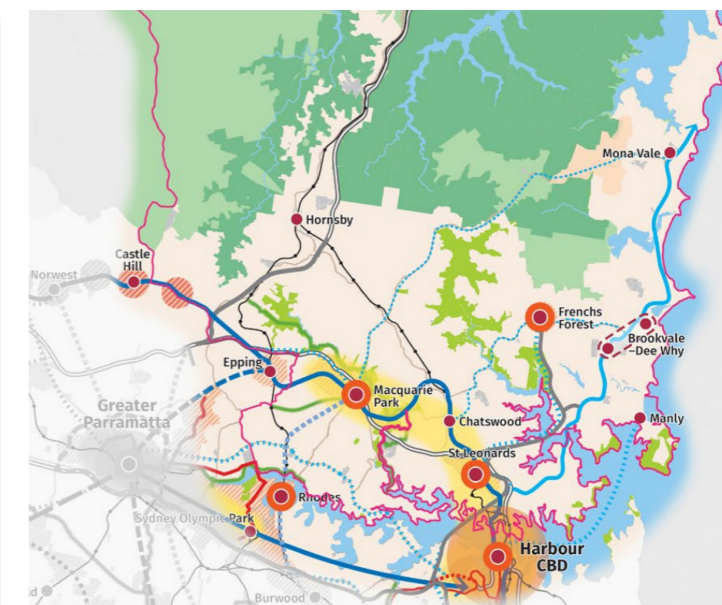


Figure 1.6 North District Plan (Source: GCS)



Figure 1.3 Greater Sydney Innovation Districts (Source: GCS)

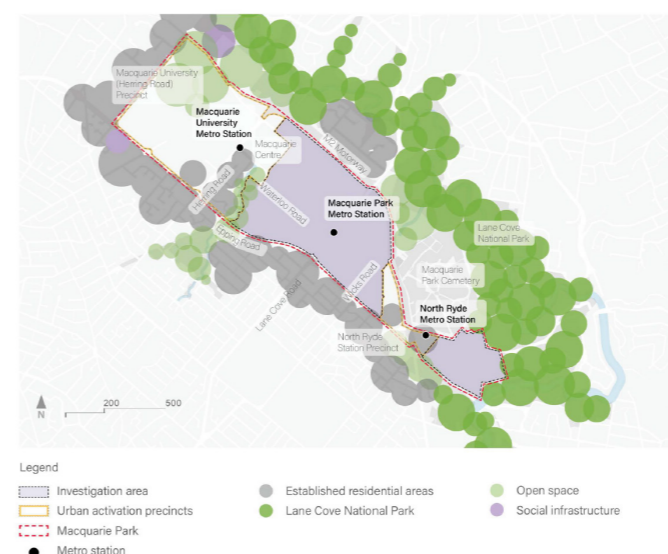


Figure 1.5 MPIP Structure Plan primary investigation area (Source: MP Precinct Innovation Place Strategy)

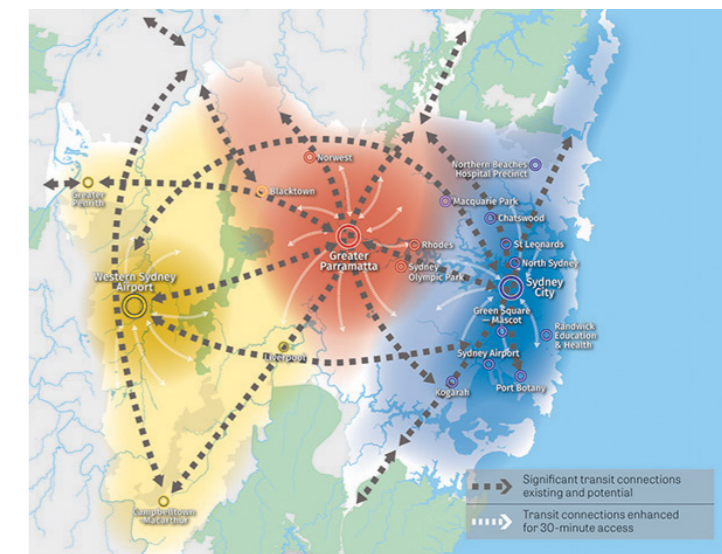


Figure 1.4 A Metropolis of Three Cities (Source: GCC)

1.3 Site context

This Vision aims to represent and provide direction to all stakeholders in the Macquarie Park site, while also taking into consideration the wider vision for MPIP. Informed by this vision a series of precinct planning opportunities and development controls will be proposed within the Primary Investigation Area.

1.3.1 Strengths

- Lane Cove National Park and existing biodiversity
- Proximity to Macquarie University and Hospital
- Proximity and accessibility to metro line
- Established businesses- telecommunications, health, tech
- Government building, Transport for NSW

1.3.2 Weaknesses

- Car-oriented mobility, and lack of public and active personal transport infrastructure.
- Lack of a distinct and cohesive identity
- Lack of identity especially Aboriginal identity
- Traffic and congestion.
- Existing grid layout of Macquarie Park that isolates people/businesses from connecting and collaborating
- Lack of vibrancy and life after work hours

1.3.3 Opportunities

- Galvanise stakeholders existing sustainability ambitions, and catalyse for greater outcomes.
- Increase quality of life for new and existing community members.
- Community capacity building through social procurement models.
- Environmental, social and economic resilience through a coordinated approach.
- Precinct-scale resource sharing efficiencies.
- Renaturalising creeks and provide green connections
- Active transport links
- Create fine grain places with more pedestrian links

1.3.4 Constraints

- Nearby M² Highway, north east of site, which limits connectivity to Lane Cove National Park
- Potential flood zones/underground previous creeks that run through the site

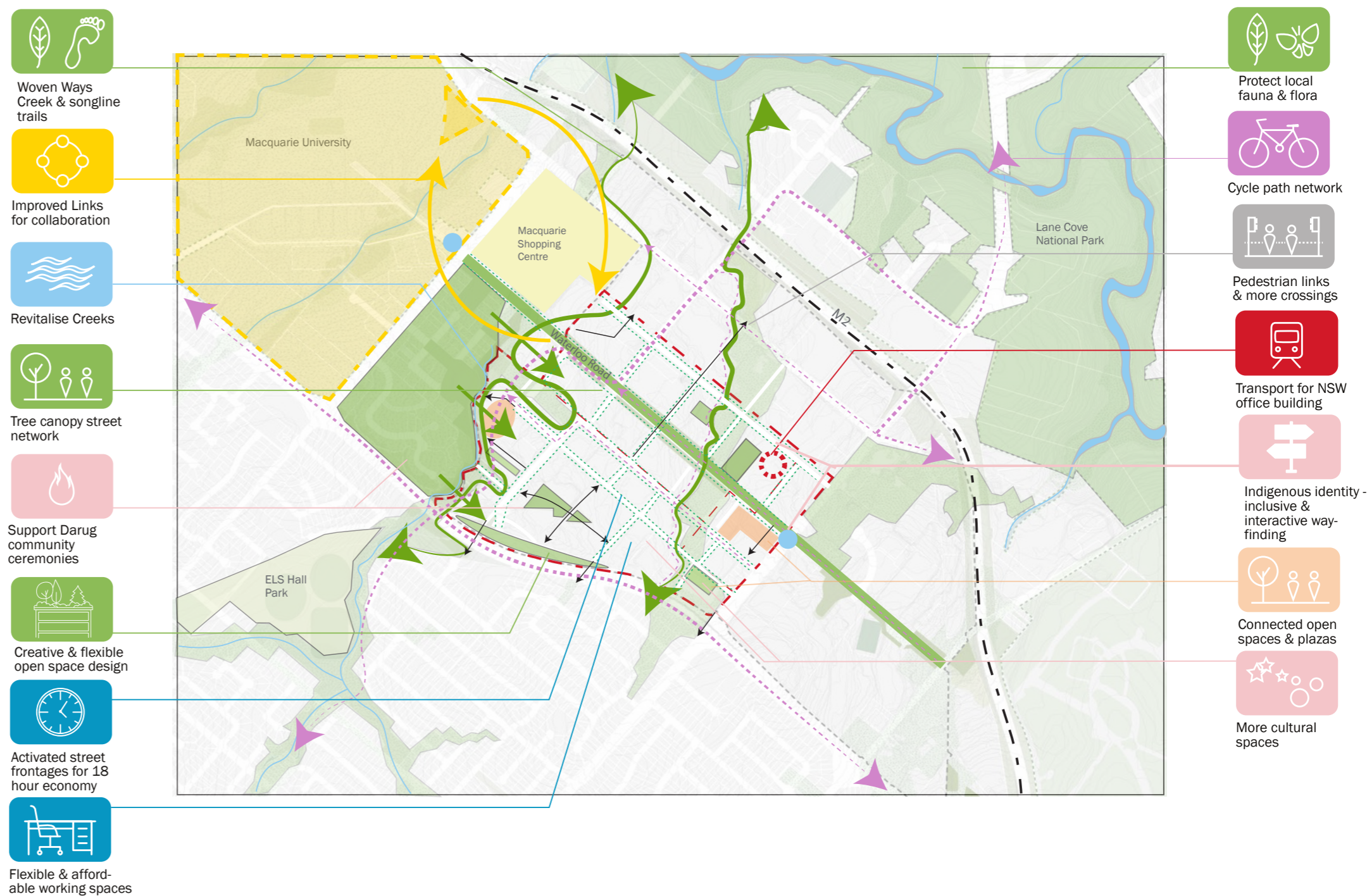


Figure 1.7 Macquarie Park Structure Plan primary investigation area (Source: Atelier Ten)

1.4 Policy and planning framework

These documents layout policy ambitions and priorities for master planning globally, in the commonwealth, in NSW and Macquarie Park.

These documents have been organised in a hierarchy based on their relevance to the Macquarie Park Structure Plan:

- **Ambition | What do we want?**
Provide the global and national goals and aspirations for sustainability, sustainable development, and climate resilience.
- **Direction | How do we get there?**
Provide state and region specific objectives and pathways for achieving ambitions.
- **Guidance | What does it look like?**
Provide design specific approaches and support for the implementation of objectives in Sydney's built environment.
- **Place | What do we do in Macquarie Park?**
Provide Macquarie Park specific strategies and actions for delivering an Innovation District

A detailed review of the **Place** documents follows on the next pages. For each a short summary is provided, as well as potential implications or actions for realising them in the Macquarie Park Structure Plan.

A review of these documents shows key and consistent themes across this policy context include:

- zero carbon
- responsible and efficient consumption and production
- climate resilient and adapted
- biodiversity, ecosystem functioning, ecosystem services and human well-being
- integrated active transport
- flexible, efficient and resilient water cycle
- leveraging open and real time data with smart city digital technology
- socially sustainable, inclusive and equitable communities
- good health and wellbeing
- connection to Country
- environmentally and socially responsible value chains
- multilateral governance centred collaboration and co-creation

Refer section 3 for further policy contextual documents supporting this Framework.

The image displays a hierarchy of policy and planning documents organized into four levels:

- Place (Green Header):** Includes documents such as 'Macquarie Park Innovation Precinct Place Strategy', 'What We Heard', 'PLANNING RYDE Local Strategic Planning Statement 2020', and 'MACQUARIE PARK INNOVATION PRECINCT STRATEGIC MASTER PLAN'.
- Guidance (Blue Header):** Includes documents like 'BETTER PLACED', 'GREENER PLACES', 'ALIGNING MOVEMENT AND PLACE', 'DESIGN GUIDE FOR HERITAGE', 'DESIGNING WITH COUNTRY', 'SYDNEY GREEN GRID', 'North District Plan', 'GOOD URBAN DESIGN', 'DRAFT GREENER PLACES DESIGN GUIDE', 'EVALUATING GOOD DESIGN', 'PRACTITIONER'S GUIDE TO MOVEMENT AND PLACE', 'GOOD DESIGN FOR SOCIAL HOUSING', 'DRAFT CONNECTING WITH COUNTRY', and 'NORTH'.
- Direction (Purple Header):** Includes documents such as 'GLOBAL', 'A metropolis of three cities', 'Next steps for Greater Sydney', 'The Pulse of Greater Sydney 2020', 'NSW 2045 Economic Blueprint', 'NSW Circular Economy Policy Statement', 'POLICY FRAMEWORK', 'Net Zero Plan Stage 1 2020-2025', 'Regional Plan', 'SMART PLACES STRATEGY', 'NSW Water Strategy', 'Building Momentum', 'NSW Circular Economy Policy Statement', 'NEW LANDS TRUST TRANSPORT MASTER PLAN', and 'Net Zero Plan Stage 2 2020-2025 Implementation Update'.
- Ambition (Red Header):** Includes documents such as 'OUR COMMON INTEREST', 'OUR FUTURE WORLD', 'Returns to meet Australia's future infrastructure needs', 'NATIONAL QUALITY', 'NATIONAL QUALITY', 'The Plan to Deliver the East of the Australian Bay', and 'The Plan to Deliver the East of the Australian Bay'.

1.4.1 MPIP Place Strategy

MPIP is a place where people will go to share ideas and foster creativity through interconnected relationships between people, businesses, places of education and a renewed connection to Country.

The MPIP Place Strategy has proposed six big moves that centre around: a new innovation precinct, planning for infrastructure, transport variation, improving pedestrian experience, sustainable neighbourhoods and connecting to country.

Key Moves and Actions for Sustainability are:

- **Big Move 3: Rebalance transport uses**
 - Action 3.7 Create a master plan for each neighbourhood to provide a safe, direct, attractive, comfortable and adaptable walking and cycling network.
- **Big Move 4: Prioritise and enrich the pedestrian experience**
 - Action 4.3 Improve Waterloo Road as a pedestrian connector between neighbourhoods.
- **Big Move 5: Create sustainable neighbourhoods within MPIP, each with their own identity and role**
 - Action 5.4 Introduce best-practice resilient building design controls to mitigate environmental impacts and promote energy and water savings/recycling.
 - Action 5.5 Ensure a diversity of dwelling typologies including 5-10% affordable housing.
 - Action 5.6 Contribute to the goal of net zero emissions by 2050.
 - Action 5.7 Identify potential water-sensitive urban design opportunities in new open space and creek restoration works for optimised urban stormwater management
- **Big Move 6: Connect to Country and deliver better quality open spaces**
 - Action 6.4 Become a leader in green space design, providing new, inviting, accessible, diverse and comfortable public open space and enhanced public open space.
 - Action 6.2 Work with Traditional Custodians and knowledge holders to enliven the public realm with programming, activation and installations.
 - Action 6.6 Investigate opportunities to show and open up the creek spaces and historic lines as open water and as places of increased biodiversity and green infrastructure.
 - Action 6.7 Create a richer urban tree canopy along major roads and intersections.

Implications for MPIP

- Develop active transport for neighbourhoods including adaptable walking and cycling network
- Improve roads such as Waterloo Road as a pedestrian connector between neighbourhoods
- Ensure resilient building design for minimal environmental impacts
- Implement a diversity of dwelling typologies and affordable housing
- Renaturalise creeks and incorporate water sensitive design
- Create flexible and accessible public green space

- Increase canopy and vegetation coverage for urban cooling especially along major roads
- Collaborate with Aboriginal people to enliven the public realm



Figure 1.8 MPIP Place Strategy (Source: DPE)



Figure 1.9 Proposed Movement Framework (Source: MPIPSP)

1.4.2 MPIP Strategic Master Plan

The MPIP master plan contains strategies for transforming the study area into an innovation precinct, with key priorities for sustainability.

Key priorities:

Vision & Objectives

- **Objective 1: Improve the quality of movement**
 - Increase walkable links and walking choices within and into MPIP and its neighbourhoods;
 - Increase the quality of interchange between metro, bus and active transport networks
- **Objective 2: Improve the quality of place**
 - Increase opportunities where the MPIP community and its visitors can connect to the deep history and features and attributes of Wallumattagal Country to continue its long tradition of sharing knowledge and culture

Strategic Principles

- **Strategic Landscape Framework**
 - Restore the creeks and corridors
 - Fine grain open space network
 - Strengthen the urban tree canopy
- **Strategic Movement Framework**
 - Prioritise movement along natural routes
- **Strategic Uses and Activities Framework**
 - Make a 'place of many places'
 - Increase Cultural Activity in MPIP

Placemaking Strategy Summary

- Reconnect MPIP to the natural environment by increasing access to and from the Lane Cove National Park

Integrated Transport Plan Summary

- Provide sustainable access to MPIP centres for people and goods while safeguarding liveability and vibrancy of place.
- Take every opportunity to design with Country. Reveal the natural paths that the Creeks once took. Design with, not against the natural topography of MPIP.

Implications for MPIP

- Develop a walkable MPIP with good links to neighbourhoods
- Increase the quality of active transport networks
- Design with Country through restoring natural creeks and pathways that go against the formal grid style streets and follow natural routes
- Increase the urban tree canopy and plant native plants
- Create places that are rich with cultural activity
- Develop a 'place of many places' through adaptive reuse and temporary use of existing buildings and places which are planned to be redeveloped
- Increase access to and from Lane Cove National Park



Figure 1.10 MPIP Strategic Master Plan (Source: Arup)

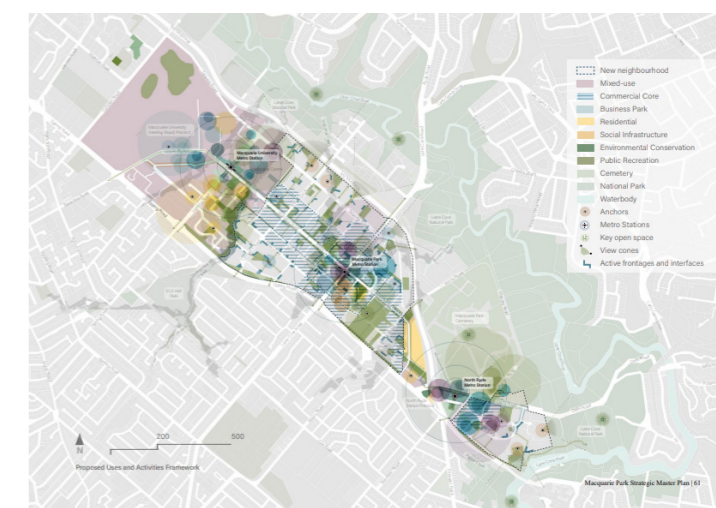


Figure 1.11 MPIP Strategic Uses and Activities Framework (Source: MPIPSP)

1.4.3 Open Space Future Provision: Technical Appendix, City of Ryde

The report identifies the demand for open space facilities currently and in the future, the scale and location of gaps in the current network, and priorities for addressing these gap.

Planning

- Access to open space is central to community health and wellbeing
- The increasing number of people moving into Ryde, creating higher density development (with reduced private open space), will increase the need for different types of open space
- Draft Urban Tree Canopy Guide, sets a target of increasing Greater Sydney's tree canopy to 40% (>25% in medium density and >40% in suburban areas).
- Sharing and increasing the capacity of what we have, including sharing school open space and sporting facilities, multi-use of our sports fields, golf courses, and facilities.

Changing trends:

- National, State and local trends indicate a higher demand for open space that supports informal, unstructured recreational activities above competitive organised sport.
- Making the most of existing assets and space through increasing their capacity and ability to accommodate higher levels of use or more diverse activities

14.3 Macquarie Park (MP) Open Space

- The high density form means that open space will need to function as backyard, meeting place, event space, play space for a range of age groups
- MP is a major opportunity to see new large public open spaces and sports facilities delivered
- Hierarchy and diversity of connected, quality open spaces, including new regional/destination, district and local level public open space and semi-private (communal) and private open space
- Catherine Hamlin Park and Lachlan's Line- open spaces in MP
- All residents in the high density housing areas have access to an open space within 200 metres
- Common green spaces- informal shared spaces
- Access to nature- biophilic architecture such as green walls/roofs, indoor plants and nature-inspired design elements such as the use of fractal patterns in materials
- MP is defined by Lane Cove River and National Park along the entire northern border, creating opportunities for future communities to be well connected to nature.
- Consider the activation of MP's open spaces during the evening e.g. having creative lighting and urban features like Centenary Plaza
- Consider recreation on rooftops, utilising the high density form of buildings to create an activated public space e.g. Park'n'Play Denmark; Ultimo Community Centre
- Prince Alfred Park - casual and formal sports space, are likely be in high demand, especially after work in the evenings



Figure 1.12 Open Space Future Provision: Technical Appendix (Source: City of Ryde)



Figure 1.15 Centenary Square Parramatta (Source: City of Parramatta)



Figure 1.13 Catherine Hamlin Park, Macquarie Square (Source: City of Ryde)

1.4.4 Macquarie Park Innovation District Study, Arup

The Study investigates the industry specialisations and economic structure of Macquarie Park to realise potential for the future innovation district.

Economic Profile and direction:

- The precinct has strong industry specialisations in knowledge intensive industries including technology and pharmaceuticals
- Significant distance between the University, Hospital and the Commercial Core. This physical separation can be a barrier to interaction and reduce opportunities for inter-business engagement.
- Macquarie Park would benefit from added diversity in scale of firms (more SMEs)
- Improved urban vibrancy to attract high growth firms
 - MP scores well on access to rail/transit, and is attractive to firms seeking 'campus style' accommodation
 - MP has poor-quality pedestrian environment, an absence of amenities (with few options for activities after 5pm), limited visitor attractions and road congestion, limits Macquarie Park's attractiveness for businesses, workers and residents

Key Moves and Actions:

- **Key Move 1: Support skills development to build resilience to external change**
 - Action 1.2 Develop a purpose-built building in a strategic location within the commercial core which provides curated, affordable and agile office space for new and innovative enterprises
- **Key Move 6: Deliver a range of social and transport infrastructure and services to support community diversity and wellbeing**
 - Action 6.1 Create high-quality pedestrian environment and public domain works
 - Action 6.3 Leverage off the National Park and other natural assets
 - Action 6.4 Develop an investment fund for programmed public spaces
 - Action 6.5 Provide social infrastructure, including open space and leisure amenity for children and young people
 - Action 6.6 Provide high- quality green infrastructure including creek restoration
 - Action 6.8 Develop business case for transit links to Parramatta and Epping to meet long term demand and reduce car mode share
 - Action 6.9 Consider changes to the planning controls to encourage mixed-use
 - Action 6.10 Encourage an alternative built form in key areas which activates the ground plane, delivers a centre-based typology, and creates places and spaces for community and worker interaction

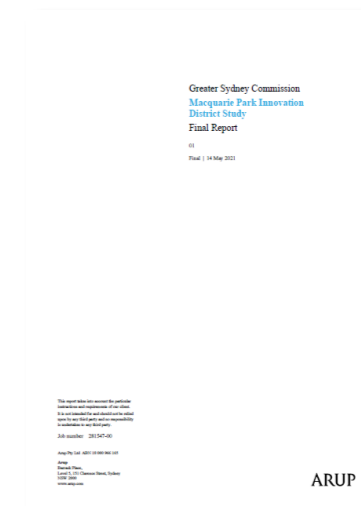


Figure 1.14 Macquarie Park Innovation District Study (Source: GSC)

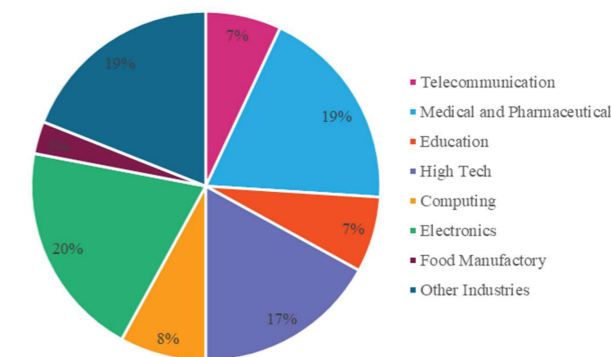


Figure 1.16 Percentage of companies per sector amongst largest firms in 2018 MPIP (Source: MPIIDS)

1.4.5 What We Heard Macquarie Park Precinct, NSW Government

DPE consultation for the place strategy, master plan and supporting technical documents to the community, landowners and stakeholders.

Key issues raised in feedback in relation to sustainability are:

- Transport and movement
 - Reduce congestion, car use and parking in MPIP. There was strong support for improved walking and cycling paths and access to public transport.
 - Response: 9.6 km of new roads and 22.2 km of pedestrian and cycle paths are proposed.
- Natural environment and climate change
 - Creating sustainable neighbourhoods, addressing climate change and prioritising biodiversity
 - Response: a target to contribute towards net zero emissions by 2050
- Open space and tree canopy
 - The masterplan provides more open space including recreation and passive open space and green links
 - Response: Tree canopy targets have been increased to 40%
- Cycling and pedestrian links
 - Prioritise walking and cycling with an emphasis on improving safety and urban amenity for pedestrians and cyclists
 - Response: diversification of the precinct will see more people using public transport or cycling or walking

Implications for MPIP

- Reduce reliance on car use by improving walking and cycling paths and access to public transport
- Develop sustainable neighbourhoods
- Create more open space, green links and more tree canopy
- Prioritise the safety of pedestrians and cyclists



Figure 1.17 MPIP What We Heard
(Source: Dep. of Planning)

1.4.6 Planning Ryde Local Strategic Planning Statement 2020, City of Ryde

The City of Ryde LSPS outlines the vision for land use planning in the local area over the next 20 years, and will guide all planning decisions.

The LSPS is divided into four topics: Infrastructure and Collaboration, Liveability, Productivity and Sustainability. Within these topics challenges, targets, planning priorities and actions are stated. Key topics in relation to sustainability are:

- 2 - Infrastructure and Collaboration
 - 2.3.4 Fine grain roads will continue to be delivered in MPIP, which will reduce block sizes, increase permeability and connectivity for vehicles and pedestrians, increase route options and reduce traffic congestion.
 - 2.3.4 there will be a 60/40 private vehicle/active and public transport modal split of total journeys to and from work.
- 3 - Liveability
 - 3.1.4 Increase the proportion of the population within 400 meters of public open space greater than 1,500m²
 - 3.1.4 Increase the proportion of the population within 400 meters of public transport connections and active transport / regional routes.
 - 3.2.4 Public domain within all centres will be increased and, there will be more street trees and shade.
 - 3.2.4 Our town centres will be safer for pedestrians.
 - C7 Create a sense of place and promote community identity
- 5 - Sustainability
 - 5.1.4 An increase in the amount of both structured and unstructured public open space in the City of Ryde, providing benefits across all ages and abilities.
 - 5.1.4 There will be an extended network of recreational corridors, links and connections running through the City of Ryde.
 - 5.2.4 By 2050, there will be net zero carbon emissions across the City of Ryde (carbon neutral).
 - 5.2.4 By 2025, waste going to landfill will be reduced by at least 20 per cent (kg/capita) from 2018 levels.

Implications for MPIP

- Improved fine grain roads to improve access and connections for vehicles and pedestrians a like
- Improved public transport for journeys to work
- Increase the amount of public open and greenspace
- Create improved connections to public transport
- Increased trees for cooling public areas
- Recreational corridors for the community and to facilitate innovation
- Reduce waster going to landfill and aim for net zero carbon emissions

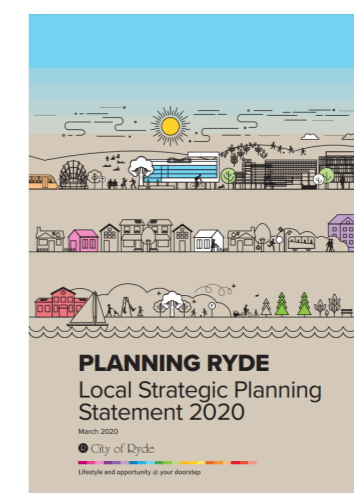


Figure 1.18 Planning Ryde LSPS 2020 (Source: City of Ryde)



Figure 1.19 Ten Steps to a living river (Source: City of Ryde)

1.4.7 Wallumatta Macquarie Park Masterplan, Old Ways New

The purpose of this document is to share how Country Centered Design informs the conception, application and implementation of the Macquarie Park Strategic Masterplan.

This masterplan report provides key recommendations for improving social and environmental sustainability that's inextricably connected to Aboriginal culture:

Masterplan objectives:

- Quality of movement: flowing through the area, following desire lines and natural paths;
- Quality of place: a place that connects to Country, that is conscious of and celebrating its story and identity;
- Strengthening the business community: a place where networks are formed and value is exchanged.

Constellations - Seven Sisters Constellation - Development of seven neighbourhoods in the study area with independent and interconnecting identities:

- The creeks provide boundaries to break down the singularity of MPIP as part of its long term evolution to 'place of many places'

1. Badu Nawi, Waterloo Corridor

- A green 'welcome to Wallumatta' as point of arrival from stations and bus interchange quickly indicates its identity
- The healing heart of Wallumatta: health, medicine, pharmaceutical businesses translates to a corridor of water and healing plants (such as lilly pilly)
- The new MQ University Faculty of Engineering is an opportunity for collaboration, with public facing uses and learning, aligning with Porters Creek
- Walking trails, cycle ways, possible micro mobility corridors that weave through and across the water corridors is proposed.
- Bus prioritization as part of consolidated public transport plan to connect Macquarie Park Station and Macquarie University Station.
- TfNSW headquarters building and nearby open space forms a new anchor for the innovation precinct

6. Waragal Birrung, Shrimptons Quarter

- Neighbourhood that is between two creeks
- Creek regeneration of Porter's Creek and increased access to Shrimpton's Creek can provide opportunities for innovation and interconnections between the University and business community
- Opportunity for cultural spaces to mix the previously separate users of Ivanhoe Estate and commercial precinct
- Link open space using natural corridors/pathways (Muru) to Ivanhoe Estate
- Publicly accessible courtyards and shared spaces
- Potential for collaboration between Optus and wider tech cohort

7. Gari Nawi, Macquarie Living Station

- High levels of metro connectivity and strategic bus routes

- Hyundai's HQ is based here providing a strong brand and identity
- Junction of Lane Cove Road and Waterloo provides views down the creek lines to the river and National Park
- Development should include the delivery of cultural spaces and activity areas which benefit from evening footfall and connectivity to metro

Language & Place naming

- Dharug Language especially relating to waterways to guide all place names for MPIP.
- Rename Macquarie Park to Wallumatta.
- Contemporary interpretive signage to expand the language of place names through story.
- Acknowledgement of Country signage on main transport facilities and arteries entering and exiting Wallumattagal Country.
- Improved metro connections to the concourse
- Safer crossings over Lane Cove Road

Wallumattagal placemaking initiatives

- Implement a digital interpretation and wayfinding strategy that integrates knowledge sharing about Country, pedestrian and cyclist signage. Wayfinding would be based upon the Songlines, trade routes, and other significant places, supported by smartphone app hosting oral recordings, music, art etc.
- Identify public space locations for Darug-led community ceremonies (consult Indigenous design team)
- Restore rivers to be swimmable by 2050
- Develop guidelines for an innovative public art program representing Wallamattagal Ngurra.
- Working with Traditional Custodians, design pathways through the open space that adheres to the natural creeklines and contours of Ngurra leading to adjacent neighbourhoods, Lane Cove National Park and safe access to water.
- Develop a hierarchy of urban/trail pedestrian thoroughfares



Figure 1.20 Wallumatta Macquarie Park Masterplan (Source: DPE, Old Ways New)

1.4.8 Macquarie Park Place Strategy Finalisation Report, NSW DPE

This finalisation report illustrates the key messages heard from the public regarding the MPIP Place Strategy and how we have responded.

State agencies:

- Transport for NSW suggests reducing parking around the metro stations.
 - Response: We will consider parking rates in the detailed precinct transport study (incorporated into Ryde DCP)
- Health NSW supports the 25% urban tree canopy target and a 2:1 tree replacement ratio
 - Refer to the Healthy Built Environment Checklist
 - Improve access to fresh, affordable food, including healthy food outlets, supermarkets, greengrocers or bubblers
 - MP could be a leading creative green space design and be an exemplar of green urbanism including living roofs and walls and solar.
- Create NSW suggests cultural and night-time components will allow people to share ideas and collaborate and inform identity
 - Voluntary planning agreements or a percent-for-art scheme will achieve cultural outcomes in MPIP.
- NSW Planning & Environment - EES
 - Requests further consultation with NSW National Parks and Wildlife Service regarding access points and funding for Lane Cove National Park infrastructure
 - Response: additional infrastructure will be required to minimise visitation impacts

Community & landowners

- 6.2 Access & Infrastructure
 - Resolve congestion
 - Prioritise walking and cycling and improve safety and amenity for pedestrians
 - incentivise developers to create innovation and creative spaces;
 - Integrate with Greater Sydney Green Grid, bike network and transport hubs
 - Separate walking and cycling infrastructure - shared paths are not suitable for high activity areas.
- 6.4 Environmental
 - Address impacts on plants and animals and pressure on Lane Cove National Park and Shrimptons Creek; prioritise biodiversity
 - New trees delivered via a community building program
 - Resilient to climate change, including flooding, net zero targets/controls, zero increase in potable water use and waste recovery.
- 6.7 Social
 - Address concerns about overcrowding and a loss of amenity
 - Plan for more schools
 - Activate the precinct with more cultural activities and improve safety

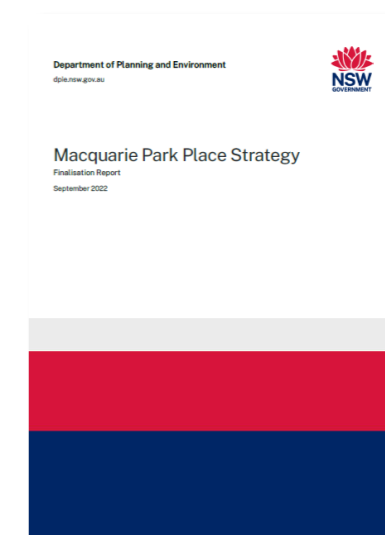


Figure 1.21 Macquarie Park Place Strategy (Source: NSW DPE)

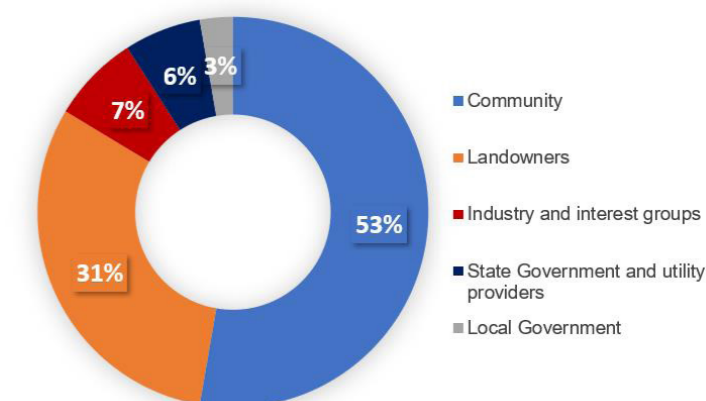


Figure 1.22 Submissions for feedback by stakeholder type (Source: NSW DPE)

1.4.9 Macquarie Park Strategic Masterplan - Integrated Transport Plan, Arup

The masterplan enables MPIP to provide strong transport connections that are vital for economic and social activity, supported with strong local and regional connectivity.

Vision and Objectives:

- Activating the centre with a new Movement and Place framework,
- Encouraging active travel (walking and cycling) and public transport use,
- Providing a safe road environment, suitable pathways, and streets that balance movement of people and goods and access with amenity of place, and
- Enhanced accessibility to/from MPIP within 30 minutes by public transport, seven days a week.”

Facilitate lower emissions transport

- EV vehicle charging stations within all neighbourhoods
- Introduce lower emissions bus fleet

Walking (masterplan specifies places/street names for implementation of below):

- Provide more signalised pedestrian / cyclist crossings
- Deliver the Fine Grain Street Network – all neighbourhoods. Will increase the number of opportunities (such as jobs, schools or restaurants) within acceptable walking distance.
- Implement lower speed limits
- Construction of pedestrian crossings on all legs of intersections
- New and upgraded paths.

Cycling

- Complete missing links in Macquarie Park’s Connected Metropolitan Cycling Network (CMCN).
- Provide a cycling link to Northern Beaches via A3.
- Deliver comprehensive network of dedicated cycle & micro-mobility connections.
- Deliver increased publicly accessible bicycle parking.
- Deliver south-facing grade separated active transport link into Riverside Business Park

Bus

- Deliver Mona Vale to Macquarie Park public transport improvements.
- Deliver Strategic Bus Corridor from Macquarie Park to Parramatta
- Additional infrastructure to support bus operations.
- Provide new and upgraded bus stops.
- Deliver the Macquarie University Bus Interchange (MUBI).
- Provide new northern and southern bus layovers.
- Deliver BPIP Stage 1 and Stage 2.



Figure 1.23 Macquarie Park Strategic Masterplan - Integrated Transport Plan (Source: Arup)

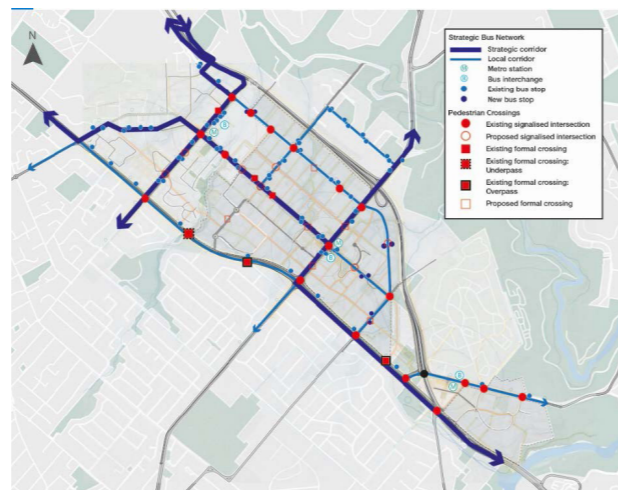


Figure 1.24 Proposed Strategic Bus Network (Source: Arup)

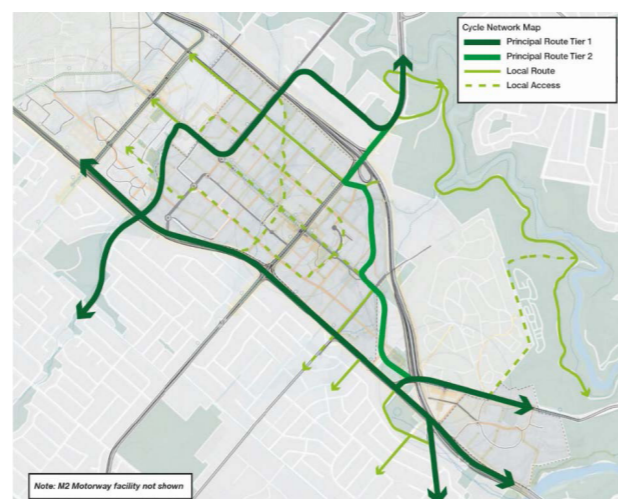


Figure 1.25 Proposed Cycle Network (Source: Arup)

1.4.10 Handbok for the Strategic Guide to planning for Natural Hazards, NSW DPE

This document help planning authorities and councils create more resilience int he community and build economic stability, protect valuvable assets, integrate environmental principles and balance these with housing an dindustry demand.

Guide aims to inform the consideration of natural hazards int he preperation of:

- Regional and district plans
- Local strategic plans and community strategic plans
- Planning proposals
- Other Strategic planning activities that relate to land use planning.

The guide Identifies eight strategic principles:

1. Be strategic, consider risks form natural hazards eraly
2. Protect vulnerable people and assets
3. Adopt an “all-hazards’ approach
4. Involve the community in conversations about risk and values
5. Consider emergency response and evacuation
6. Be information driver and evidence based
7. Plan to build and rebuild for the future with a changing climate
8. Understand the relationship between natural processes and natural hazards



Figure 1.26 handbook for Strategic Guide to Planning Natural Hazards (Source: NSW DPE)



Figure 1.27 Example of a naural hazard risk triangle (Source: NSW DPE)

1.4.11 Green Star Future Focus, Green Building Council of Australia (GBCA)

In March 2018, Green Building Council of Australia (GBCA) embarked on an ambitious journey to reshape the Green Star rating system and create the next evolution of the tools.

Green Star Future Focus will see the rating system evolve and adapt to ensure the sustainable built environment delivers what it needs to, whilst also responding to global megatrends and emerging challenges.

Implications for MPIP Structure Plan

- Amenities that enhance a person's well-being, encourage healthy and active transport and lifestyle decisions.
- Mimic or connect with nature and provide a comfortable environment.
- Conceived, built and operated to reduce or eliminate toxic materials, are well ventilated and lit.
- Ready to address the future impacts of climate change and to respond positively to other changes and shocks.
- Resilient to natural disasters and man-made impacts including changing technology and demographics.
- Resilient to long-term risks to its value.
- Minimise exposure to risks negatively impacting people's health and human rights.
- Continue working in the face of adversity.
- Make the community and surroundings more resilient too.
- Highly efficient with the use of our limited natural resources.
- Lower energy consumption thanks to smarter design.
- Renewable energy powers the buildings and infrastructure (on-site or off-site).
- Mostly fossil-fuel free and is carbon neutral by offsetting all its emissions.
- Reducing and offsetting its embodied carbon.
- Smart, well-designed, managed and governed.
- Safe, comfortable, inclusive and of high amenity.
- Improve the urban fabric, enhance the local infrastructure, and provide value to the community.
- Designed for everyone, beyond accessibility compliance laws.
- Designed to respect and celebrate our culture and our history.
- Built with consideration of the rights of future occupants, the workers involved, those involved in the supply chain, and those in the surrounding community.
- considerate of the current and historic impacts to our natural environment.
- Reduce any impact on the site and enhance it as much as possible.
- Contribute to increasing the ecological value and biodiversity of the site and beyond.
- Connect green corridors in the city and work to enhance a city's biodiversity.



Figure 1.28 Green Star Future Focus (Source: GBCA)

1.4.12 Green Star for Communities: A Future Focus Discussion Paper, Green Building Council of Australia (GBCA)

Green Star Communities aims to continue the success of Green Star on a precinct scale.

It aims to provide a clearer definition of a sustainable precinct, as well as set a pathway for net zero precincts to be delivered over the next decade. Green Star Communities:

- Introduces a new set of categories and credits reflecting issues relevant to the market now and in the future
- Prioritises the elimination of carbon emissions from the built environment
- Considers impacts at a precinct and building level
- Establishes a clear, well-defined entry point for best practice precincts
- Caters to distinct sectors through the introduction of sector specific credit

Implications for MPIP Structure Plan

- A new definition of a community
- A broader scope of issues with a clearer and more accessible language.
- All projects to deliver carbon reductions.
- Exploring the goal of net zero emissions precincts by 2030.
- Including a focus on buildings.
- The rating tool will place greater weight on the sustainability of built form, whilst acknowledging diverse levels of control across precinct types.
- Ensuring that all projects deliver a minimum set of clearly defined outcomes that align with what stakeholders are wanting in a sustainable precinct, in the short and long term.
- Higher levels of sustainability leadership, with the recalibration of requirements for 4,5 and 6 star.
- More consistent categories and language across all rating tools -to maximise how tools may work together, reduce documentation, and increase understanding of the benefits.



Figure 1.29 Green Star for Communities: A Future Focus Discussion Paper (Source: GBCA)

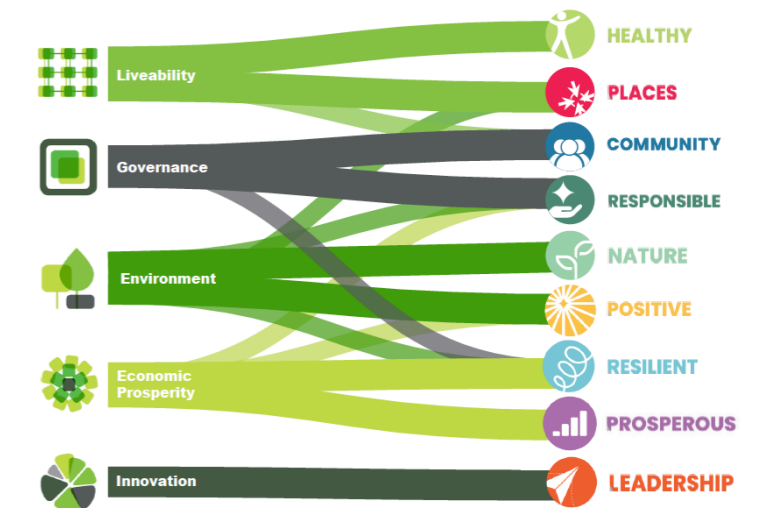


Figure 1.30 Alignment of old to new categories (Source: GBCA)

1.4.13 Climate Positive Roadmap for Precincts, Green Building Council of Australia (GBCA)

The Climate Positive Roadmap for Precincts contains a set of principles to guide precinct carbon reductions and ambitious targets for all new precincts to be climate positive by 2030 and existing precincts by 2050.

It spells out the five key actions to achieve climate positive precincts:

1. Embed climate positive pathways into all stages of planning.
2. Commit to fossil fuel-free precincts, and ensure policy and planning processes support this ambition.
3. Remove the barriers to low carbon precinct energy solutions.
4. Drive lower upfront carbon in materials and construction activity.
5. Commit to delivering low carbon buildings in all precincts.

Implications for MPIP Structure Plan

- Building & precinct scale energy generation and storage.
- Electric vehicle optimisation for transport, solar energy capture and building consumption.
- Intelligent microgrids and virtual power plants balancing energy supply and demand.
- Precinct scale energy trading supported by networked metering and retail platforms.
- Offsite power purchase agreements for renewable energy.
- Capture of waste heat and coolth for re-use.

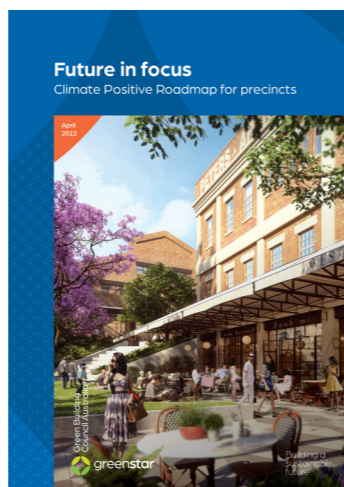


Figure 1.31 Climate Positive Roadmap for Precincts (Source: GBCA)

Actions for government

1. Understand the cumulative carbon impacts of sustainable precinct development and develop frameworks for tracking their contribution to city and state carbon reduction targets
2. On high priority precincts, provide the vision, clear governance frameworks for the design, approvals, and curation of the development following climate positive principles.
3. Position government land organisations (GLOs) as leaders on climate positive precincts; trialling new innovations and partnerships
4. Ensure all lessons are captured from government projects, and shared with industry stakeholders.
5. Set zero carbon targets for all government delivered/operated social and transport infrastructure
6. Ensure conversations with utility network planners addresses the need to support for innovative precinct energy solutions
7. Plan and deliver sustainable forms of transport earlier in development areas, and prioritise the adoption of electric vehicles and supporting charging infrastructure
8. Develop residential and business grant schemes to support the transition to all electric existing buildings.
9. Develop plans to transition all infrastructure in the public domain to efficient, all electric and powered by renewables (e.g. street and open space lighting, maintenance facilities).
10. Integrate climate positive principles into priority neighbourhood renewal strategies and explore how this can be delivered through statutory planning, education and behaviour change, and the upgrade of public spaces.

Figure 1.32 Actions for government to deliver climate positive precincts (Source: GBCA)

1.4.14 Green Star Buildings v1, Green Building Council of Australia (GBCA)

The latest version of the Green Star Buildings rating tool is the first to be aligned with the new focus areas aligned with megatrends.

Some key insights we think will translate over to the newest version of the Green Star Communities tool:

Implications for MPIP Structure Plan

- 10 Minimum Expectations that must be achieved by all projects
- 6 Star rated projects must be designed to be fossil fuel free, powered by renewables, and built with low carbon materials
- Rewards products that have lower environmental impact, are transparent, respect human rights, and are lower in carbon content
- Creating a driver for low carbon products by introducing a requirement that must be met by all buildings to reduce their embodied carbon to achieve a rating
- Climate Positive Pathway will increase in stringency over time.

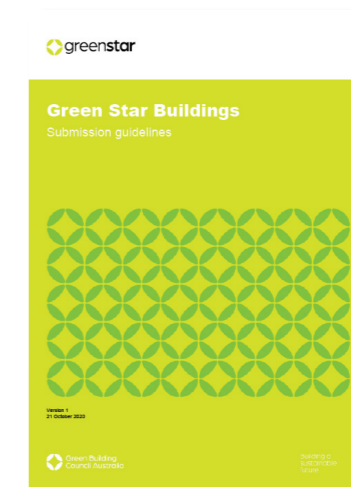


Figure 1.33 Green Star Buildings v1 (Source: GBCA)



Figure 1.34 Green Star Buildings v1 categories (Source: GBCA)

Credits	Criteria	2020*	2023*	2026*	2030**
Energy source	Renewable electricity	6 star	5 star	All registrations	All certifications
	Renewable energy	6 star	5 star	All registrations	All certifications
Energy use Reductions over typical building	10% reduction	All registrations			All certifications
	20% reduction	6 star	5 star	All registrations	All certifications
	30% reduction				
Upfront carbon emissions Reductions over a typical building	10% reduction	All registrations			All certifications
	20% reduction	6 star	5 star	All registrations	All certifications
	40% reduction			6 star	All certifications
Other carbon emissions Scope 1 eliminated or offset (refrigerants and fossil fuels) All remaining emissions offset (embodied carbon and other under control)		6 star	5 star	All registrations	All certifications
			6 star	5 star	All certifications***

* Denotes year of registration
** Denotes year of completion
*** under consideration

Figure 1.35 Increasing stringency of Climate Positive Pathway over time (Source: GBCA)

1.4.15 Future of NABERS Energy (FoNE) Consultation Paper, NSW Government

Over the past decade, the property and energy markets have gone through several transformations, such as the decarbonisation of the grid and the rise in net zero emissions targets.

The Future of NABERS Energy project seeks to adapt NABERS Energy to these trends. NABERS has developed proposals in consultation with a Technical Working Group and the NABERS National Steering Committee, and is now inviting stakeholders to provide feedback.

Key topics in this consultation paper include:

- Update to the emissions factors used in NABERS
- Recognition for net zero emissions
- Enhanced recognition for renewable energy purchases
- Aligning to the Greenhouse Gas Protocol's market-based carbon accounting method
- Renewable energy purchasing

Implications for MPIP Structure Plan

- Current average NABERS Energy ratings for 100% electric buildings in NSW is ~4 Star.
- Average NABERS Energy rating for 100% electric building in NSW based on predicted future National Greenhouse Accounts (NGA) emissions factors will be ~4 Star.
- Lower emissions fuel choices will continue to be rewarded in ratings.
- Over the past year, various Property Council Australia (PCA) members and Technical Working Group (TWG) members have requested that NABERS consider introducing a net zero emissions recognition for existing buildings, that could be conducted alongside a NABERS Energy rating.
- NABERS proposes to recognise buildings that are energy efficient and run on 100% renewable energy with a NABERS Net Zero Emissions certification.
- The proposed NABERS Net Zero Emissions certification would be equivalent to the 7th star of NABERS Energy with GreenPower.
- The NABERS Net Zero Emissions certification would be different to Carbon Neutral in two ways:
 - The scope of NABERS Energy rating tools only includes energy consumed for the operation of the buildings: electricity and onsite fuels (typically gas and diesel). Therefore, the NABERS Net Zero Emissions certification would only include stationary energy.
 - Renewable energy would be the only method to achieve the NABERS Net Zero Emissions certification (as NABERS does not allow the use of carbon offsets).
- NABERS proposes to update the NABERS Energy with GreenPower tool to align with the market-based carbon accounting method.

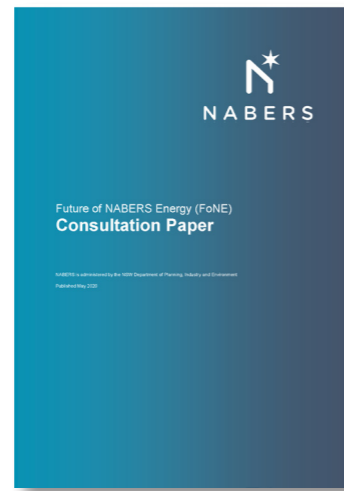


Figure 1.36 Future of NABERS Energy (FoNE) Consultation Paper (Source: NSW Government)

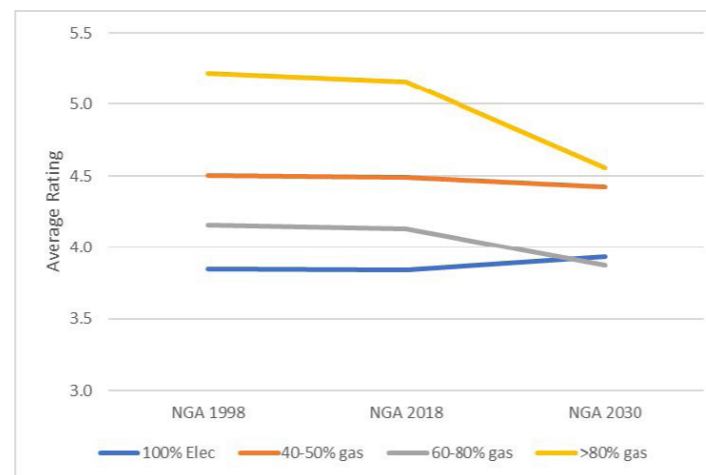


Figure 1.37 Average NABERS Energy for office base building ratings with updated NGA factor NSW/ACT (Source: NSW Government)

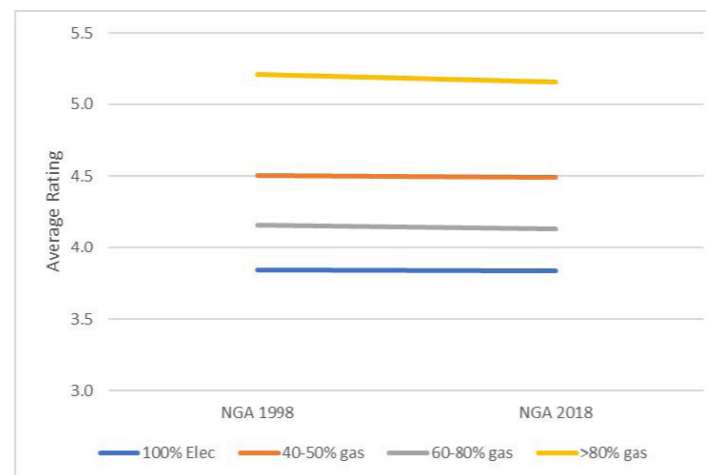


Figure 1.38 Average NABERS Energy for office base building ratings with predicted 2030 NGA factor NSW/ACT (Source: NSW Government)

1.4.16 Embodied Emissions Consultation Paper, NSW Government

Australia currently has no consistent method of measurement for embodied emissions. Over 12 months, NABERS has worked in partnership with the GBCA and collaborated with industry and governments across Australia to understand the appetite for a standard for embodied emissions and the role of NABERS in administering that standard.

In developing this consultation paper NABERS has engaged with 207 individuals from 139 organisations across 38 workshops. The feedback from industry told us that NABERS has a clear role to play in accelerating efforts to reduce embodied emissions in Australia's commercial building stock.

NABERS has published a consultation paper containing 10 proposals for feedback covering five topic areas:

- Scope of the tool
- Calculation method
- Benchmarking
- Certification Process
- Future Development

The 10 proposals outline how a rating tool, which we are tentatively calling the NABERS Embodied Emissions tool, would measure, verify and compare embodied emissions in new buildings and major refurbishments.

Implications for MPIP Structure Plan

- Embodied emissions are an emerging focus for the property sector.
- There is no single accepted approach to calculating embodied emissions from buildings in Australia or globally.
- NABERS will provide an industry standard method for measuring embodied carbon.
- This will be tied to existing NABERS tools which are well understood by industry, and used by Government.
- It will provide consent authorities and developers a method for assuring and certifying true whole of life net zero.
- GBCA will recognise the NABERS Embodied Emissions tool as a verification pathway in the current 'Upfront carbon emissions' credit of future versions of the Green Star Buildings rating tool.
- Stakeholders recognised that, as the grid becomes less reliant on fossil fuels, operational emissions will fall and this will elevate the issue of embodied emissions.
- Stakeholders acknowledged that interest in measuring and reducing embodied emissions is increasing across all segments of the property sector, driven by influencers such as investors, developers, builders, suppliers and policy makers.

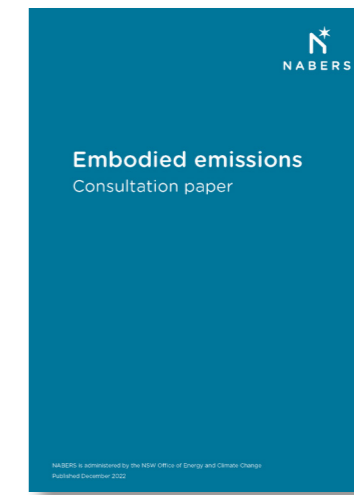


Figure 1.39 Embodied Emissions Consultation Paper (Source: NSW Government)

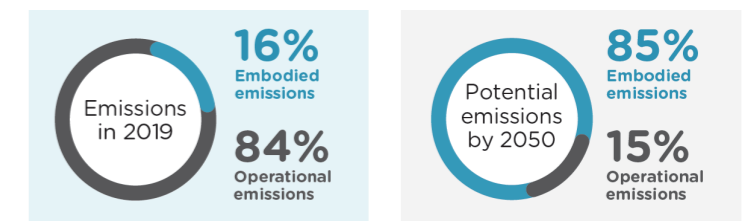


Figure 1.40 Comparison of embodied emissions and operational emissions in 2019 and forecast for 2050 (Source: NSW Government)

1.4.17 Climate Active, Australian Government

The Climate Active Carbon Neutral Standard is a voluntary standard to manage greenhouse gas emissions and to achieve carbon neutrality, and is the only government accredited carbon neutral certification scheme in Australia.

Climate Active is a world-leading, government-backed certification that is aligned to national and international greenhouse gas accounting protocols, focused on operational carbon emissions at present, with a probable future focus on upfront carbon as well.

It provides best-practice guidance on how to measure, reduce, offset, validate and report emissions that occur as a result of the operations of a precinct.

Climate Active certification is available for :

- **Organisations** (Certification that the business operations of an organisation have resulted in a state of carbon neutrality)
- **Products** (Certification that a product being created, used and disposed has resulted in a state of carbon neutrality)
- **Services** (Certification that the provision of a service has resulted in a state of carbon neutrality)
- **Events** (Certification that the activities associated with running an event have resulted in a state of carbon neutrality)
- **Buildings** (Certification that the operations of a building have resulted in a state of carbon neutrality)
- **Precincts** (Certification that the operations of a precinct have resulted in a state of carbon neutrality)

Implications for MPIP Structure Plan

- Climate Active certification represents the Gold Standard for carbon neutral certification in Australia.
- Building certification is available through the National Australian Built Environment Rating System (NABERS) or the Green Building Council of Australia (GBCA).
- Climate Active certification sends a clear signal that organisations are serious about addressing climate change and committed to sustainability, innovation, and industry leadership.
- It provides an edge over competitors and taps into an increasing number of consumers driving the market for sustainable and ethical products and services.



Figure 1.41 Climate Active Carbon Neutral Standards for Precincts and Buildings (Source: Australia Government)

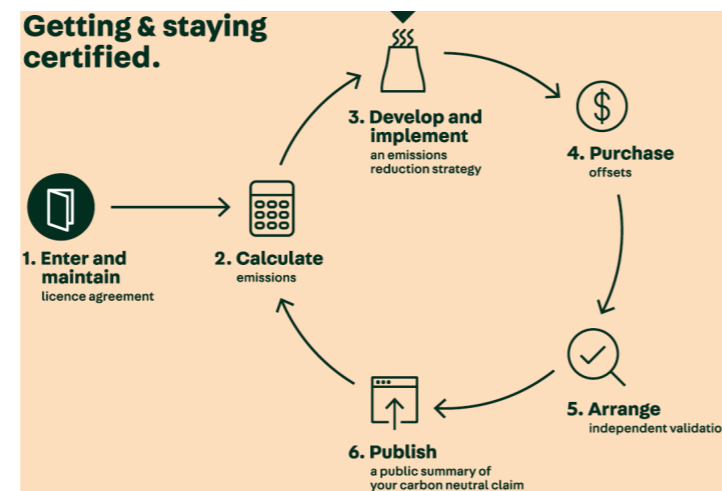


Figure 1.42 Applying for and maintaining carbon neutral certification (Source: Australian Government)

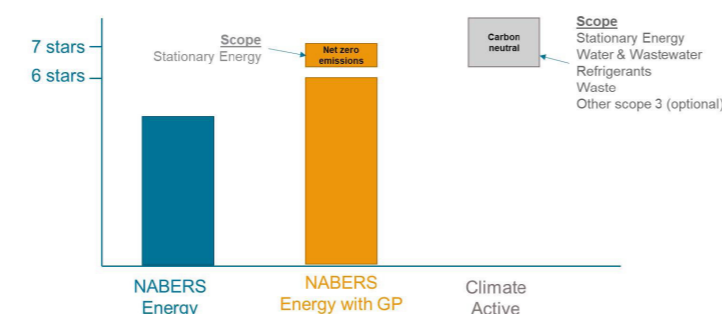


Figure 1.43 Difference between the NABERS Energy ratings tools and Climate Active Carbon Neutral certification for buildings (Source: NSW Government)

1.4.18 WELL Standard, International WELL Building Institute (IWBI)

The WELL rating system follows performance-based criteria that measure, monitor and certify parts of the built environment that have an innate impact on wellbeing and health of humans.

Its aim is to help prevent chronic diseases by using the built environment through the improvement of nutrition, mood, fitness, sleep patterns and performance of its occupants. It assesses how “healthy” a building is across 10 categories: air, water, nourishment, light, movement, thermal comfort, sound, materials, mind and community.

Implications for MPIP Structure Plan

- The COVID-19 pandemic had led to a rapid uptake of health, safety and well-being considerations in buildings, communities and organisations.
- Australia leads the market with about 25 per cent of commercial office space now WELL-enrolled, largely spurred by workplaces wanting to support a return to the workplace.
- The biggest momentum has come from the large real estate owners, which then influences the rest of the market.
- There is growing global awareness that by creating healthier buildings and a culture that prioritises human well-being, employers will benefit from a healthier, more productive workforce and building owners and property investors gain a higher-valued asset.
- There is growing demand from tenants for health-focused buildings.
- The existence and popularity of a health and wellbeing focused third party rating system in the marketplace demonstrates the enthusiasm from investors, tenants, and the public for places that contribute positive health outcomes.
- The rate of adoption both locally and globally demonstrates recognition that the Standard, its evidence-base, and its future pathway represents an authoritative exemplar of healthy places.



Figure 1.44 WELL Building Standard (Source: IWBI)



Figure 1.45 WELL Community Standard (Source: IWBI)

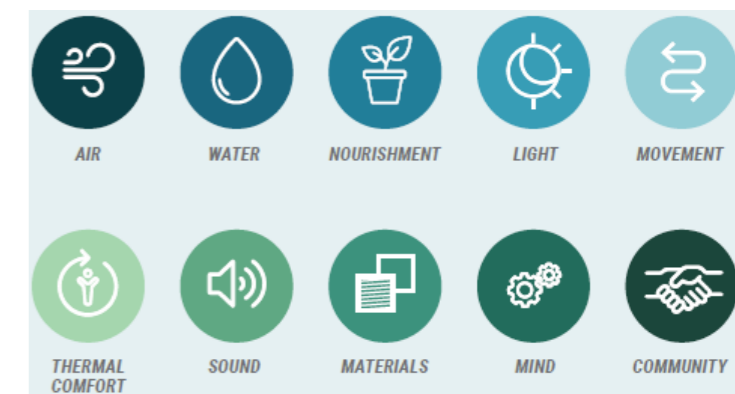


Figure 1.46 10 WELL concepts (Source: IWBI)

1.4.19 Creating Great Australian Cities, Property Council of Australia

The Property Council has commissioned this project to stimulate debate about the future of our cities, to improve public understanding of the issues at stake, and to help governments make good decisions for the future.

This report examines what is required to create great Australian cities. It provides an 'outside in' perspective based on our analysis of city megatrends, new research into global benchmarks, international case studies and the distinctive underlying issues present in Australian cities.

This research identified ten megatrends that will shape Australia's cities for decades to come:

- Urbanisation and metropolitan growth
- Aging population
- Exponential technology change
- Globalisation of trade, supply and value chains
- Intensifying climate change
- Re-urbanisation of jobs and capital
- Economic transition and the rise of the innovation economy
- The rise of Asia
- Resource scarcity and energy convergence
- Rising infrastructure and governance gaps

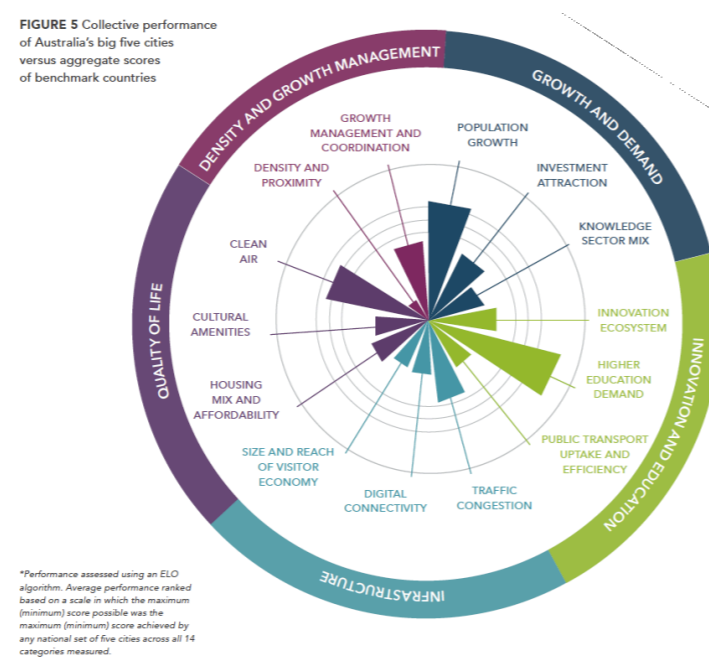
Implications for MPIP Structure Plan

- A consistent high rate of infrastructure investment and infrastructure finance innovation
- Use of public land, anchors and assets to strategic goals allows cities to unlock new areas of opportunity, catalyse new development processes, and adjust to new economic and social trends.
- A high quality of placemaking, place management and tactical urbanism
- Master-planning and pooled public budgets for neighbourhoods and areas
- Growing political divides between educated 'anywheres' and rooted 'somewheres'.
- Spiralling climate, pollution and health threats result in much more frequent extreme weather.
- Governments, companies and societies will be forced to create more capacity to combat challenges, but stronger planetary pushback may exacerbate existing concerns and create new ones.
- More cities become exposed by failures to integrate climate change with public health, co-ordinate among local governments, and support the most vulnerable groups.
- New weather patterns and extreme events incur immediate costs and long-term effects on productivity, tourism and reputation associated with damaged natural assets.
- Reduced investor appeal if resilience against unexpected events is not improved.
- Spikes of migration from other climate-affected regions.



Figure 1.47 Creating Great Australian Cities (Source: Property Council of Australia)

FIGURE 5 Collective performance of Australia's big five cities versus aggregate scores of benchmark countries



*Performance assessed using an ELO algorithm. Average performance ranked based on a scale in which the maximum (minimum) score possible was the maximum (minimum) score achieved by any national set of five cities across all 14 categories measured.

Figure 1.48 t

1.4.20 Creating Great Australian Cities: Insights for Sydney, Property Council of Australia

The report sets out a further 12 broad recommendations designed to equip Australian cities for the future. The Property Council has distilled these into 3 key actions for Sydney.

When evaluated against more than 300 benchmarks to assess relative performance, Sydney is an established member of the second tier of 'contender' cities, in a peer group with cities such as San Francisco, Boston, Toronto and Madrid. Sydney's success, as evidenced by global benchmarks and the mix of its global functions, means it is now a 'contender' among the established group of global cities.

For Sydney, the 'outside-in' analysis against the comparable cities revealed that:

- Sydney's industry profile is globally facing, comparable to Toronto and Stockholm, but there is room to grow and diversify the knowledge economy to the likes for San Francisco
- Sydney is very prominent in global benchmarks relative to its size and economic role
- Sydney is ranked in the bottom third of cities globally for peak period congestion
- Sydney is one of the most unaffordable metropolitan markets in the world, substantially more expensive than nearly all North American and European metros.

Implications for MPIP Structure Plan

- Higher than average congestion
- Lower than average public transport coverage
- Growing commute distances
- Lengthening commute times and journey times
- Low digital/internet speeds
- High carbon intensity of infrastructure systems
- Relatively low density urban forms leading to lower public transport suitability.



Figure 1.49 Creating Great Australian Cities: Insights for Sydney (Source: Property Council of Australia)

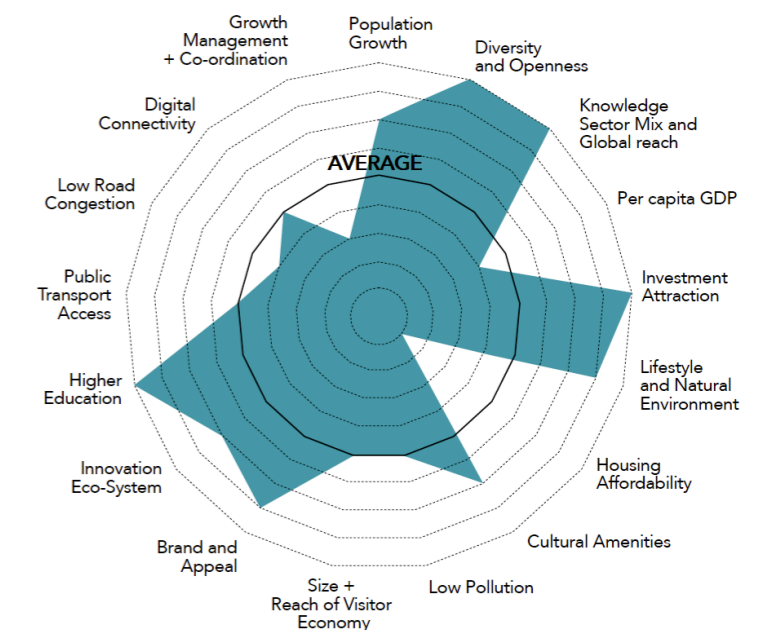


Figure 1.50 Performance of Sydney versus aggregate scores of benchmark countries (Source: Property Council of Australia)

1.4.21 A Common Language for Social Sustainability, Property Council of Australia

A common language for social sustainability, launched by the Property Council in 2018, sparked a new industry conversation about the S in environmental, social and governance.

The handbook, A common language for social sustainability, provides definitions and context of social sustainability and the 17 Sustainable Development Goals.

The handbook covers five key areas and uses examples to explain how social sustainability applies to:

- Culture and community
- Health and wellbeing
- Mobility and access
- Equity and fair trade
- Economic outcomes

Implications for MPIP Structure Plan

- Contributing to ‘closing the gap,’ reconciliation, and Indigenous inclusion are critical success factors.
- Community engagement, investment, and partnership is key to generating buy in, shared value, and long-term success.
- Diversity of race, ethnicity, gender, sexual orientation, socio-economic status, work experience, educational background, marital or parental status, income, age, physical abilities, geographical location, religious beliefs, political beliefs or other ideologies throughout operations is necessary.
- Placemaking reveals and responds to the location, culture and people that gives each place its unique value and authentic qualities.
- The capacity of communities and their members to survive, adapt and grow, regardless of the chronic stresses and acute shocks imposed by the economy or natural environment needs more focus.
- Health and wellbeing needs to be viewed as a state of “complete physical, mental and social wellbeing and not merely the absence of disease of infirmity”, as defined by the World Health Organisation.
- The key components that influence the health, comfort and wellbeing of building occupants. IEQ is determined by many factors, including air quality, lighting and views, acoustic and thermal comfort, radiation, décor, amenity, layout and ergonomics.
- Liveability is important and broad, encompassing: the built and natural environments; economic prosperity and affordability; social diversity, stability and equity; educational opportunity; cultural, entertainment and recreation. Other factors influencing community liveability include: amenities; connection or sense of belonging; sense of safety; education provision; support for personal health; resilience and citizenship.
- The goal of accessibility is to create an inclusive society for all people, regardless of their physical, mobility, visual, auditory or cognitive abilities.
- Equal access to community resources and opportunities. No individuals or groups of people should be asked to carry a greater social or environmental burden than the rest of the community.



Figure 1.51 A Common Language for Social Sustainability (Source: Property Council of Australia)

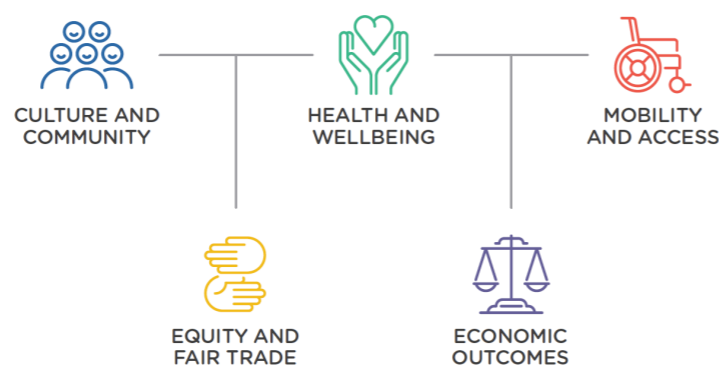


Figure 1.52 Social sustainability themes (Source: Property Council of Australia)

1.4.22 Health & Well-being in Real Estate, Green Health Partnership and GRESB

This report summarises outcomes from a multi-year collaboration between the Green Health Partnership and GRESB to provide real estate companies and investors with actionable information on health and well-being within ESG (environment, social, governance) reporting.

Health and well-being are emerging as a global leadership and market differentiation opportunity for property companies and funds around the world. Forward-looking real estate companies and investors incorporate environmental, social and governance (ESG) considerations into business operations. While human health and wellbeing is an implicit component of ESG, it is now becoming an intentional and increasingly institutionalised focus across the entire real estate industry.

Implications for MPIP Structure Plan

- High performing employees – present, healthy, engaged – are prepared to support high performing companies.
- An explicit focus on health and well-being helps fund managers maximise the potential value of real estate assets and services and mitigate associated risks.
- Engaged investors ask about efforts to promote health through real estate fund management and development.
- Top performing companies implement holistic processes that influence asset design, construction and operation to promote health and well-being among employees, tenants and communities. Engaged investors ask about the purpose and scope of an organization’s health efforts.
- Engaged investors ask organisations about the quality of health strategies management and request information about results.
- Engaged investors ask organisations about the presence or state of development of fundamental health promotion processes, including leadership, policy, needs assessment, business strategy and performance measurement.
- Companies should ensure that health and well-being are explicit components of business strategies.
- Increase utilisation of secondary data while working to increase the availability of primary data.
- Leading companies are implementing a variety of actions, simultaneously including those related to asset design, operation and programming as well as actions to benefit the communities surrounding assets.
- Many GRESB participants use third party building certifications to take action to promote health and well-being for tenants and customers (WELL or Fitwel).



Figure 1.53 Health & Well-being in Real Estate (Source: Green Health Partnership and GRESB)

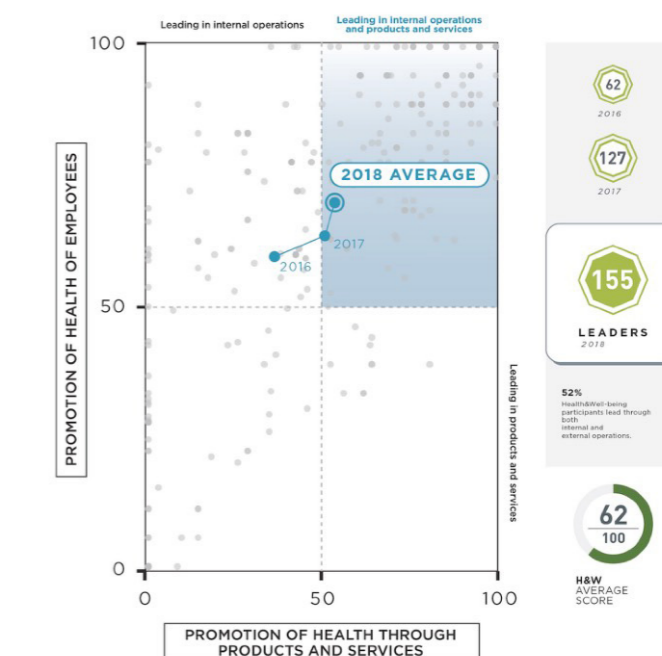


Figure 1.54 Average GRESB Health & Well-being score (Source: Green Health Partnership; and GRESB)

1.5 Development environment

Equally important to policy and planning is the industry context in which the project will be delivered.

1.5.1 Industry

Beyond statutory requirements the property and real estate industries, along with NGOs have begun to set their own (often more ambitious) objectives for future investment.

Here we explore meta-trends identified by industry groups and recommendations for their members to achieve economically attractive and resilient real estate assets.

1.5.2 Rating tools

Additionally, a valuable sustainability assurance mechanism used by industry are third-party rating tools. Many local and international tools have recently been updated or are currently in the process of doing so. These updates are designed to better incorporate changes in industry preferences, clearer climate goals, and post-COVID responses.

These provide insights into future directions for sustainable property development in Australia over the coming decade.

Refer to Section 3 for further detailed policy context and supporting documents review.



1.5.3 Unleashing Sydney's innovation Economy

Sydney currently faces an opportunity to drive innovation to emerge economically strong with world-changing ideas.

The recommendations in the report are summarised into five ideas:

6. Invest government dollars in important R&D efforts.
7. Make it easy to start new companies and create good jobs.
8. Make Sydney's underlying economic systems more efficient.
9. Make it easy for talented people to come and stay in Sydney.
10. Give Sydneysiders the skills they need to be successful

Implications for MPIP Structure Plan

- A shared goal to actually drive collaboration is required
- Support a strong governance model that supports collaboration
- Encourage collaboration from major anchor tenants – a major, established international firm and a university with research expertise in the relevant area,
- Support University-led research tethered to the hub
- Implement shared-use facilities to support local firms and researchers
- Create an ecosystem of start-ups and SMEs operating within the precinct, supported by incubators/hubs
- Link a precinct with a specific problem and goal, aligned with a CSIRO National Mission – with government funding to drive research
- Provide affordable and non-market housing
- Make Sydney a vibrant, cultural city by: improving the night-time economy; funding the cultural sector to improve Sydney's
- Global cultural standing; promoting the existing diverse, multicultural culture across Sydney.
- Encouraging high-density, well-connected communities;
- Mitigate and adapt to climate change to protect Sydney from heat, sea-level rises and natural disasters



Figure 1.55 Unleashing Sydney's Innovation Economy (Source: Committee for Sydney)

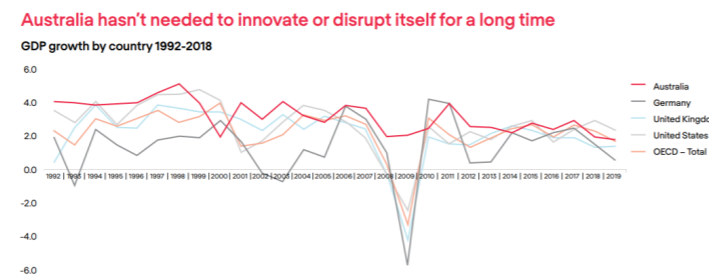


Figure 1.56 GDP growth by country compared to Australia 1992-2018 (Source: Committee for Sydney)

1.5.4 Decarbonising Sydney, Committee for Sydney

This report considers further actions to prepare Sydney for a decarbonised economy, building on the expected successful delivery of emissions reductions in the NSW Electricity Infrastructure Roadmap.

It identified five key moves to put Sydney on track for net zero:

1. Electrify Sydney's road transport with 40% sustainable transport by 2030; fuel emissions standards for cars and trucks; and a date to shift all car sales to electric, and all truck sales to battery or hydrogen
2. More sustainable buildings with electric space heating, water heating and cooking, gas phased out in new buildings, and residential energy performance disclosure
3. Increase distributed energy with incentives for rooftop solar, battery storage and smart meters, and better access for low-income groups, renters and others
4. Prepare the energy grid with innovative tariffs and demand management measures to reward customer behaviour, and vehicle to grid technology
5. Work collaboratively across Greater Sydney to track and manage progress to emissions goals, and accelerate coal closures to make up the deficit if needed.

Implications for MPIP Structure Plan

- Increase EV charging infrastructure in the public domain and in private developments of all types.
- Supporting retrofitting of EV infrastructure in existing buildings.
- Ban on new residential and commercial gas connections.
- Strengthen building codes and guidelines for focus on passive heating and cooling – and reduce reliance on electricity where possible.
- Update planning instruments (e.g. Exempt and Complying Development, DCP and LEP) to encourage electrification of buildings including provision of incentives.
- Use incentives to accelerate the uptake of rooftop solar and distributed battery storage,
- Support access to community-scale batteries for lowrise commercial or public buildings, which would also help lower income households access solar

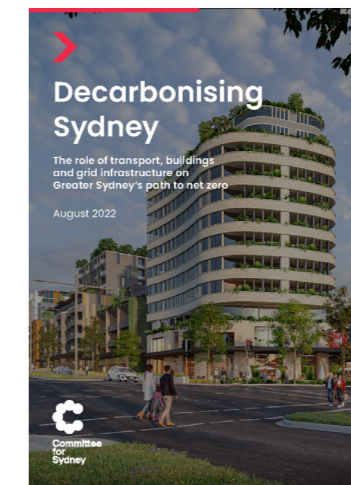


Figure 1.57 Decarbonising Sydney (Source: Committee for Sydney)

Chart 8: Electrification of household energy use could reduce household energy costs ~\$1900 per year by 2050, a 45% reduction from 2020

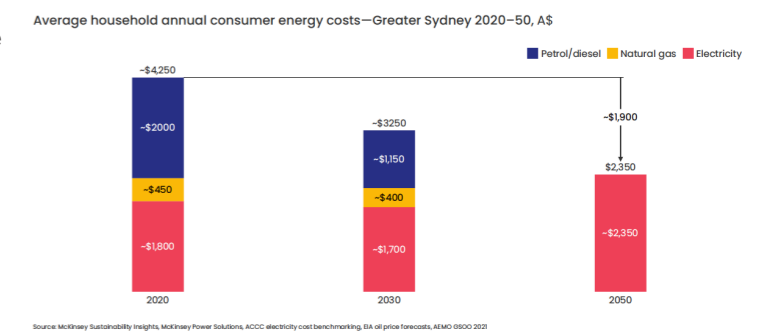


Figure 1.58 Average household annual consumer energy costs—Greater Sydney 2020–50, A\$ (Source: Committee for Sydney)

Chart 9: Decarbonisation technologies could reduce consumer energy costs by ~80% to <\$1,000, from ~\$4,250 today

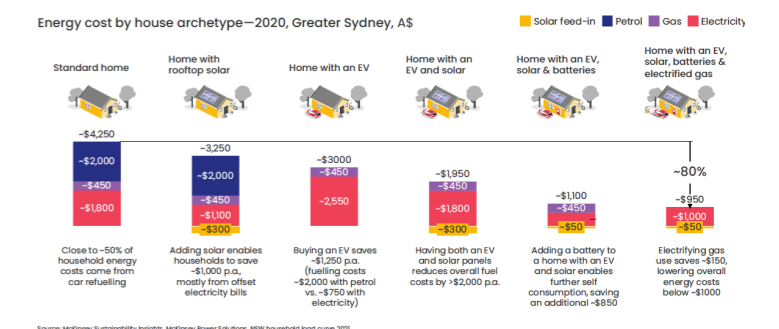


Figure 1.59 Energy cost by house archetype—2020, Greater Sydney, A\$ (Source: Committee for Sydney)

1.5.5 Unlocking the pathway: Why electrification is the key to net zero building, Australian Sustainable Built Environment Council (ASBEC)

A report from the Australian Sustainable Built Environment Council (ASBEC) confirms 100% electrification is the lowest cost, fastest emissions reduction pathway for Australia’s built environment.

SPR modelled three ‘plausible but divergent’ decarbonisation scenarios: 100% electrification; a combination of electrification and green hydrogen; and a ‘base case’, representing ‘business as usual’ of electrification, fossil gas, green hydrogen and carbon offsets.

This report finds 100% electrification is the lowest cost option to decarbonise our built environment – but lowest cost does not mean no cost. Our detailed analysis by building type, geography and lifecycle reveals that electrification, while necessary, is not always cost-beneficial. Failing to acknowledge and address these costs will significantly impede the transition to net zero building operations.

Implications for MPIP Structure Plan

- Energy efficiency matters to the electrification agenda. A wealth of literature supports a “fabric first” approach to energy efficiency, in which the building does the hard work rather than bolt on energy devices.
- Improvements to energy efficiency can decrease the space requirements and size of equipment, minimise the need for purchased energy, and enable a higher share of operational costs to be covered by rooftop photovoltaics.
- The building sector cannot rely on offsets in the future, as these will need to be allocated to sectors that are harder to abate in other words, those industries that don’t have the decarbonisation solutions readily available.



Figure 1.60 Unlocking the pathway: Why electrification is the key to net zero building (Source: ASBEC)



Figure 1.61 Projected future costs of naturebased offsets in Australia (Source: ASBEC)

1.5.6 Rapid and Least Cost Decarbonisation of Building Operations, Australian Sustainable Built Environment Council (ASBEC)

The “Rapid and Least Cost Decarbonisation of Building Operations” project which encompasses new and existing, commercial and residential buildings examines the lowest cost pathways to decarbonise building operations aligned with a net zero by 2050 target.

Specifically, the final report is intended to provide:

- A detailed inventory of operational emissions (scope 1 and scope 2) in residential and commercial buildings
- A detailed characterisation of decarbonisation options available to building owners, and the internal costs, benefits and barriers associated with each option
- Modelling which considers the likely take up of decarbonisation options in at least three divergent scenarios for decarbonisation of fuel sources (including electricity, gas, biofuels and hydrogen)
- Analysis of implications for industry and government.

Implications for MPIP Structure Plan

- Solar and battery storage technologies, and the new business models that they enable, are disrupting traditional energy supply models but also creating significant value for consumers.
- Power Purchase Agreements (PPAs) allow customers to hedge electricity price risks at the same time as ensuring their consumption is fully supplied by renewable energy sources. They also enable building owners to choose a fully electric solution while achieving zero operational emissions immediately, ahead of full grid decarbonisation.
- Solar energy systems, batteries, and demand management require long term investments, but returns are highly susceptible to short term changes in tariffs and regulatory settings.
- The electrification of the transport sector, now underway around the world albeit more slowly in Australia will shift much of the transport energy demand to the built environment, with many electric vehicle (EV) drivers and fleets recharging their vehicles at home or at work, adding to building loads.
- EVs offer the facility of being ‘batteries on wheels’, with vehicle to load (VTL) possibilities, along with smart chargers, enhancing grid stability.



Figure 1.62 Rapid and Least Cost Decarbonisation of Building Operations (Source: ASBEC)

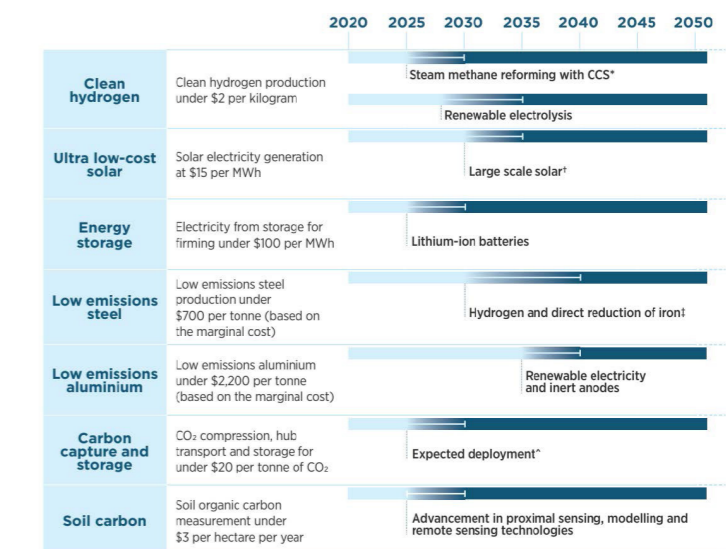


Figure 1.63 The Australian Government’s Long Term Emissions Reductions Plan (Source: ASBEC)

1.5.7 Five ways the built environment can help Australia transition to a net zero future, Australian Sustainable Built Environment Council (ASBEC)

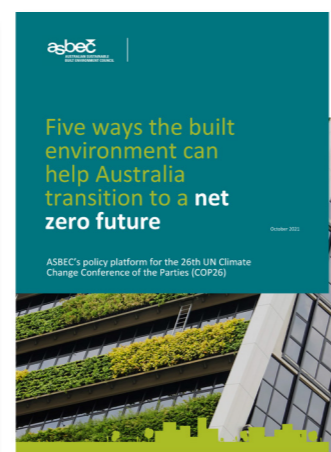
The Australian Sustainable Built Environment Council (ASBEC), as the peak body of key organisations committed to a sustainable, productive, resilient built environment in Australia, urges the federal government to seize the unique opportunity the built environment offers to dramatically reduce carbon emissions in highly cost-effective ways that will also stimulate the economy.

In this policy platform for COP26, ASBEC recommends five practical policies across residential, commercial and public buildings that should be implemented by federal government to drive emissions reduction:

1. Give households the energy performance information they need to achieve healthy, affordable, comfortable homes
2. Demonstrate government leadership through high performing government buildings
3. Position Australia as a global leader in high performance building products and technologies
4. Provide economic stimulus by incentivising building upgrades
5. Deliver a Net Zero Carbon Ready building code and pathways to decarbonise building operations

Implications for MPIP Structure Plan

- Support beyond code energy efficiency standards.
- Publicise consistent, easily-understood information about home energy performance.
- Prioritise passive design strategies to maximise energy efficiency.
- Implement a best practice governance model based on NABERS that brings governments together with industry to collectively manage energy performance benchmarks for homes.
- Assertive action is needed to raise the energy performance of new buildings and incentivise investment in existing building upgrades.
- Measures could include strong minimum standards for new buildings and fitouts, targets for onsite energy efficiency and requirements around renewable energy, offsite renewable energy and offsets.
- Promote the adoption of building sustainability rating systems such as Green Star and NABERS to drive sustainable outcomes.
- Review of existing accommodation and leasing policy presents an opportunity for leadership in the transition towards net zero buildings.
- High performance glazing and heat recovery ventilation systems.
- Building and precinct level batteries.
- Thermal or battery energy storage at the building level to support local energy generation.
- Using electric vehicles and building and precinct level batteries to provide distributed energy storage, flatten energy demand and reduce the impact of peak events.
- 10% reduction in embodied emissions in new commercial and residential buildings.
- Incentivise deep retrofits to improve performance.



1.5.8 Issues Paper: Reshaping Infrastructure for a net zero emissions future, Infrastructure Sustainability Council of Australia (ISCA), ClimateWorks Australia, and the Australian Sustainable Built Environment Council (ASBEC)

The *Issues Paper: Reshaping Infrastructure for a net zero emissions future* is designed to progress a new conversation to better understand the challenges and opportunities in reshaping transport, energy, water, communications and waste infrastructure for a net zero emissions world.

It is the first step in a broader effort to reshape Australia's infrastructure agenda and makes the case for why emissions reductions should be prioritised in infrastructure advice and decisions today.

Implications for MPIP Structure Plan

- Planning for sector transitions to net zero emissions (e.g. in electricity and transport), and identifying strategic infrastructure needs and priorities to enable these transitions.
- Examining proposed needs, issues and opportunities for compatibility with a broad set of scenarios achieving net zero emissions by 2050.
- Designing adaptive strategies, where required, to ensure solutions are resilient to future changes.
- Drawing on existing standards to guide design and lifecycle decisions, such as Green Building Council of Australia's Green Star tool, and ISCA's Infrastructure Sustainability Planning Rating Tool. Upgrading or developing new tools where relevant.
- Prioritising and investing in infrastructure projects critical to enabling a net zero emissions future.
- Testing the performance of project options against a broad set of scenarios achieving net zero emissions by 2050, with only those that perform well in such scenarios progressing to business case development.
- Drawing on existing standards to guide investment decisions at the portfolio and asset level, such as GRESB's Infrastructure Assessment tool. Upgrading or developing new tools where relevant.
- Undertaking detailed cost-benefit analysis (and sensitivity tests of demand and cost modelling) of chosen project design, testing for robustness across a variety of future climate change scenarios, including multiple net zero emissions by 2050 scenarios.
- Setting emissions performance standards for infrastructure, including caps for emissions embodied in construction materials, produced during construction and operation.
- Seeking opportunities to reduce operating emissions (e.g. through retrofitting infrastructure, or through renewable power, energy efficiency, electrification, and offsets)
- Reviewing projects post-completion to evaluate whether a project achieved its emissions performance objectives, along with its strategic objectives and economic performance.

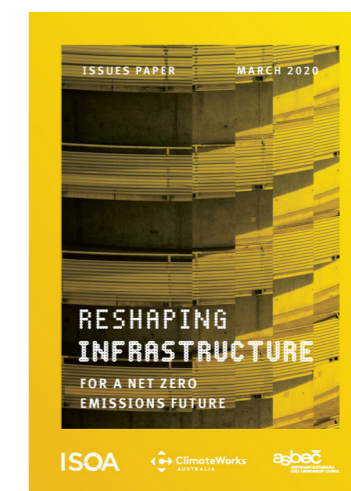


Figure 1.64 Issues Paper: Reshaping Infrastructure for a net zero emissions future (Source: ISCA, ClimateWorks Australia, and ASBEC)

FIGURE 3: Carbon reduction potential of strategic infrastructure choices**

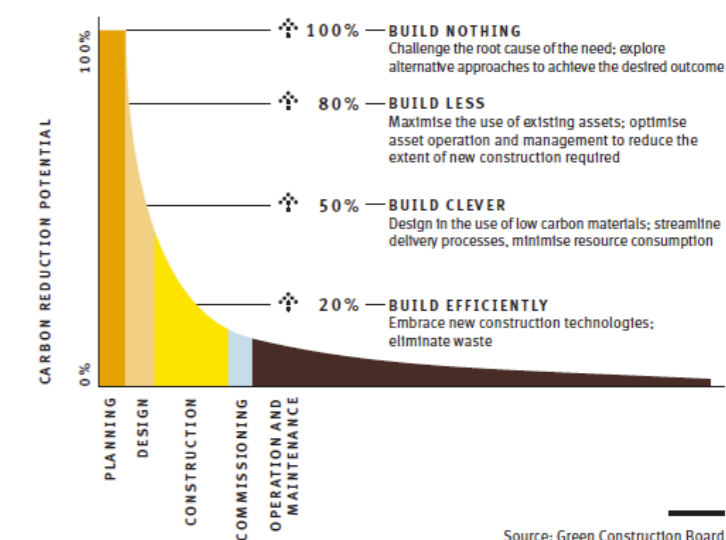


Figure 1.65 Carbon reduction potential of strategic infrastructure choices (Source: ISCA, ClimateWorks Australia, and ASBEC)

1.6 Urban research

Another lens in support of sustainability is the body of research in climate, ecology and sociology that affirms that human impacts on natural systems are approaching key tipping points, and that we face a rapidly escalating risk environment for societal stability in a changing world.

There are new research-based frameworks for viewing these sustainability trends through several distinct yet complementary lenses, all of which have shaped the approach to this framework.

All three research directions suggest that a forward-looking Structure Plan for MPIP must integrate sustainability in a holistic manner across environmental, social, economic domains, and recognise and engage with opportunities beyond project borders.

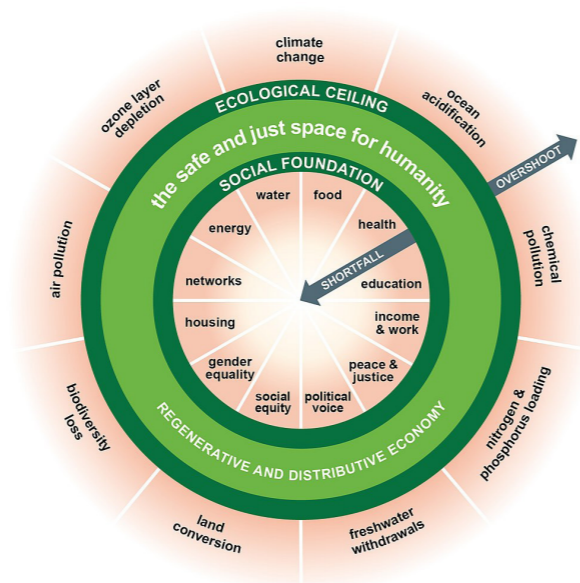


Figure 1.68 Doughnut economics visual framework for sustainable development (Source: Doughnut Economics Action Lab)

1.6.1 Doughnut Economics

Developed by University of Oxford economist Kate Raworth, the Doughnut Economics framework for sustainable development, combines the concept of planetary boundaries with the complementary concept of social needs.

The framework regards the performance of an economy by the extent to which the needs of people are met without overshooting Earth's ecological ceiling. In this model, an economy is considered prosperous when all twelve social foundations are met without overshooting any of the nine ecological ceilings. This situation is represented by the area between the two rings, considered by its creator as the safe and just space for humanity.

Doughnut Economics is a model increasingly influencing sustainable urban development and valuable for MPIP to utilise as it formalises the social needs of a community and provides a useful set of metrics to work towards.

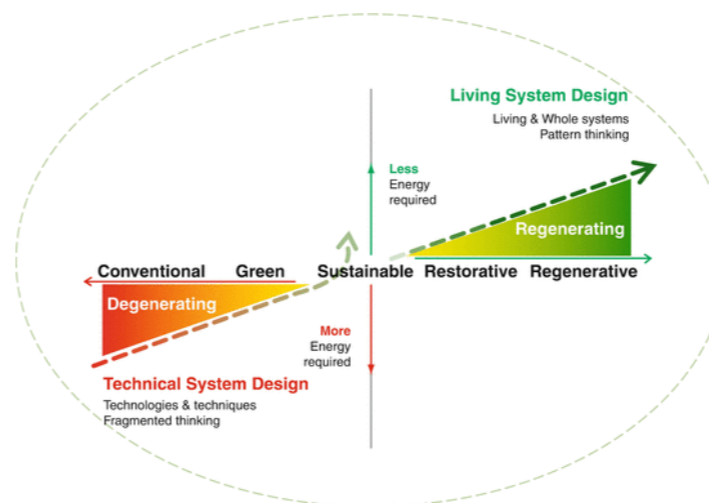


Figure 1.66 The spectrum of sustainability practices: From less bad to more good. (Source: Regenesis)

1.6.2 Regenerative Development and Design

Regenerative Design, developed by Bill Reid and the Regenesis Institute for Regenerative Practice, is a design process that engages and focuses on the evolution of the whole of the system of which we are part.

Within a regenerative economy, the focus moves up from the purely mechanical activities of production and consumption to the developmental activity of wise management. This wise management seeks to grow not only wealth but the wealth-generating capacity of all participants, as well as growing the natural capital that underpins societal wealth.

Regenerative Development and Design is a model relevant for MPIP because it provides a framework for development which moves beyond mitigating negative impacts and looks to actively rehabilitate; not just the environment, but also social and economic systems in a mutually beneficial way.



Figure 1.67 A framework to create connected, vibrant, and inclusive communities (Source: Project for Public Spaces)

1.6.3 Transformative Placemaking

Transformative Placemaking, developed by the Brookings Institute and the Anne T. and Robert M. Bass Center for Transformative Placemaking, is an outcome-oriented framework that defines transformative placemaking as a new form of integrated development.

Transformative Placemaking expands the scope of development to include efforts aimed not only at improving our social, emotional, and physical wellbeing, but at remaking the relationship of place and economy in ways that generate widespread, and locally-led, prosperity.

The key aim is to nurture an economic ecosystem that is regionally connected, innovative, and rooted in the assets of its local residents and businesses.

Transformative Placemaking is a useful model for MPIP because it has developments of a physical scale that can contribute meaningful outcomes to the community, as well as the appetite and ambition to support the area's sensitive and sustainable growth.

1.7 Innovation districts

A new complementary urban model is now emerging, giving rise to what we and others are calling “innovation districts.”

These districts are geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators and accelerators.

1.7.1 Reports

Here we explore contemporary research by the NSW Innovation and Productivity Council, and the Brookings Institute which seeks to define the physical and intangible elements which make successful Innovation Districts, as well as the factors which hinder their realisation.

1.7.2 Australian case studies

We explore several local case studies of innovation precincts to uncover what, if any, are the defining characteristics from a sustainability perspective.

These projects represent the competitive market in which MPIP will be operating and it is critical to understand what publicised sustainability ambitions and objectives are, as well as how they are proposed to be delivered.

1.7.3 International case studies

We then explore a broad collection of international precedents which have elements relevant to MPIP, and demonstrate best practice approaches to delivering holistic sustainability including: social sustainability, nature and biodiversity, transport, circularity and assurance.



1.7.4 NSW Innovation Districts: Lessons from International Experience, NSW Innovation and Productivity Council

This report has been developed by the NSW Innovation and Productivity Council as a resource for local, state and federal government agencies, universities, local health districts, and the wide range of actors in the innovation ecosystem – from large businesses, property developers and real estate providers, through to small to medium-sized enterprises (SMEs), startups and accelerators.

It proposes that irrespective of their beginnings, the experience of globally significant innovation precincts suggests seven broad factors for success:

6. Market drivers
7. Competitive advantage
8. Collaboration
9. Infrastructure
10. Amenity
11. Enterprise culture
12. Leadership

Also that, international research suggests a number of factors are at play in precincts that falter:

- Weak market demand
- Barriers to investment and commercialisation
- Lack of entrepreneurial culture
- Poor access to capital
- Poor access to skills
- Poor place-making and connectivity
- Restrictive regulation and a lack of policy support and coordination

Implications for MPIP Structure Plan

- New innovation precincts provide opportunities to set ambitious built environment performance standards and ‘good design’ objectives, an area of focus in recent NSW planning reforms.
- Social housing, cultural infrastructure and green spaces.
- High level of urban and environmental amenity to foster a high-value cultural sector.
- Improving the workability, liveability and built environment for the local area.
- Active support of the local artist community through cultural programming such as exhibitions, events and workshops created a vibrant, creative centre.
- Cities and communities that foster strong creative industries and a vibrant cultural sector have been shown to provide diverse and wide-ranging benefits from positive health impacts, to cognitive and behaviour gains.
- Digital and specialist infrastructure
- Transport infrastructure
- Flexible facilities, services and amenities
- Maintenance of affordable commercial rents.
- Liveability and sense of place
- Social interaction and inclusion
- Investment and collaboration from organisations into innovation and collaboration with smaller start-ups



Figure 1.69 NSW Innovation Districts: Lessons from International Experience (Source: NSW Innovation and Productivity Council)



Figure 1.70 Nine local, geographical features of innovation precincts globally, adapted from The Business of Cities Ltd, University College London (Source: NSW Innovation and Productivity Council)

1.7.5 The Rise of Innovation Districts: A New Geography of Innovation in America, Brookings Institute

This report documents an emerging urban geography of innovation that sits at the intersection of economy-shaping, place-making, and network-building.

All innovation districts contain *economic, physical, and networking assets*. When these three assets combine with a supportive, risk-taking culture they create an *innovation ecosystem*—a synergistic relationship between people, firms and place (the physical geography of the district) that facilitates idea generation and accelerates commercialisation.

- **Economic assets** are the firms, institutions and organizations that drive, cultivate or support an innovation-rich environment. Economic assets can be separated into three categories:
 - Innovation drivers
 - Innovation cultivators
 - Neighborhood-building amenities
- **Physical assets** are the public and privately-owned spaces—buildings, open spaces, streets and other infrastructure—designed and organised to stimulate new and higher levels of connectivity, collaboration and innovation. Physical assets can also be divided into three categories:
 - Physical assets in the public realm
 - Physical assets in the private realm
 - Physical assets that knit the district together and/or tie it to the broader metropolis
- **Networking assets** are the relationships between actors—such as individuals, firms and institutions—that have the potential to generate, sharpen and accelerate the advancement of ideas.

Implications for MPIP Structure Plan

- Spaces accessible to the public, such as parks, plazas and streets that become locales of energy and activity.
- High speed internet, wireless networks, computers and digital displays embedded into spaces such as public parks
- Streets transformed into living labs to flexibly test new innovations, such as in street lighting, waste collection, traffic management solutions and new digital technologies.
- Shared work and lab spaces and smaller, more affordable areas for start-ups.
- Micro-housing with smaller private apartments that have access to larger public spaces, such as co-working areas, entertainment spaces and common eating areas.
- Remove fences, walls and other barriers and replace them with connecting elements such as bike paths, sidewalks, pedestrian-oriented streets and activated public spaces.



Figure 1.71 The Rise of Innovation Districts: A New Geography of Innovation in America (Source: Brookings Institute)

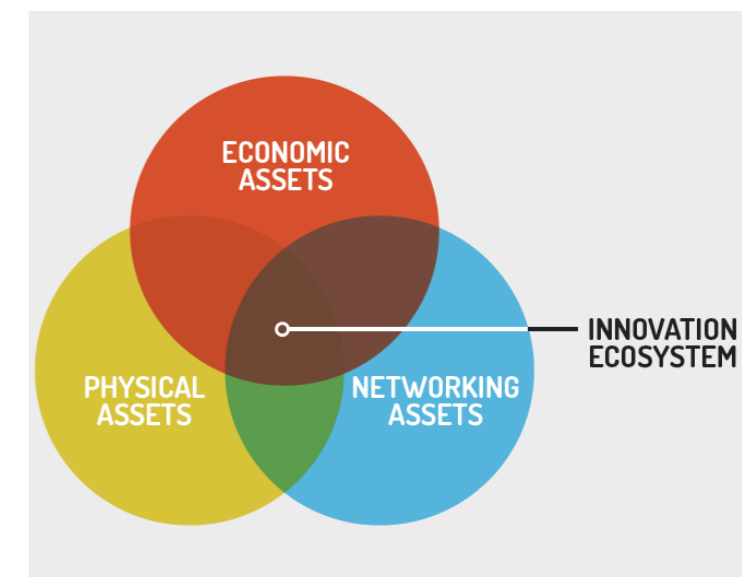


Figure 1.72 Assets which combine to create an innovation ecosystem (Source: Brookings Institute)

1.7.6 Tonsley, Adelaide

Tonsley is a sustainable innovation district which incorporates high-value industry, commercial, education and training, retail and residential.

Innovation & Business

- Public spaces including internal forests, exhibition and meeting spaces, with eating and lounge areas and Wi-Fi hotspots. The Main Assembly Building (MAB) is Tonsley's social hub, attracting workers, students, residents and visitors
- Support networks for entrepreneurs that provide continual expert analysis, intensive mentoring, and peer-to-peer learning
- Other programs provide affordable co-working spaces and partnerships with Flinders University
- Connections with private and public sector counterparts and research institutions in and around Tonsley, providing regular networking and industry events, facilitating sporting competitions, fitness programs and other activations.

Community and People

- Variety of shared facilities such as lecture theatres, board rooms and labs available
- Retail services and recreational areas are available including a town square, forests and plazas, cafés, table tennis and a world-first 24/7 all glass squash court.
- Internal forests have also become a communal place for kids birthday parties, an alternative park and even weddings

Nature and Biodiversity

- 4,500 trees and plants have been planted in the MAB indoor forests, around outdoor meeting rooms, study spaces and lunch areas
- Forests also facilitate "collision spaces" for serendipitous encounters
- Wetlands have been retained on the western side

Energy and Carbon

- Adaptive re-use of the former automotive manufacturing building (MAB), preventing the loss of approximately 90,000 tonnes of carbon emissions
- Retention and redevelopment of the Western Plant and Boiler House
- District Energy Scheme will reduce greenhouse gas emissions while increasing resilience to the existing national electricity grid supply
- A 10 megawatt battery has been installed to capture excess energy and store it for later use

Waste and Circularity

- Water sensitive urban design including on site rain gardens and recycled water from nearby wetlands
- Recycled water, captured at the nearby Oaklands Wetlands, maintains Tonsley's streetscape during hotter months. In the future, it is planned that a dual-pipe system will pump grey water into homes at Tonsley Village – an initiative that will save 25 megalitres of water per annum for the entire project.

Transport

- A regional integrated transport approach that includes walking and cycling paths for easy access to public transport, end-of-trip facilities, such as showers and bicycle repair stations, and a car share scheme.

Assurance

- Australia's first urban renewal development to receive the internationally recognised 6 Star Green Star – Communities certification
- 2018 Property Council of Australia Award for Best Development Innovation
- Tonsley Forests received the Healthy Parks Healthy People Prize at the 2021 Australian Institute of Landscape Architects (AILA) Awards.
- 2017 National Good Design Awards for Sustainability and Best Overall Architectural Design.



Figure 1.76 Tonsley Masterplan (Source: Tonsley Innovation Precinct website)



Figure 1.73 Interior Forest at Tonsley (Source: Tonsley Innovation Precinct website)

1.7.7 Liverpool Innovation Precinct, Sydney

The Liverpool Innovation Precinct is reimagining how health, education and research is undertaken individually and collaboratively to drive innovation

Innovation & Business

- Development of a new education and research building integrated with the Ingham Institute
- Establish a health precinct that allows connectivity and opens the campus to hospital partners, students, health-related industries and the general public
- Adjacency of the education and research precinct affords opportunities for integration and the cross-sharing of facilities such as libraries, auditorium and playing fields
- The BioBridge provides key connections between clinicians, researchers, and industry within the health innovation ecosystems of Australia and New Zealand. Trans-Tasman connections are supported through curated workshops and 1:1 meetings.

Nature and Biodiversity

- Regeneration of Georges River and flood management strategy
- Recycle rain and stormwater for landscape irrigation
- Create open space and areas for recreation
- Tree planting and landscaping along the primary streets to improve pedestrian amenity, reinforce the street grid and reduce the heat island effect.
- Upgrades to Bigge Park will enhance its value as the primary open space within the town centre.
- New landscaping and public spaces to provide improved connectivity between Warwick Farm Station, High Schools and towards the Hospital

Energy and Carbon

- Shared infrastructure amongst precinct partners to realise efficiencies in the cost of building, the cost of operation and land use
- Promote and utilise renewable energy
- Consolidate building plant into central energy zones of mechanical and electrical services will increase the viability of sustainable initiatives such as tri-generation

Transport

- Infrastructure to support rapid bus connections between Liverpool and Western Sydney Airport
- Future metro line to support extension of Sydney Metro Line from Bankstown to Liverpool with potential expansion to Western Sydney Airport or the south.
- Develop, test and trial autonomous electric vehicles
- Implement major pedestrian priority roads and links
- Increase dedicated bicycle lanes
- New pedestrian and vehicular connections across the river and rail line have been identified to improve connectivity to the eastern sites.

Social Sustainability

- Increase of play areas for children and pets
- Implement walking trails
- Elizabeth Street has the potential to be a major public boulevard connecting the existing retail and health precincts to one another, and new links across the rail line and to the river
- Bigge Park to be reinforced as the 'Civic Heart' of the town centre, through improved pedestrian connectivity, amenity and adjacent development for public and community uses



Figure 1.74 Proposed Liverpool Innovation Precinct (Source: LIP website)



Figure 1.75 Liverpool Innovation Precinct artist interpretation (Source: Innovate Liverpool Report)

1.7.8 Oslo Science City, Norway

The new Oslo innovation district will be a platform that will stimulate collaboration, strengthen innovative capacity and contribute to value creation and new sustainable jobs.

Oslo Science City (OSC) will create an innovation environment for an estimated 150 000 scientists, students, entrepreneurs whilst aiming to be a net zero emissions area during development and operation. Efficient land use, densification and increasing the areas biomass are apart of the holistic approach to the precinct.

Innovation & Business

- Focus on the establishment of start-up enterprises that originate from research, in close collaboration with mature companies in the district
- Foster collaborations between informatics organizations, universities, and research consortiums

Nature and Biodiversity

- Environmentally friendly buildings and an increase of biomass
- New green and densely vegetated corridors
- Extensive tree planting throughout the entire neighbourhood
- The Green Belt that will run through the Oslo Science District creates a green connection to the fjords in the south and mountains in the north. Secondary corridors/hiking trails further connect the belt to the entire innovation district

Energy and Carbon

- Fine-meshed network of emission free mobility solutions,
- The innovation district aims to be a net zero emission area, building on renewable energy, energy efficiency, circular economic principles and zero emission solutions, both during development and operation

Transport

- Optimize transport of people and goods, and develop attractive walking and biking connections
- provisions of soft mobility (active transport) including bike share, e-bike, e-vehicles, autonomous buses and shared mobility
- Strengthened connections of transport hubs, creating a loop that connects campus areas to new developments

Social Sustainability

- A continuous loop of welcoming multifunctional buildings and spaces that open out to the streets
- Mix of programs within walking distance
- Facilities for exercise, activity and recreation in nature
- Attractive ground floors with open facades, social meeting places, cultural activities
- Establish housing, urban life, mobility and digital functions that make the area open 24/7 and alive also outside ordinary working hours

Identity

- Attractive, inviting and innovative public spaces with a clear identity
- Pulling identity and urban design from the Loop as arms to create further connections to key points of interest



Figure 1.79 2045 Green Belt (Source: Oslo Science City website)



Figure 1.80 OSC artist interpretation (Source: Bjarke Ingels Group)



Figure 1.81 OSC artist interpretation (Source: Bjarke Ingels Group)

1.7.9 South Lake Union, Seattle, USA

The transformation of South Lake Union (SLU) has been spearheaded by Vulcan Real Estate, a company owned by Microsoft co-founder Paul Allen.

The growth of SLU has been marked by a close public/ private partnership—including key public investments to build transit, fix congestion, and enhance energy—as well as extensive engagement of local neighbourhoods and residents.

Innovation & Business

- Amazon global headquarters is located in SLU and acts as an anchor, accelerating growth in not only housing and retail but also entrepreneurial businesses.
- The innovation precinct organically grew in the 1990s-2000s with a collaboration of start-ups and established companies. However mid 2010s a lack of direction/governance and increased prices has caused many start-ups to leave

Nature and Biodiversity

- SLU is comprised of parks, lakefront access
- Lake Union Park is a 12 acre park on the waterfront and provides a central gathering space, playing field, boat rental and a Museum of History and Industry situated to the north of the park

Energy and Carbon

- Amazon Office building has achieved LEED Gold rating

Transport

- Pedestrian orientated infrastructure
- South Lake Union Streetcar, similar to metro, connects to the wider neighbourhood. This project was realised by investments from those property owners and public funding combined

Social Sustainability

- SLU has had a rapid population growth, with the development of new residential buildings facilitating this
- Diversity of housing stock and affordable housing programs
- Of the nearly 2,300 housing units developed in SLU between 1990 and 2010, approximately one third (690) of these units were below market affordable units
- Variety of activities, retail and restaurants creates a vibrant district

Identity

- Public art, pocket parks and historic buildings provide tranquillity and a rich culture

Assurance

- Public art, pocket parks and historic buildings provide tranquillity and a rich culture
- LEED-certified neighbourhood plan, LEED-certified buildings.



Figure 1.77 South Lake Union aerial visualisation (Source: South Lake Union)



Figure 1.78 Amazon HQ (Source: South Lake Union)



Figure 1.82 South Lake Union Park (Source: South Lake Union)

1.7.10 Brooklyn Navy Yards, New York, USA

The Brooklyn Navy Yard is a mission-driven industrial park that is a nationally acclaimed model of the viability and positive impact of modern, urban industrial development

The Brooklyn Navy Yard Development Corporation (BNYDC) is a not-for-profit corporation that serves as the real estate developer and property manager of the Yard on behalf of its owner, New York City.

Innovation & Business

- The Yard is home to 450+ businesses employing more than 11,000 people and generating over \$2.5 billion per year in economic impact for the city.
- 33% of tenants located at the Yard have adopted sustainable business practices
- Masterplan proposes affordable vertical manufacturing space
- Food manufacturing and food hall
- Newlab (within BNY) contains over 170 startups

Nature and Biodiversity

- Green strategy to offset environmental footprint
- Landscaping with water-loving plants and permeable paving
- Largest rooftop farm in NYC that was financed by Green Infrastructure grant from the federal Environmental Protection Agency

Energy and Carbon

- NYC's first building with mounted wind turbines
- Wind and solar powered lights across BNY
- Solar facades on LEED certified building

Transport

- 11 Citi Bike locations on the Yard within a one block radius
- Bike parking facilities
- Hybrid and low-emission vehicles for the management's fleet
- Brooklyn Waterfront Greenway for bicyclists and pedestrians

Identity

- Repurposing the old naval yard into a manufacturing and innovation precinct
- Adaptive reuse of historic structures and materials

Community and People

- The Brooklyn STEAM Center is an innovative career and technical training hub for 11th and 12th grade students who can engage in high quality professional work, develop real industry networks, and explore pathways to economic opportunity, all within the industry ecosystem at BNY
- LEED-Platinum-certified exhibition and visitor centre which every year places 200 job seekers—particularly residents of local public housing, veterans, and formerly incarcerated individuals—in well-paying industrial jobs in the Yard
- Activation of open pedestrian plazas, ground floor space in new development sites, and the Barge Basin Loop waterfront esplanade

- Current plans for new museums, classrooms, offices, retail stores, and community gathering spaces

Water and Circularity

- Major water/sewer upgrades for ageing infrastructure and improving water conservation
- The rooftop farm helps capture and divert 1 million gallons of stormwater runoff each year
- Waste-management program to encourage recycling

Assurance

- New buildings and renovations are to be certified minimum LEED silver



Figure 1.83 BNY development interpretation (Source: wxy Studio)

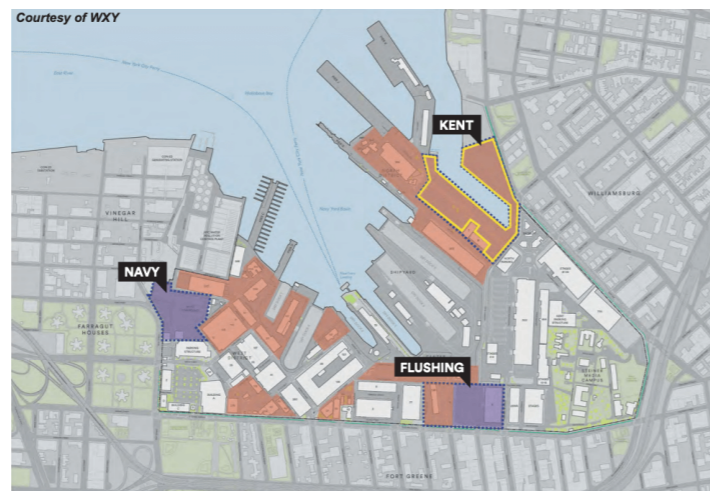


Figure 1.84 Proposed BNY masterplan (Source: wxy Studio)

1.8 Summary of key findings

Climate action

Climate action is a top priority amongst the entire strategic context, with a focus firstly on mitigating any additional contributions to climate change by targeting net zero, carbon neutral, and high performance, low carbon. Responsible and efficient consumption and production of materials and resources, prioritising renewable energy, and offsetting unavoidable impacts.

Climate adaptation

Responding to the unavoidable impacts of climate change is a concern with a greater focus now that we are beginning to feel the physical changes in our built environment. Maximising efficiency, increasing autonomy, sharing resources, and reducing dependency are all initiatives explored that contribute to resilience.

Biodiversity and ecology

Consideration of the negative effects of development and climate change on flora and fauna, ecosystem functioning, and the detrimental consequences on liveability is becoming more widespread. Governments and organisations now take more nuanced and integrated view of nature than purely canopy or green coverage and consider habitat, nature-based solutions, and ecosystem services, as well as the complementary benefits these bring to our cities and communities.

Health and wellness

There is a greater focus on, and understanding of, the interrelationship between our built environment and the health and wellness of its residents. There is also a greater appreciation for the benefits that come from intentionally seeking to create places that enhance liveability. Actively co-creating communities leads to improved resilience, higher commercial value and faster sales, greater talent attraction and retention, and encourages further good design in an area.

Social sustainability

Society is beginning to widen its understanding of sustainability to incorporate broaden social sustainability concerns including equity, inclusion, diversity, accessibility, and stewardship. Empowering communities and maximising shared value capitalises on the existing resources in a location rather than relying entirely on the import of external capital and people.

Value chains

There is greater recognition, particularly from rating tools, that the impacts, both positive and negative, that come from development reach far beyond the physical project boundaries. Proper holistic sustainability across the entire project lifecycle considers the source of all products and materials, their manufacture and end of life, the people that have contributed to their creation and whether they have benefited. The aim is to create a cascade of sustainable practices that

flows smoothly throughout the supply chain. Sustainability is equated with corporate social responsibility and stewardship – with being a good global citizen.

Data and technology

Technological sustainability poses a new set of opportunities for developed societies to explore. These objectives centre around data - collection, use, sharing and security - and leveraging them in real time for dynamic smart city outcomes. Data collection and analysis are important elements of today's society, and utilised correctly can have huge sustainability implications. How it is collected, stored and accessed is of the utmost importance though. People are, for the most part, happy to relinquish their personal data to certain companies with the understanding that they know what is being accessed, how it is being used, and what benefits they will receive in response.

Governance

To enable large scale urban development and expansion projects it is important to consider the governance and institutional framework to enable the partnerships required for coordination and management, planning, land assembly finance and risk sharing mechanisms as well as any special incentives which may be available to catalyse development. An effective governance framework is also critical to assure sustainability outcomes are tracked and delivered (standards, compliance, management).

Case studies

Collectively, they demonstrate several defining characteristics with respect to sustainability:

- Sustainability targets are generally not publicised, or are purely aspirational.
- Where sustainability targets are promoted they are tied to a specific organisation.
- Strong commitments to social sustainability through the provision of free public infrastructure.
- Contributing to and facilitating other social outcomes (education, training, etc.).
- Focus on provision of multiple space types and at varying price points.
- Buildings, and sometimes communities, assured through independent sustainability verification.
- Focus on provision of financing and business support services.
- Healthy, active, pedestrianised public domain.
- Strong public transport connections to, from, and within districts.

Sustainability ambition

In order to align with other NSW Innovation Districts and be competitive on a global scale MPIP should target world's best practice sustainability. Here we provide a brief comparison of the types of sustainability initiatives and outcomes which represent standard practice, best practice, and world's best practice.

Sustainability theme	Standard practice	Best practice	World's best practice
Connected with Country	<ul style="list-style-type: none"> - Protect and make accessible cultural heritage sites for local Aboriginal communities to continue cultural practices - Public art 	<ul style="list-style-type: none"> - Create opportunities for Indigenous communities through the program development. - Support sustainable growth of Aboriginal owned businesses by driving demand via government procurement of goods and services. 	<ul style="list-style-type: none"> - Replace offensive place names with culturally inclusive and appropriate ones. - Co-design with Indigenous designers.. - Develop a Reconciliation Action Plan (RAP) for the precinct.
Climate positive	<ul style="list-style-type: none"> - BASIX compliance - NCC Section J compliance 	<ul style="list-style-type: none"> - Beyond minimum compliance - Rooftop solar 	<ul style="list-style-type: none"> - Third-party sustainability rating (Green Star, LEED, WELL, etc.) - Net zero certified with nature-based offsets
Resilient and adaptable	<ul style="list-style-type: none"> - On-site stormwater detention for heavy rainfall events that delay discharge. 	<ul style="list-style-type: none"> - Locate above probable maximum flood (PMF) levels all critical equipment 	<ul style="list-style-type: none"> - Building systems and infrastructure continue operating during utility failure. - Floodplains manage floods naturally
Biodiverse and regenerative	<ul style="list-style-type: none"> - Canopy cover and deep soil compliance - Locally-sensitive drought tolerant plant species which require little irrigation and maintenance 	<ul style="list-style-type: none"> - Protect priority habitat corridors and refuge areas to protect mobile species, and migratory birds and fish. 	<ul style="list-style-type: none"> - Restore and re-link the degraded creek systems. - Create new habitats for locally targetted fauna species.
Integrated mobility	<ul style="list-style-type: none"> - End of trip facilities - Regularly located bicycle parking 	<ul style="list-style-type: none"> - Electric vehicle charging - Micro-mobility stations 	<ul style="list-style-type: none"> - Fully separated pedestrian and bicycle pathways - Multimodal mobility hubs
Vibrant and healthy	<ul style="list-style-type: none"> - Physical social infrastructure and exercise facilities e.g. playground, benches 	<ul style="list-style-type: none"> - Dedicated community spaces for promoting and collaborating with the public on innovation projects - Public restrooms located in public spaces 	<ul style="list-style-type: none"> - Clear wayfinding messaging throughout precinct that encourages physical activity (e.g. x mins to walk to x landmark)
Innovative community	<ul style="list-style-type: none"> - Support mobile and outdoor working with frequent interior and exterior GPOs, charge stations, and a variety of spaces for individual and collaborative working - "I" and "we" spaces 	<ul style="list-style-type: none"> - Use public spaces to display new innovation and technology from start-ups, similar to a Living Lab - Ability to add sensors throughout spaces targeted for investigation by potential Living Lab opportunities. 	<ul style="list-style-type: none"> - Develop a purpose-built building in a strategic location within the commercial core which provides curated and affordable office space/labs for new and innovative enterprises

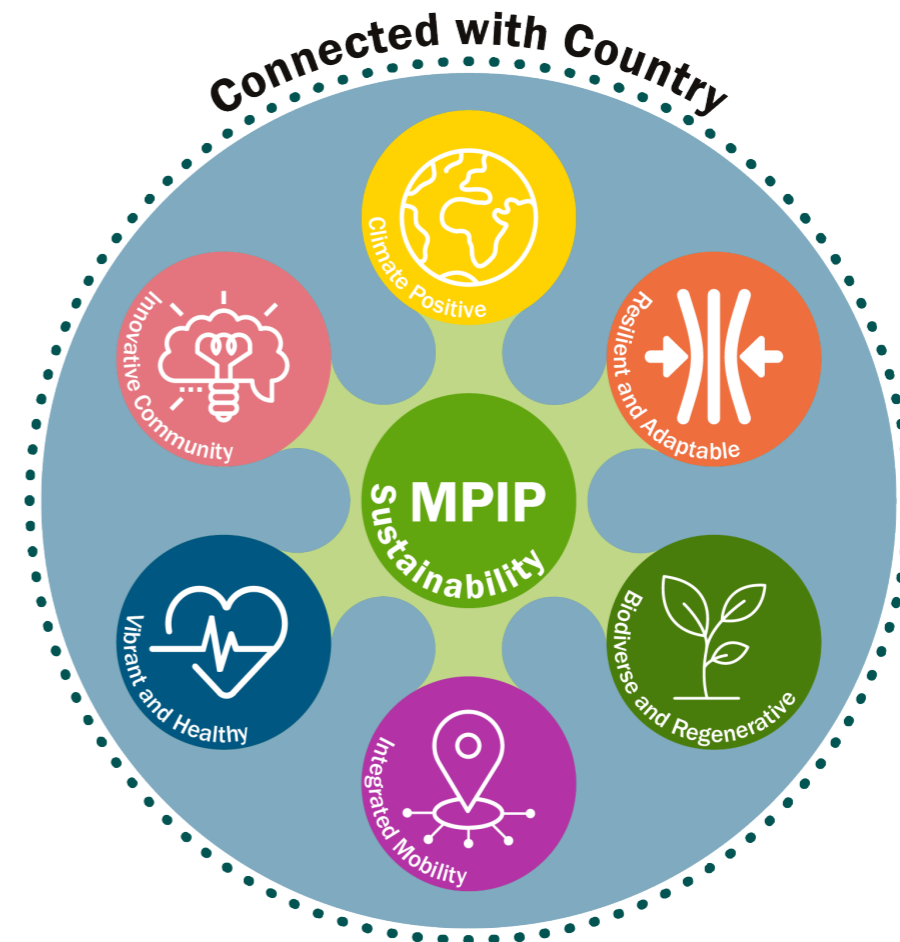
02 SUSTAINABILITY STRATEGY

2.1 Sustainability Vision

MPIP will catalyse the existing innovation community and expand the significant natural ecosystems to foster a place which champions Connection with Country and represents an exemplar of healthy sustainable placemaking.

It will enrich the quality of life of residents, workers, and visitors, enhance the wellbeing of the local community, and work to protect broader environmental and climate health.

2.2 Sustainability Themes



In support of this Vision an overarching commitment to connecting to Country is proposed, along with six Themes which provide direction to specific targets and design initiatives.

Connected with Country

The recognition and responsibility that this place was, is, and will continue to be a place of cultural significance for Aboriginal Peoples

Climate Positive

MPIP fosters climate positive outcomes in construction and operation, and industry leading in resource efficiency

Resilient and Adaptable

MPIP and its residents thrive despite short term shocks from weather and acute events and can adapt to longer term stresses like climate change

Biodiverse and Regenerative

MPIP has a net positive impact on biodiversity, prioritises natural systems, and fosters local ecology to create a biophilic environment

Integrated Mobility

MPIP facilitates movement of people and goods that is easy, healthy, efficient, and zero emission within the precinct and to and from the surrounding regions

Vibrant and Healthy

MPIP enriches the quality of life of visitors and the community and is welcoming to all people, regardless of their age, size, gender, cultural background, disability or ability

Innovative Community

MPIP leverages existing stakeholders and research partnerships to learn from and continually improve this place and its impact on people

2.3 Connected with Country

Respecting and celebrating the area’s history, and particularly Connecting with Country underpins all of the sustainability ambitions for MPIP Structure Plan and its ongoing operations.

Rationale

A strong understanding of, and connection to Country will produce a place that has a distinct identity, shaping a unique sense of place that is necessary to attract investment and ensure longevity, social justice and inclusion. A place that actively engages in connecting with Country will continually be contributing to sustainability and resilience.

Principles

- Incorporate shared histories of cultural landscapes into project design principles.
- Acknowledge Traditional Owners and other Aboriginal peoples in the local and regional communities.
- Develop mutually beneficial relationships with Country.
- Cultural heritage sites are protected and accessible to local Aboriginal communities for ongoing cultural practices.
- Indigenous ecosystems endemic to the local area have been regenerated.
- Indigenous culture, heritage, and knowledge of local country is embedded and evident in the built and cultivated environments of the development.
- Opportunities for Indigenous communities are regularly created through ongoing development.
- Create meaningful, ongoing engagement between Aboriginal communities and precinct authorities.

Benchmarks

- Indigenous culture, heritage, and knowledge of local country is embedded and evident in the built and cultivated environments (International Indigenous Design Charter)
- 1 per cent of total addressable spend is directed to Aboriginal businesses (NSW Aboriginal Procurement Policy).
- 3 per cent of total goods and services contracts are awarded to Aboriginal businesses (NSW Aboriginal Procurement Policy).

Planning opportunities

- Create places where social and business networks can be formed and value exchanged
- Break down the singularity of MPIP for a ‘place of many places’ by using creeks as boundaries
- Regenerate Porter’s Creek and increase access to Shrimpton’s Creek
- Provide green pathway links that flow through the area, following desire lines and natural paths which link to Lane Cove National Park
- Avoid damaging intact or remnant Country
- Protect and make accessible cultural heritage sites for local Aboriginal communities to continue cultural practices
- Reinstate Aboriginal names for places, and help stakeholders understand, pronounce and value these names.

- Replace offensive place names with culturally inclusive and appropriate ones.
- Collaborate with the new MQ University Faculty of Engineering for public facing uses
- Restore rivers to be swimmable by 2050.
- Implement cultural spaces to mix the previously separate users of Ivanhoe Estate and commercial precinct
- Link open space using natural corridors/pathways (Muru) to Ivanhoe Estate
- Placemaking opportunity at Junction of Lane Cove Road and Waterloo Road which provide views down the creek lines to the river and National Park

Design opportunities

- Include Indigenous designers in the design teams for public realm, buildings and infrastructure.
- Protect and restore local Indigenous historical and cultural sites.
- Support and nurture publicly accessible traditional food production endemic to the area.
- Support the “healing corridor” of Waterloo Road through creating a corridor of water and healing plants that reflects the surrounding health businesses

Operational opportunities

- Develop a Reconciliation Action Plan (RAP) for the precinct.
- Include Indigenous designers and decision makers, especially ones with Ancestral connections to these lands, throughout projects.
- Set up an Aboriginal Advisory Panel that includes local on-Country living and working in the community.
- Create opportunities for Indigenous communities through the program development.
- Support employment opportunities for Aboriginal people within Aboriginal and non-Aboriginal owned businesses.
- Support sustainable growth of Aboriginal owned businesses by driving demand via government procurement of goods and services.
- Develop guidelines for an innovative public art program to represent Wallamattagal Ngurra

Supports

- UN SDGs
 - SDG 8 Decent Work and Economic Growth
 - SDG 10 Reduced Inequalities
 - SDG 11 Sustainable Cities and Communities
 - SDG 16 Peace, Justice and Strong Institutions
- International Indigenous Design Charter
- Australian Indigenous Design Charter
- National Agreement on Closing the Gap
- Uluru Statement from the Heart
- NSW Aboriginal Procurement Policy
- NSW Draft Connecting with Country Framework, Government Architect NSW
- Designing with Country Discussion Paper, Government Architect NSW
- Deign Guide for Heritage, Government Architect NSW
- The Six Cities Region, Greater Cities Commission



Figure 2.3 The seven proposed neighbourhoods of MPIP Innovation Precinct (Source: Wallumatta Macquarie Park Masterplan)

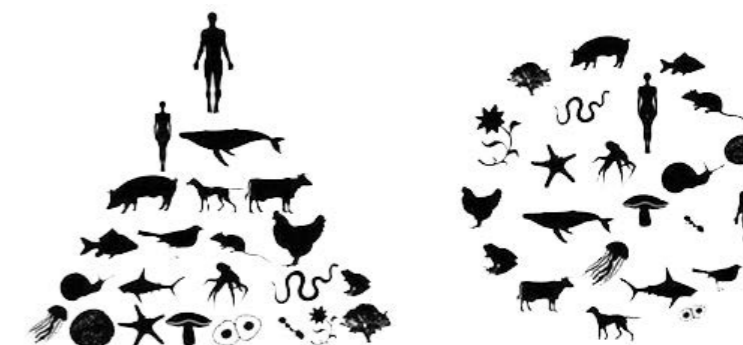


Figure 2.1 Ego-centric v Eco-centric diagram adapted from Art Tawanghar, Designer, San Diego (2016) (Source: GANSW)

Reciprocal relationships with Country and community form cultural practices, which in turn shape individual identities. All are also influenced by external factors including environment, politics, and wider society.

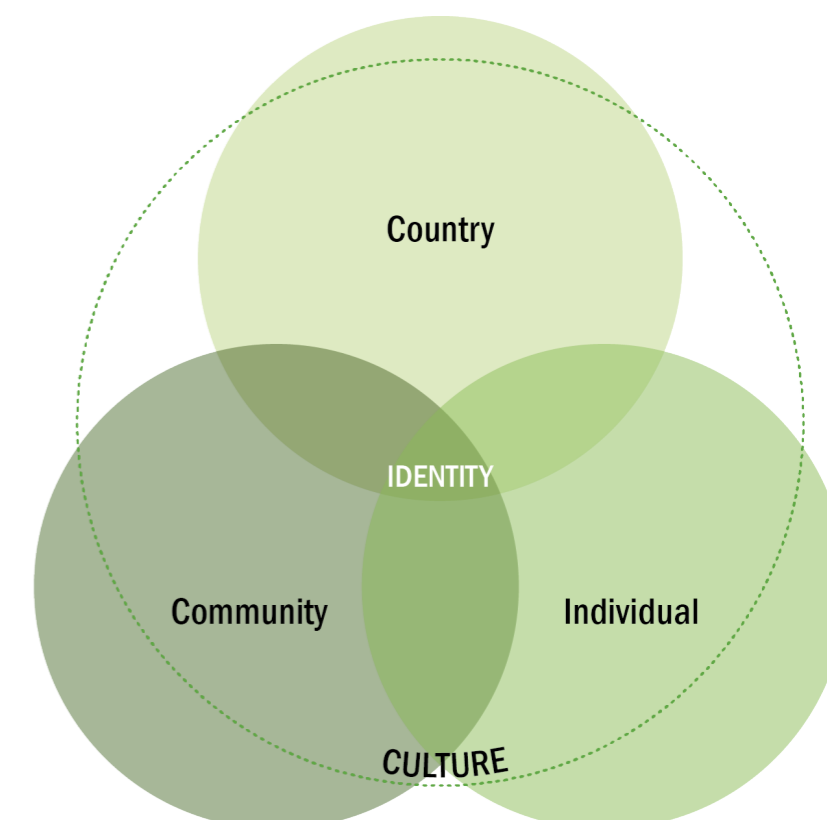


Figure 2.2 Interrelationships between Country, community and individuals, adapted rom Draft Connecting with Country Framework, GANSW (2020) (Source: Atelier Ten)

2.4 Climate Positive

Net zero emissions in construction and operation by 2030.

Rationale

A zero carbon future is central to all sustainability strategies and policy documents at all tiers of government. A zero carbon present is rapidly becoming the basic expectation for innovative and thought leading industries like those targeted for investment in this precinct.

Principles

- Minimise upfront greenhouse gas emissions.
- Eliminate on-site fossil fuel combustion.
- Prioritise passive design to minimise operational energy use
- Decrease of workers travelling to MPIP via car
- Increase and prioritisation of public and active transport
- Minimise demolishing existing buildings especially concrete structure/foundational structure
- Implement circular economy principles for waste reduction

Benchmarks

- Net zero emissions by 2050 (Net Zero Plan Stage 1: 2020-2030).
- 70% reduction below 2005 level of emissions by 2035 (Net Zero Plan Stage 1: 2020-2030).
- Net zero emissions from organic waste by 2030 (Net Zero Plan Stage 1: 2020-2030).
- 40% reduction in embodied carbon by 2030 (World Green Building Council)
- TfNSW to achieve net zero emissions from their operations and fleet by 2035
- By 2025, waste going to landfill will be reduced by at least 20 per cent (kg/capita) from 2018 levels (Ryde SLPS)
- 60/40 private vehicle/active and public transport modal split of total journeys to and from work (Ryde SLPS)

Planning opportunities

- Maximise onsite renewable energy generation and storage.
- Regenerated landscapes sequester carbon.
- All-electric built environment.
- Prioritise timber and other plant-based building materials that sequester carbon in their growth.
- Prioritise low embodied carbon materials.
- Invest in shared infrastructure to support waste stream diversion to recycling.
- Creation of end-markets for recycled products.
- Build distribution networks for water supply and discharge streams.
- Facilitate on site electric vehicle (EV) charging.
- Create extensive and efficient active transport paths and facilities to discourage private car use, decreasing emissions
- Provide more public transport routes that provide an efficient and easy way for workers to travel to/from home
- Potential for microgrid, especially for any new buildings to be built, link energy to shared generator/storage

Design opportunities

- Ensure roof space is maximised for solar panels and/or biosolar roofs, where green cover is integrated with solar panels as it supports increased efficacy of solar panels if co-installed with green roofs.
- Prioritise timber and other plant-based building materials that sequester carbon in their growth.
- Choose low embodied carbon materials and products for major building systems (structure, cladding, foundations, etc.).
- Minimise operational energy through climate responsive design.
- Construct buildings to exploit use of thermal mass to regulate internal temperature.
- Optimise all façades to shade glazing to reduce cooling energy use yet provide high quality daylighting.
- Maximise the free cooling provided by outdoor air through design for cross ventilation, and night purging.

Operational opportunities

- Mandatory minimum green building and infrastructure ratings for all built environment.
- Guarantee and verify operational energy efficiency through building performance tuning (e.g. NABERS ratings)
- Mandatory use of recycled materials and products with recycled content through built environment construction.
- Purchase 100% renewable energy for all operations.
- Offset all residual emissions from construction and operation with nature based solutions.
- Implement circular waste solutions for organic waste e.g. compost, biofuel

Supports

- UN SDGs
 - SDG 3 Good Health and Well-being
 - SDG 9 Industry, Innovation and Infrastructure
 - SDG 11 Sustainable Cities and Communities
 - SDG 12 Responsible Consumption and Production
 - SDG 13 Climate Action
- UN Paris Agreement
- IPCC
- NSW Climate Change Policy Framework
- Net Zero Plan Stage 1: 2020-2030
- The Six Cities Region, Greater Cities Commission
- North District Plan
- MPIP Place Strategy
- Planning Ryde Local Strategic Planning Statement 2020



Figure 2.4 Biosolar roof combining solar panels with green roof (Source: Living Roofs)



Figure 2.6 High-speed public electric vehicle chargers (Source: NRMA)

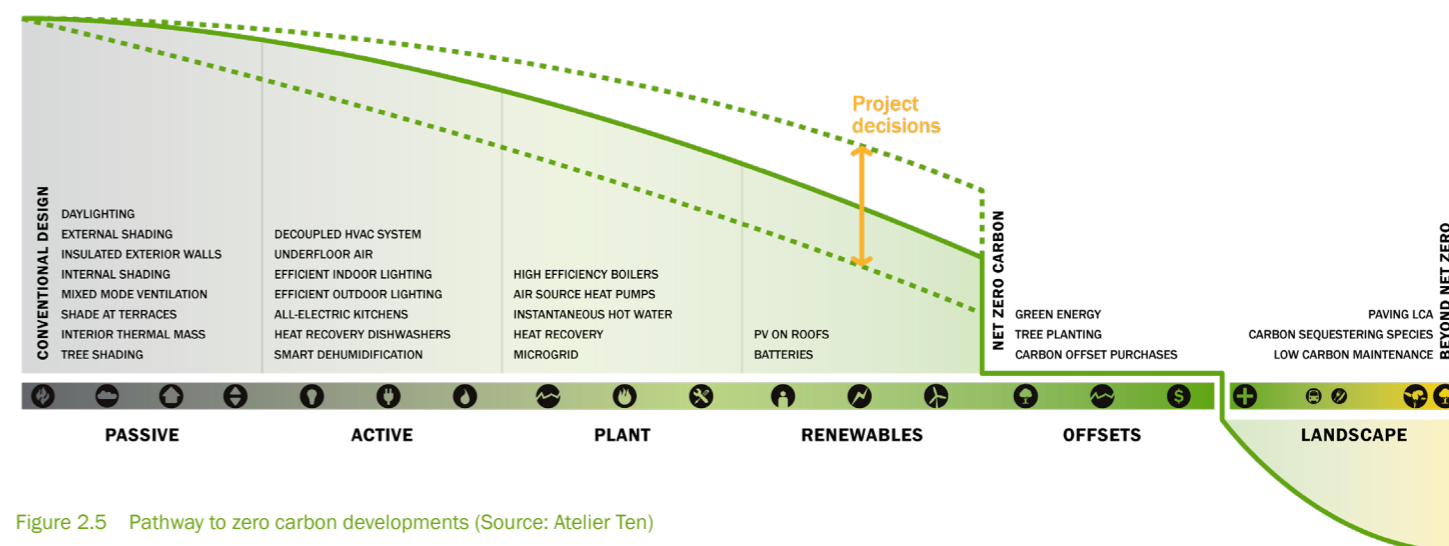


Figure 2.5 Pathway to zero carbon developments (Source: Atelier Ten)

2.5 Resilient and Adaptable

GDC will exemplify forward looking development by mitigating exposure to foreseen risks, being resilient to disruption, recovering rapidly, and being adaptable to societal advancement.

Rationale

Adapting to the direct effects of climate change on the environment and our settlements, as well as the indirect effects on society and the economy is critical to creating communities that will thrive long into the future, and will have greater capacity to support neighbouring communities and contribute to the resilience of the region as a whole.

Principles

- Resilient to short term shocks (extreme weather, utility failures).
- Adaptable to long term stresses (climate change, increasing energy costs).
- Flexible to changing market conditions and environmental performance expectations.

Benchmarks

- Complete climate change risk and opportunity assessments (NSW Climate Change Adaptation Strategy).
- Develop and deliver adaptation action plans (NSW Climate Change Adaptation Strategy).
- Reduce climate change impacts on health and wellbeing (NSW Climate Change Policy Framework).
- Manage impacts on natural resources, ecosystems and communities (NSW Climate Change Policy Framework).
- Support a more flexible and resilient water cycle (Resilient Sydney).
- Design to RCP8.5 climate scenarios (Green Building Council of Australia).
- By 2030, identified urban heat island affected precincts will have been cooled to an average temperature of 20 °C (Ryde LSPS)
- 50 resilient organisations located in the City of Ryde by 2025 (Ryde LSPS)

Planning opportunities

- Floodplains manage floods naturally- regenerating Porter’s and Shrimpton’s Creeks to act as natural floodplains
- 100% of surface runoff from roads, roofs and other hardscapes filtered through landscape treatment before discharging to waterways.
- On-site stormwater detention for heavy rainfall events that delay discharge.
- Building systems and infrastructure continue operating during utility failure.
- Green roofs, extensive tree canopies and vegetated public realm to mitigate urban heat island effects and protect against increasing peak temperatures.
- Ensure rooftop space is maximised for solar panels and/or biosolar roofs, where green cover is integrated with solar panels.
- Extensive urban street canopies to be resilient to heat and

- encourage active transport even on hot days
- Locate above probable maximum flood (PMF) levels all critical equipment and services (electrical equipment and switch gear, emergency power equipment, major HVAC plant).
- Design all structure below PMF to survive flooding.
- Include space for future energy storage (electrical or thermal batteries).
- Precinct places foster interaction and stewardship, community identity, sense of connectedness and community resilience capacity.
- Integrate community facilities that can serve as gathering places during emergencies and interruptions in services.
- Prioritise materials with low thermal mass or high solar reflectance index (SRI) to reduce urban heat island (UHI) effects.
- Landscapes balance drought tolerant low evapo-transpirative species, and high evapo-transpirative species that provide local cooling.
- Plant local vegetation and trees that can withstand forecasted extremes of environmental conditions
- Provide shade and sufficient drainage for flooding in public open spaces including green spaces
- Provide cool and healthy public spaces
- Provide resilient ecosystems and green space for endemic flora and fauna
- Ensure access to fresh and affordable food
- Create a community garden to provide local and affordable healthy food

Design opportunities

- Buildings all perform 20% better than national construction code for thermal envelope performance.
- Utilise a climate responsive design approach, optimise building envelope for passive climate control.
- Provide areas of operable facade to allow fresh air during power outages
- Allow islanding of any on-site generation and standby power circuit to enable limited building operations without utility power.
- Green roofs designed to reduce peak rainwater runoff.
- Buildings collect rooftop rainwater for onsite reserve water source during emergencies.

Operational opportunities

- Develop Climate Adaptation and Community Resilience plans.
- Facilitate and enable ongoing community programming (e.g. markets, events, etc.) to foster community cohesion and robustness.

Supports

- UN SDGs
 - SDG 9 Industry, Innovation and Infrastructure
 - SDG 11 Sustainable Cities and Communities
 - SDG 12 Responsible Consumption and Production
 - SDG 13 Climate Action
- NSW Climate Change Policy Framework
- MPIP Place Strategy
- NSW Climate Change Adaptation Strategy
- The Six Cities Region, Greater Cities Commission
- Resilient Sydney
- Planning Ryde Local Strategic Planning Statement 2020



Figure 2.7 Smoke blankets Sydney during the 2020 bushfires (Source: ABC News)

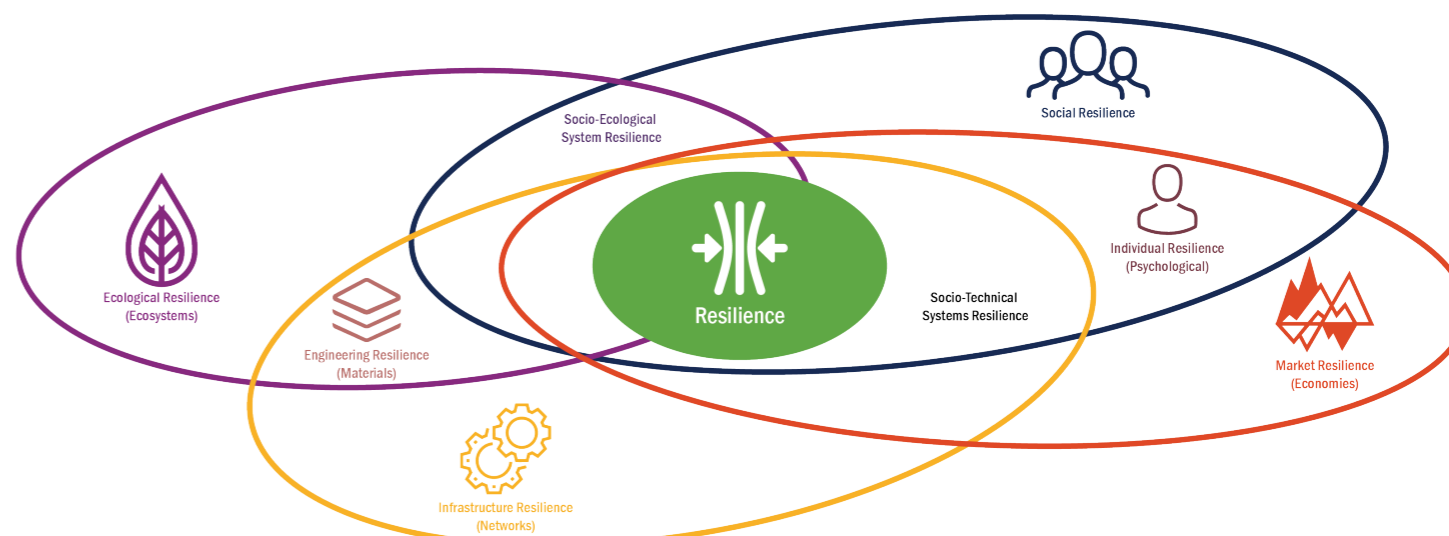


Figure 2.8 Multidisciplinary view of resilience (Source: Atelier Ten)

2.6 Biodiverse and Regenerative

MPIP will be built and operated so that it is a globally significant test bed for sustainable outcomes.

Rationale

A net zero future is central to all sustainability strategies and policy documents at all tiers of government. Actively protecting existing biodiversity and regenerating environmental and ecological damage across the value chain is rapidly becoming the baseline expectation for innovative and thought leading industries like those targeted for investment in this precinct.

Principles

- Maximise resource efficiency.
- Minimise upfront greenhouse gas emissions.
- Eliminate on-site fossil fuel combustion.
- Prioritise passive design to minimise operational energy use.
- Preserve and protect existing natural ecosystems
- Establish a biophilic environment that provides regular immersion in and contact with nature and natural systems.
- Maximise future mature tree canopy and vegetation coverage.
- Prioritise nature-based solutions wherever possible.
- Protect and enhance local habitat including both native flora and fauna.
- Prioritise the retention and protection of existing tree canopy over removal and replacement of trees to achieve canopy cover.
- Establish a biophilic environment that provides regular immersion in and contact with nature and natural systems.

Benchmarks

- 40% Tree Canopy Cover across Greater Sydney (North District Plan) and meet expectations of the Greener Neighbourhoods Strategy.
- No net loss of canopy across MPIP future development.
- Achieve site vegetation coverage of at least 40% (Greater Sydney Commission).
- Maintain and introduce habitat (Biodiversity Sensitive Urban Design, RMIT).
- Improve potential for positive human-nature interactions (Biodiversity Sensitive Urban Design, RMIT).
- Mitigate light and noise pollution impacts on nature (Biodiversity Sensitive Urban Design, RMIT).

Planning Initiatives

- Create interconnected network of open space
- Design pathways (in consultation with Traditional Custodians) through open space that adheres to the natural creeklines and contours leading to adjacent neighbourhoods, Lane Cove National Park and water.
- Increase unstructured open space in MPIP to allow for native flora, fauna and ecosystems to thrive, whilst workers and the community can enjoy these places
- Reconnect MPIP to the natural environment through increasing access to and protection of Lane Cove National Park.
- Urban tree canopy can be complemented by green ground cover, rain gardens, green roofs and green walls.

- Balance between plant species:
 - Native to the Plant Community Type (PCT) attracts local birds and insects to help with the local ecosystem.
 - Locally-sensitive drought tolerant plant species which require little irrigation and maintenance.
 - High evapo-transpirative planting for localise passive cooling
- Ensure spatial allocation of verges and green links provide adequate deep soil for long term growth.
- Where deep soil areas are constrained these should be supplemented with additional green cover through shrub beds, green roofs and green terraces, green facades and habitat boxes to support environmental outcomes of the study area.
- Carefully restrict site and precinct lighting through use of a light allowance to substantially reduce light pollution and preserve dark skies at night.
- Restore and re-link the degraded creek systems.
- Protect priority habitat corridors and refuge areas to protect mobile species, and migratory birds and fish.
- Create safe, regularly located wildlife crossings along major roads.

Design Opportunities

- Prioritise timber and other plant-based building materials that sequester carbon in their growth.
- Maximise the free cooling provided by outdoor air through design for cross ventilation, and night purging.
- Building roofs actively contribute to sustainability ambitions: solar PV, green roofs, inhabitable terraces.
- Buildings designed for disassembly.
- Buildings designed for alternative second- and third-life uses.

Operational Opportunities

- Guarantee and verify operational energy efficiency through building performance tuning (e.g. NABERS ratings)
- Mandatory use of recycled materials and products with recycled content through built environment construction.
- Purchase 100% renewable energy for all operations.
- Offset all residual emissions from construction and operation with nature based solutions.
- Develop an incubator where organisations and entrepreneurs have access to waste resources and facilities for experimentation.
- Collaborate with Macquarie University and other precinct organisations to research and protect local biodiversity

Supports

- UN SDGs
 - SDG 11 Sustainable Cities and Communities
 - SDG 12 Responsible Consumption and Production
 - SDG 13 Climate Action
- UN Paris Agreement
- Net Zero Plan Stage 1: 2020-2030
- The Six Cities Region, Greater Cities Commission
- RPA Carbon Neutral 2030 Strategy, Health Infrastructure NSW
- MPIP Place Strategy
- Planning Ryde Local Strategic Planning Statement 2020

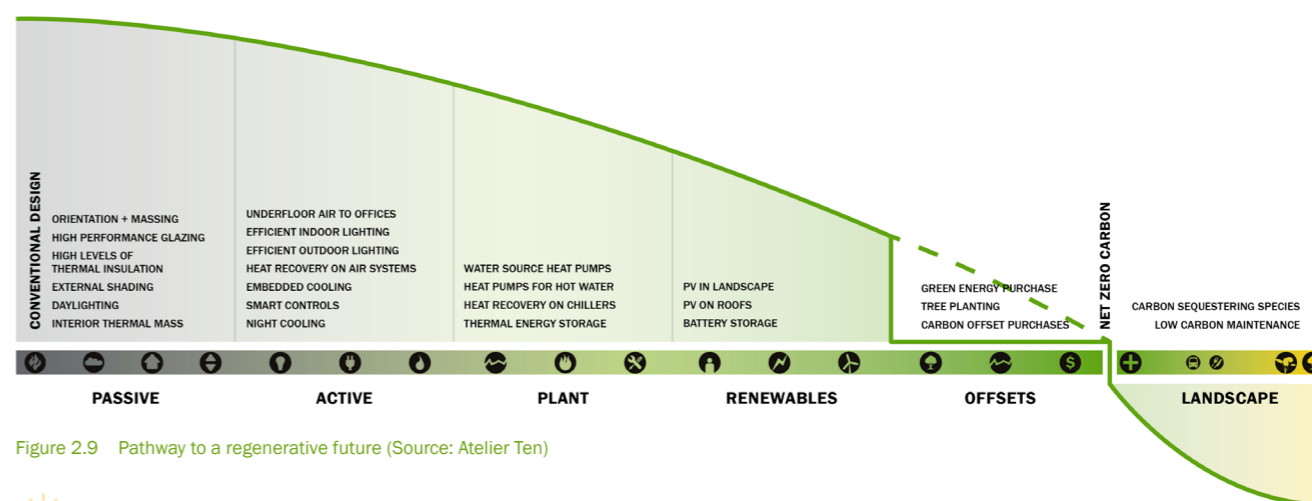


Figure 2.9 Pathway to a regenerative future (Source: Atelier Ten)

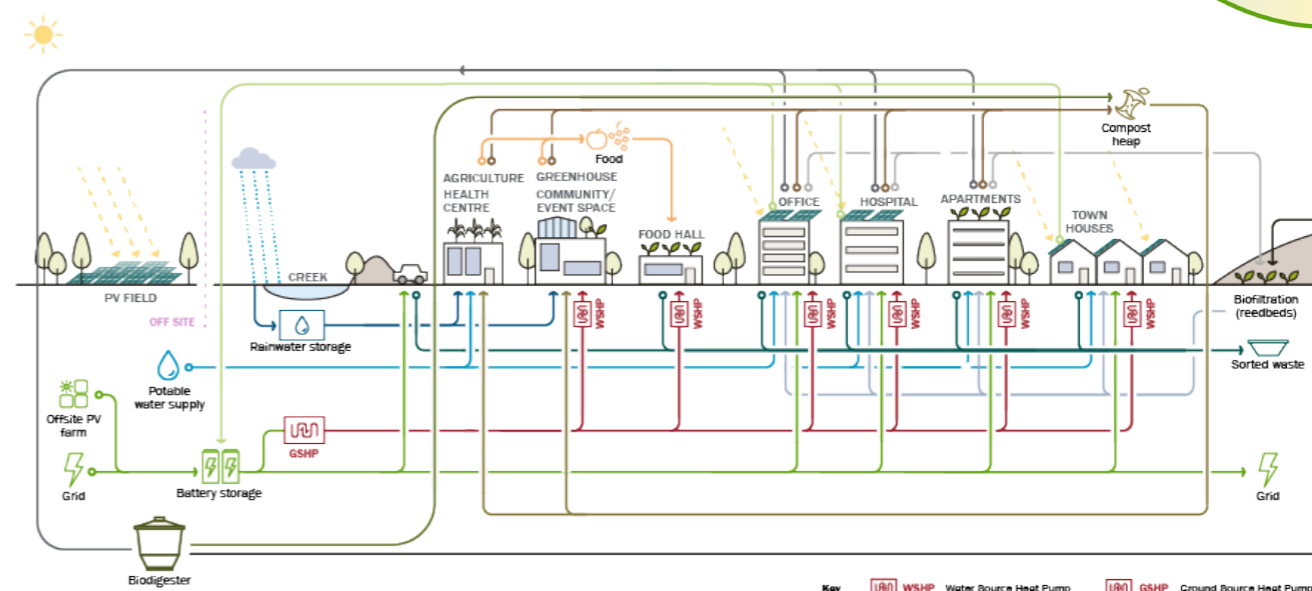


Figure 2.10 Opportunities for circular economy at MPIP (Source: Atelier Ten)

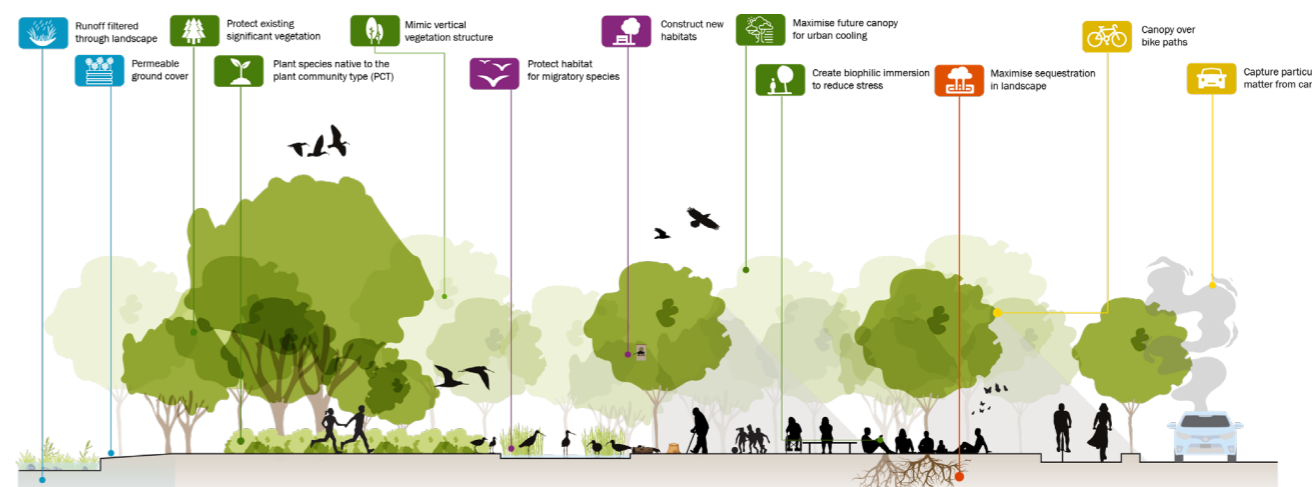


Figure 2.11 Opportunities to incorporate biodiversity in the built environment (Source: Atelier Ten)

2.7 Integrated Mobility

MPIP will operate as an exemplar of sustainable, people-oriented, place-based mobility, supporting and encouraging personal active transportation, while integrating multiple nodes and seamless transitioning between them.

Rationale

The success of the precinct will depend on diverse, flexible, and connected mobility options for goods and people. These systems must be adaptable to future transport systems both within the Precinct and out to the surrounding regions. Corridors and station and terminal areas will be protected for future transportation systems.

Principles

- Walking or cycling is the most convenient option for short trips within the precinct or to nearby destinations.
- Efficient, reliable and easy-to-understand public transportation serves most regular workers trips, and a substantial share of visitor trips, to and from the precinct.
- Seamless connectivity between precinct and airport.
- Minimal landscape given over to vehicular transportation corridors.
- Future rail and autonomous logistics vehicle corridors protected.
- Universally accessible and inclusive public transport.
- Diverse micro-mobility options.
- Walk Score, Bike Score and Transit Score are 70 or higher.
- All transportation systems are resilient to RCP8.5 climate challenges.

Benchmarks

- Provide a fine grain urban form and high amenity and walkability, in and within a 10-minute walk of centres (North District Plan)
- 30 minute access for customers to their nearest metropolitan centre and strategic centre by public transport seven days a week (Future Transport 2056).
- Fast and convenient interchanging, with walking times of no longer than five minutes between services (Future Transport 2056).
- A resilient transport system that contributes to the NSW Government's objective of net-zero emissions by 2050 (Future Transport 2056).
- 60/40 private vehicle/active and public transport modal split of total journeys to and from work (Ryde SLPS)
- Increase the proportion of the population within 400 meters of public transport connections and active transport/regional routes (Ryde SLPS)

Planning opportunities

- Fully separated pedestrian and bicycle pathways serve all areas of precinct.
- Pedestrian and cycling routes are visually pleasant and cool, with consistent tree canopies and vegetation
- Micro-mobility station areas located regularly throughout public

realm.

- Public and active transport links to main transport nodes.
- 100% of parking to have charging capacity
- All lots accessible by pedestrian routes and separated bicycle paths.
- Clear wayfinding for pedestrians and cyclists and wayfinding messaging throughout precinct that encourages physical activity (e.g. x mins to walk to x landmark)
- Digital IoT network to support live system status
- Mobility-as-a-Service (MaaS)
- Autonomous EV Shuttles within precinct
- Install bicycle fixing facilities across the precinct, along cycle routes
- Bicycle parking located in areas with passive surveillance
- Pedestrian pathways are accessible for different people including the disabled and children
- Pedestrian and cycling paths located near activated amenities e.g. cafes, gyms, grocers.
- Working with Traditional Custodians, design pathways (woven ways) that weave through open space and between buildings that adhere to natural creeklines and contours
- Cycleways and pedestrian paths are green corridors that connect to green space and Lane Cove National Park
- Integration of multimodal mobility hubs (bus stop, bike/scooter share, car share) and allied services (water filling station, charging, weather protection, public toilets, live weather and network status).
- Pick up and drop off (PUDO) bays for ride-hailing (e.g taxis, Uber, etc.) and future autonomous vehicles.

Design opportunities

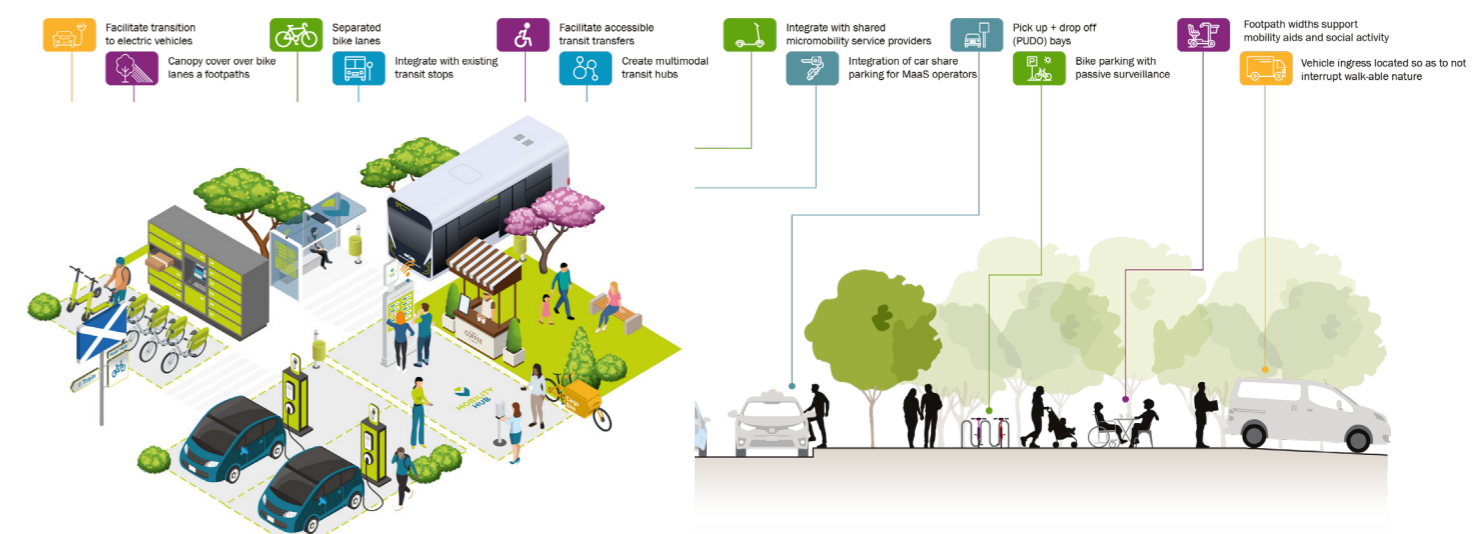
- Biophilic and visually interesting/pleasing pathways and cycleways
- Attractive high quality end of trip (EOT) facilities to facilitate and encourage active mobility e.g. showers
- Loading dock entries that do not interrupt valuable pedestrianised public domain.

Operational opportunities

- Partnerships with MaaS operators which provide free or discounted rates for building tenants, residents and/or hotel guests (GoGet, Lime, Uber).
- Precinct governance supports trialling and rapid deployment of new mobility systems.

Supports

- UN SDGs
 - SDG 3 Good Health and Well-being
 - SDG 11 Sustainable Cities and Communities
 - SDG 13 Climate Action
- Commonwealth Government, Smart Cities Plan.
- Future Transport Strategy 2056
- The Six Cities Region, Greater Cities Commission.
- Sydney Green Grid
- MPIP Place Strategy
- MPIP Strategic Masterplan - Integrated Transport Plan
- Planning Ryde Local Strategic Planning Statement 2020



2.8 Vibrant and Healthy

MPIP will create a place that is welcoming to all people, regardless of their age, size, gender, culture, disability or ability, and enrich the health and wellness of workers, visitors and the community.

Rationale

MPIP will prioritise human health and wellbeing, inclusion, mobility options, access to resources, affordability, and participation in leadership. These factors enable successful and vibrant places that improve liveability and resilience, achieve higher commercial value and faster sales, encourage further good design in an area, and demonstrate a commitment to corporate social sustainability.

Principles

- Foster a vibrant, cohesive social environment that is reflective of community history and identity.
- Encourage active mobility and recreational exercise.
- Nature, biophilia, immersion and contact with natural systems
- Safety, and enhancing social engagement.
- Built environment is welcoming to diverse users communities.
- All built environment is fully physically accessible and inclusive.
- Public and amenity space support socialising and collaboration.
- Promote responsible labour practices and support human rights

Benchmarks

- Waterways are connectors: destinations are linked by pathways for people along watercourses and natural corridors (Sydney Green Grid).
- Open up the creek spaces and historic lines as open water and as places of increased biodiversity and green infrastructure (MP Innovation Strategic Plan)
- Precinct workers and visitors rely on a range of sustainable transport options, especially active mobility (Sydney Green Grid & Future Transport 2056).
- Promote access to fresh, nutritious and affordable food and drink (Healthy Built Environment Checklist).
- Promote access to quality open spaces, including green space and recreational facilities (Healthy Built Environment Checklist).
- Become a leader in green space design, providing new, inviting, accessible, diverse and comfortable public open space and enhanced public open space. (MP Innovation Strategic Plan)
- Activation of MP's open spaces during the evening, 18 hour economy (Open Space City of Ryde)
- C7 Create a sense of place and promote community identity (Ryde SLPS)

Planning opportunities

- Working with Traditional Custodians, design green pathways through open space and developed areas that adheres to the natural creeklines and contours leading to adjacent neighborhoods, Lane Cove National Park and safe access to water.
- Serve all developed areas with fully accessible pedestrian pathways and separated bicycle paths

- Integrate diverse physical social infrastructure and exercise facilities e.g. playground, benches
- Dedicated community spaces for promoting and collaborating with the public on innovation projects
- Accessible drinking water fountains, with water bottle filling, are available in all public spaces with at least one fountain per 800 m radius.
- Public restrooms located in public spaces
- Affordable and fresh food available within the precinct
- Unobstructed lines of sight and visual connection to create a sense of openness.
- Distinct and memorable urban design and landscape features.
- Develop guidelines for an innovative public art program representing Wallamattagal Ngurra.
- Publicly accessible courtyards and cultural places
- Activated ground plane- retail and community spaces e.g. community garden, communal public hall that supports 18 hour economy
- Substantial and creative public lighting to enforce safety, orientation, drama, and accessibility.

Design opportunities

- Minimise pedestrian exposure to surface parking lots by, for example, placing parking behind buildings and providing direct footpath access to building entrances and lobbies.
- Celebrate natural materials through biophilic design.
- Design facilities and open spaces to be accessible for range of abilities

Operational opportunities

- Curated and cohesive visual narrative recognising local history.
- High quality cleaning practices, including the elimination of hazardous or harmful ingredients in cleaning
- Precinct operations, especially ecological management and stewardship, encourage individual volunteerism and community development.
- Private and public precinct organisations maintain transparent equitable and inclusive social and business practices
- All eligible built environment (including private buildings) achieves basic healthy building certification.
- Eliminate pesticide use from landscape maintenance.

Supports

- UN SDGs
 - SDG 3 Good Health and Well-being
 - SDG 11 Sustainable Cities and Communities
 - SDG 13 Climate Action
- Commonwealth Government, Smart Cities Plan.
- NSW Premier's Priorities.
- Future Transport Strategy 2056
- The Six Cities Region, Greater Cities Commission.
- MPIP Place Strategy
- MPIP Strategic Masterplan - Integrated Transport Plan
- Planning Ryde Local Strategic Planning Statement 2020
- Sydney Green Grid

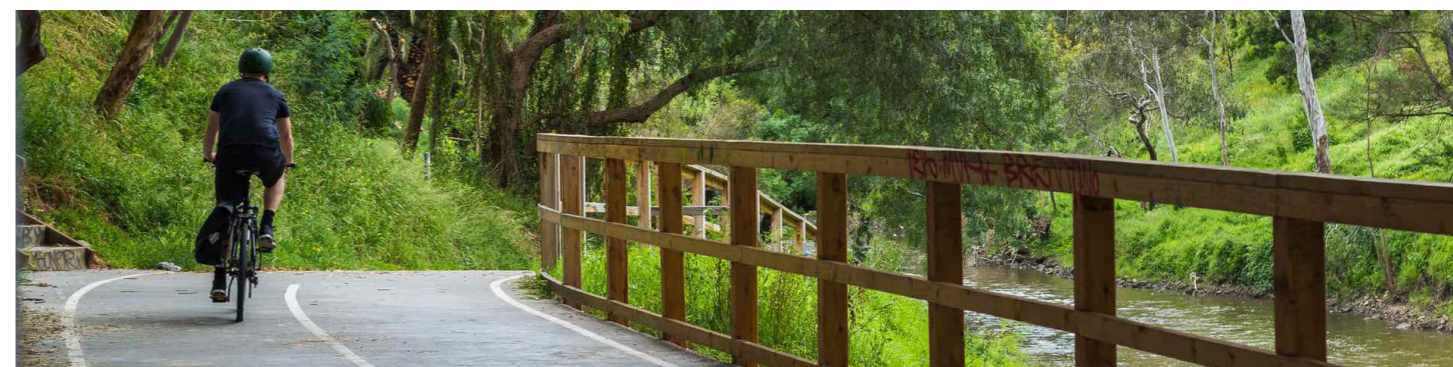


Figure 2.12 Waterways as connectors (Source: Unsplash)

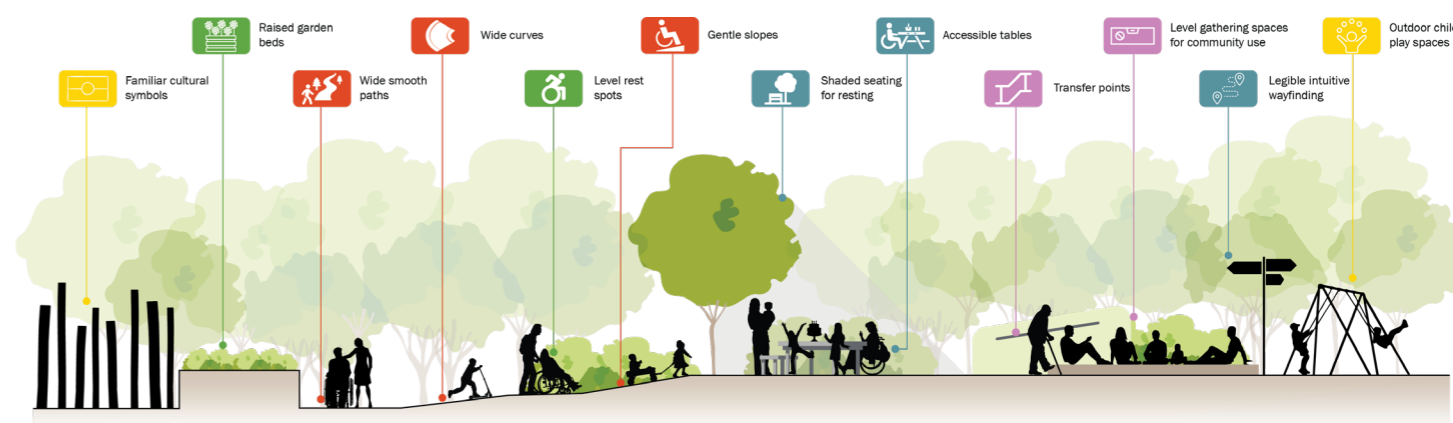


Figure 2.13 Opportunities to accessible and inclusive nature (Source: Atelier Ten)

2.9 Innovative Community

MPIP and the existing University and anchoring institutions will become a magnet for start-up businesses, entrepreneurs and inventors. The place will be engaging and exciting, becoming a testing ground for innovation.

Rationale

Digital infrastructure can improve quality of life, facilitate tracking and tracing of resource flows, monitor materials, building elements, landscapes and ecosystems, and is a prerequisite for realising other parts of the vision, especially, connected mobility, circular economy and zero carbon.

Principles

- Promote innovation through Living Labs programs and projects.
- Enabling related teaching and learning programs.
- User, worker, client and visitor experience enhanced through digitally enabled places and spaces.
- Built environment and natural resource flows are tracked digitally.
- Support the effective implementation of the circular economy.

Benchmarks

- Promote entrepreneurship and provide opportunities for smaller businesses to increase their exposure to anchor institutions (MP Innovation Place Strategy)
- Promote outward links (leveraging the Hearing Hub and medical research facilities) including using MPIP as a test bed to promote innovation and the trial of new technologies (MP Innovation Place Strategy).
- Provide open data to generate new insights and opportunities for businesses and government to innovate in the delivery of services and infrastructure (NSW Smart Places Strategy).
- Use data and smart solutions to improve efficiency in the design, approvals, delivery, maintenance and decommissioning of assets and places (NSW Smart Places Strategy).
- Strengthen a culture of trialling new approaches, technologies and procurement methods (NSW Smart Places Strategy).
- Support skills development to build resilience to external change (Macquarie Park Innovation District Study)

Planning Initiatives

- Develop a purpose-built building in a strategic location within the commercial core which provides curated and affordable office space/labs for new and innovative enterprises
- Explore affordable office space opportunities for start-ups within existing institutions to facilitate collaboration and sustainable use of existing spaces
- Plan through open space and building linkages, connections for innovation and spontaneous encounters e.g. connecting paths, shared community and cultural facilities
- Use public spaces to display new innovation and technology from start-ups, similar to a Living Lab
- Collaborate with TfNSW to explore innovation opportunities such

as a community innovation centre e.g. for students, inventors and entrepreneurs to collaborate

- 100% 10Gbps fibre-to-the-premises (FTTP) network.
- 100% high speed WiFi coverage.
- Sensoring, monitoring and control of:
 - Mobility (bicycle parking, MaaS availability, curb space, deliveries)
 - Utilities (energy, ICT, water, lighting)
 - Public realm (occupancy detection, cleanliness, security)
 - Environment (air quality, temperature, humidity, stormwater, ventilation)
 - Waste (quantity, quality, location)
- Support mobile and outdoor working with frequent interior and exterior GPOs, charge stations, and a variety of spaces for individual and collaborative working - "I" and "we" spaces.
- Dynamic digital displays situated throughout building and public domain to communicate building, precinct, Indigenous culture, history and contextual information
- Ability to add sensors throughout spaces targeted for investigation by potential Living Lab opportunities.
- QR codes inviting feedback, engaging with community, linking to interactive hybrid play.

Design Opportunities

- Provision in building designs for future integration of an in-building mobile signal solution.
- Incorporate dedicated, secure and climate controlled space for service provider equipment to be located

Operational Opportunities

- Implement future governance structure to drive growth and provide a coordinated and collaborative vision for MPIP's future.
- Engage the private sector and the local community actively in events and program development
- Develop a single digital platform for data management, monitoring and disclosure of environmental performance.
- Develop protocols for privacy, access, data security, educational benefit and civic engagement.
- Identify mandatory disclosure of ongoing performance and assurance of key sustainability objectives with a public interest.

Supports

- UN SDGs
 - SDG 9 Industry, Innovation and Infrastructure
 - SDG 11 Sustainable Cities and Communities
 - SDG 12 Responsible Consumption and Production
- The Six Cities Region, Greater Cities Commission.
- Macquarie Park Innovation District Study
- Macquarie Park Precinct Innovation Place Strategy
- NSW Smart Places Strategy

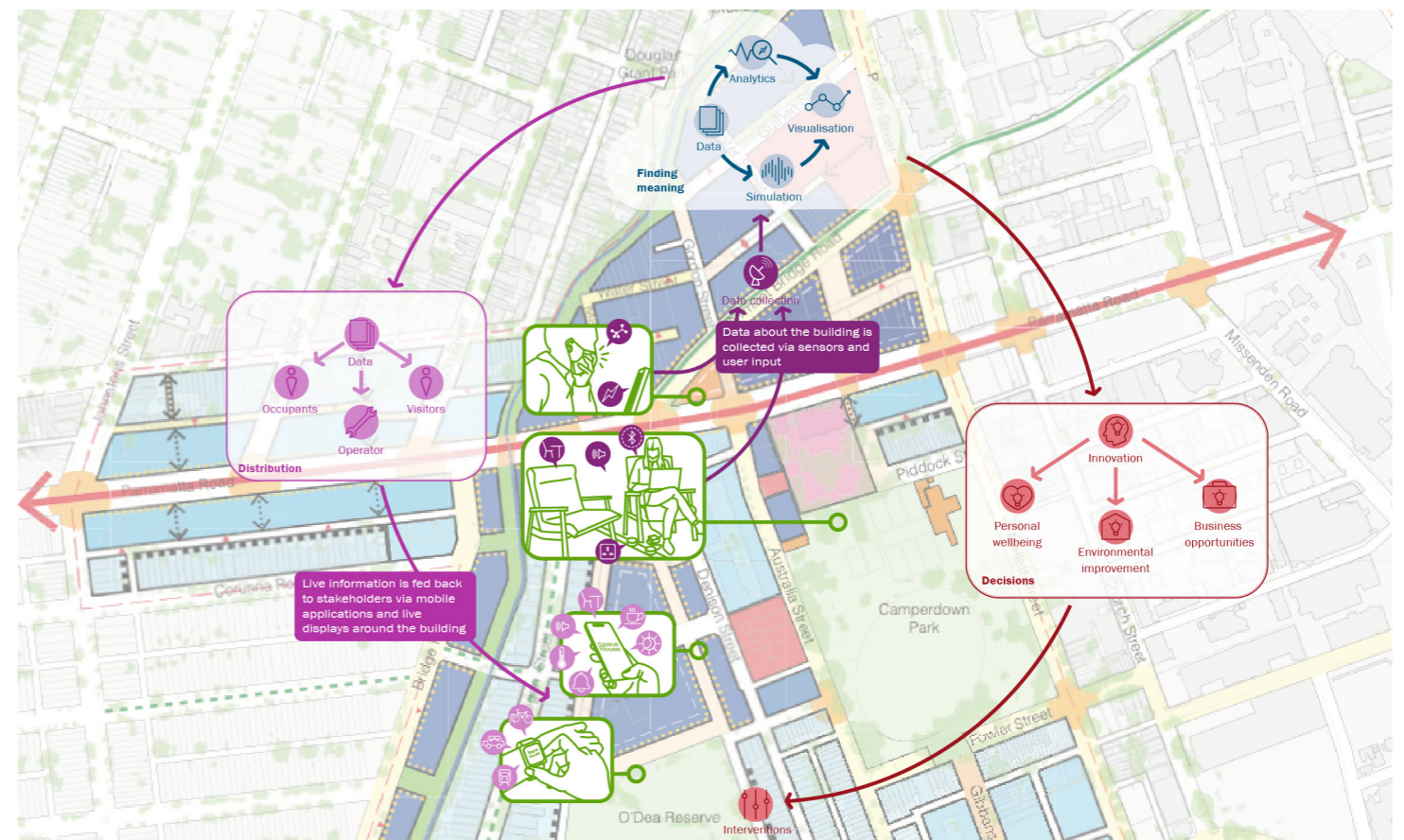


Figure 2.14 Smart city data (Source: Atelier Ten)

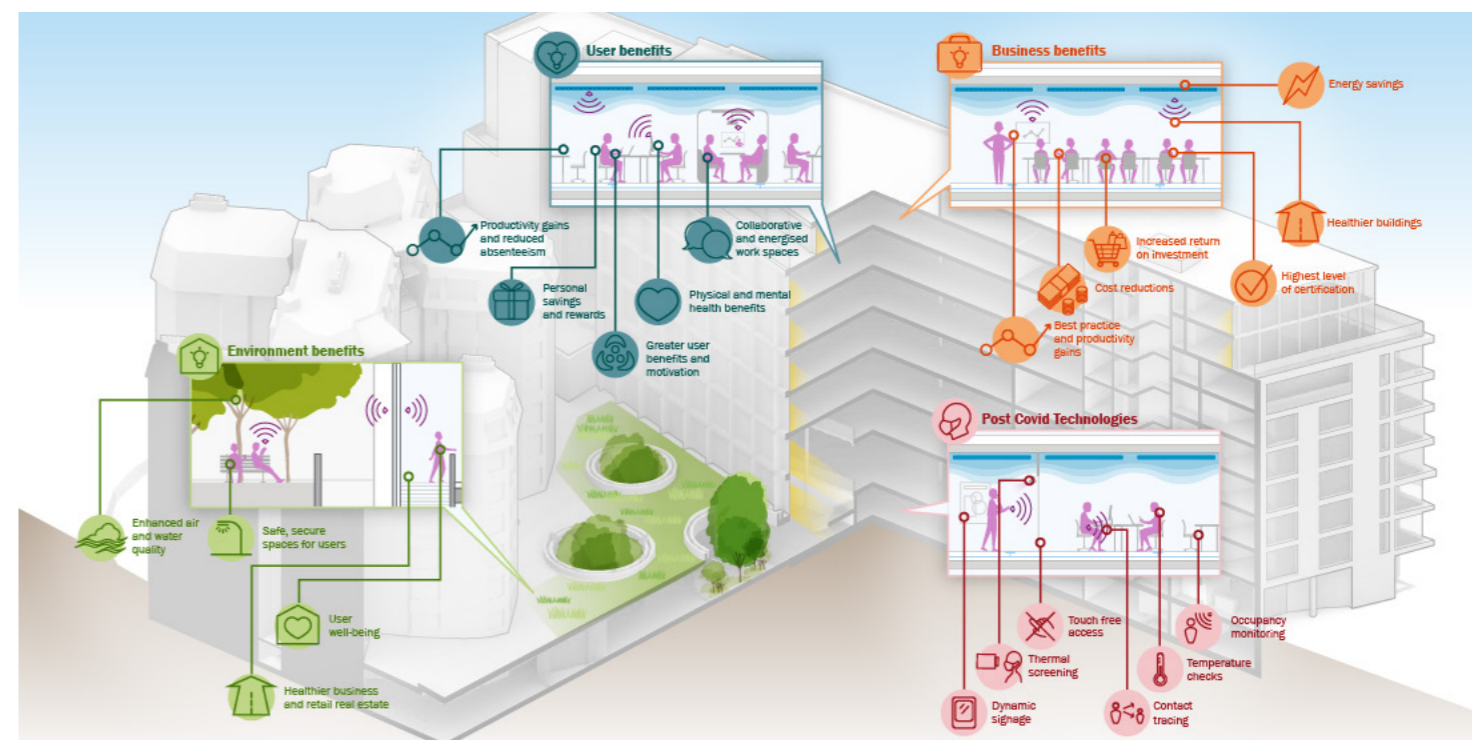


Figure 2.15 Smart city benefits (Source: Atelier Ten)

03 PLANNING CONTROLS



Macquarie Park Innovation Precinct

SUSTAINABLE PLANNING CONTROLS

JULY 2023

Acknowledgment

We acknowledge the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters, skies, and community.

We are inspired by and learn from knowledge and stories of Country.

Atelier Ten pay our respect to Traditional Owners and their cultures, and to Elders past and present.

PROJECT INFORMATION

JOB TITLE: MACQUARIE PARK INNOVATION PRECINCT
JOB NUMBER: 1917
DOCUMENT TITLE: SUSTAINABLE DEVELOPMENT CONTROLS
VERSION: 00

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REVISIONS

NO	DATE	CHECKED	APPROVED
00	25/05/2023	BR	PDS
01	14/06/2023	BR	PDS
02	27/06/2023	MM	SM
03	13/07/2023	MM	SM

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Glossary

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AR4	The IPCC Fourth Assessment Report (2007)
AR5	The IPCC Fifth Assessment Report (2013)
AR6	The IPCC Sixth Assessment Report (2021)
ARI	Average Recurrence Interval
AS	Australian Standard
BoM	Bureau of Meteorology
CAP	Climate Adaptation Plan
CRA	Climate Risk Assessment
CSIRO	Commonwealth Scientific and Industrial Research
EIS	Environmental Impact Statement
ENSO	El Niño–Southern Oscillation
FFDI	Forest Fire Danger Index
FRM	Floodplain Risk Management
GBCA	Green Building Council of Australia
HAT	Highest Astronomical Tide
GCM	Global Climatic Models
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IP	Infrastructure and Place Division
ISCA	Infrastructure Sustainability Council Australia
NARcliM	NSW / ACT Regional Climate Modelling project
OEH	NSW Office of Environment and Heritage
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCPs	Representative Concentration Pathways
RCMs	Regional Climate Models
REF	Review of Environmental Factors
SDG	Sustainable Development Guidelines
SLR	Sea Level Rise
SS	Storm Surge

TERM	Transport for NSW Enterprise Risk Management
TfNSW	Transport for NSW
TSR	Transport for NSW Standard Requirements
WCRP	World Climate Research Program's
WRF	Weather Research and Forecasting model

Executive Summary

The Department of Planning and Environment (DPE) is leading the rezoning of Macquarie Park in collaboration with Ryde Council and the Ryde Coordination Group. This general Sustainability Planning Advice has been prepared to support the master planning process and rezoning application for Macquarie Park Innovation Precinct (MPIP). The planning controls are intended to support DPE in developing a design guide for precinct implementation.

This planning control covers climate risk, resilience, greenhouse gas emissions, energy, circular economy, supply chain of materials, systems, waste management and digital sustainability.

Sustainability Framework

Atelier Ten has been commissioned to provide an overarching sustainability framework to support the master planning and rezoning process at Macquarie Park. The objective is to embed environmental, social, and economic sustainability into the structure plan for Macquarie Park. This report provides an analysis of Australian, NSW Government, Local and International context for sustainable innovation precinct development for the MPIP. The reports make several recommendations including strategic initiatives for the precinct and actions.

Overview of the Precinct

MPIP envisages additional land use opportunities. The intention is that MPIP will become an exciting new place for homeowners, residents, business, and the community by planning in such a way to celebrate country and aid biodiversity.

Precinct success will be marked by the big moves identified in the Macquarie Park Place Strategy:

- Creation of a master plan for each neighbourhood to provide a safe, direct attractive, comfortable, and adaptable walking and cycling network.
- Introduce best practice resilient building design controls.
- Ensure diversity of dwelling types.
- Creation of locally native ecologies and habitat for keystone species and protection objectives and create a richer urban tree canopy along major roads and intersections.
- Provision of safety for all visitors, and the residents during disruption, and mitigation to reduce or remove further to ongoing disturbance.
- Become a leader in green space design, providing new, inviting, accessible, diverse, and comfortable public open space and enhanced public open space.
- Work with Traditional Custodians and knowledge holders to enliven the public realm with programming activation and installations.



FIGURE 0.1: MACQUARIE PARK INNOVATION PRECINCT STRATEGIC USES MASTER PLAN

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1.0 Introduction

This general Sustainability Planning Advice has been prepared to support the master planning process and rezoning application for Macquarie Park Innovation.

The Greater Cities Commission identified Macquarie Park as a key innovation district. Innovation districts are setting world class sustainability targets within their strategic development and delivery.

These controls form part of the sustainability framework for MPIP. The planning controls are intended to support DPE in developing a design guide for precinct implementation. These controls provide guidance for the development within the site. The guidance is aimed to be clear, measurable, and achievable.

Sustainability Framework

Atelier Ten has been commissioned to provide an overarching sustainability framework to support development at Macquarie Park. The intention is to embed environmental, social and economic sustainability into the structure plan for Macquarie Park.

This report provides an analysis of Australian, NSW Government, Local and International context for sustainable innovation precinct development for the MPIP. The reports makes a number of recommendations including strategic initiatives for the precinct and actions.

The proposed controls align with NSW Government planning for technology precincts. The controls set standards to improve environmental performance of new built form and public domain and are to assist the creation of a design guide for MPIP.

Value Statement

The planning controls for environmental sustainability, climate change and waste management promote action on climate change and contribute to the NSW Government goal to reduce greenhouse gas emissions by 50% below 2005 levels by 2030 and reach net zero emissions by 2050. The planning controls will set the best practice for sustainable and environmental performance measures for the design, construction and operation of buildings and public space to minimise environmental footprint of the precinct.

1.1 Project Overview

Macquarie Park Innovation Precinct will become an exciting new place for homeowners, residents, business, and the community by planning in such a way to celebrate country and aid biodiversity. The Department of Planning and Environment (DPE) is leading the rezoning of Macquarie Park in collaboration with Ryde Council and the Ryde Coordination Group and this new Precinct will drive the success of the project by:

- Create public spaces that use traditional language, embody cultural stories, and create locally native ecologies and habitat for keystone species.
- Protect and enhance the local flora and fauna and achieve a net-positive impact on biodiversity.
- Maintain safety of visitors, and the public during disruption, and not contribute further to ongoing disturbance.
- Infrastructure and service continue during disruption, or bounces back immediately following, and requires little to no remedial works.
- planning for Country by incorporating Country-centred planning principles and actions that respect the surrounding diverse communities.
- delivering a socially and environmentally sustainable precinct.
- Mitigate the threat of potential financial loss from direct and indirect climate related disruptions.
- Enabling active mobility to the site and supporting future mobility transitions

1.2 Planning controls

The proposed planning controls indicate objectives of the control and provisions of the instrument.

1.2.1 Climate Risk and Resilience

Objectives

- a) Embed design for a future climate in all design processes using Representative Concentration Pathway (RCP) 8.5 in 2090 climate scenarios.
- b) Identify mechanisms to manage heat, bushfire (and smoke), flood and storm impacts through extreme events.
- c) Provide community facilities that support social resilience during major shock events.
- d) Effectively mitigate climate risk in alignment with the Taskforce for Climate-related Financial Disclosures (TCFD).
- e) Enable flexible, adaptive and regenerative systems with the capacity to be changed subject to uncertain future pressures.
- f) To promote sustainable use of water across the precinct and encourage water conservation and reuse.

Provisions

1. Development must deliver a climate positive precinct, including:
 - a. All electric built environment; and,
 - b. Zero fossil fuel use for regular building operations.
2. Design to Representative Concentration Pathway 8.5 in 2090 climate scenarios.
3. Design all residential buildings, including student accommodation, is to achieve thermal safety outcomes aligned with Chartered Institution of Building Services Engineers (CIBSE) TM59 Design methodology for the assessment of overheating risk in homes (2017).
4. Development must manage overland flooding by requiring:
 - a. All critical equipment and services to be located above Probable Maximum Flood (PMF) levels.
 - b. All structures below PMF must be designed to survive flooding.
 - c. Flood events are managed for peak flow to avoid damage to bio retention areas; and,
 - d. Water sensitive urban design elements are included.
5. Where possible, provide space for centralised precinct thermal and power utilities.
6. Include space within buildings for future energy storage (electrical and/or thermal batteries).
7. Community facilities are to be designed to serve as gathering places during emergencies and interruptions in services.
8. The development must identify mechanism to manage natural hazards: including but not limited to storms, flooding, heat, bushfire, smoke, dust and reduced air quality events.
9. Balance evapotranspiration through planting for local passive cooling and drought-tolerant plant species.

1.2.2 Greenhouse Gas Emissions and Energy

Objectives

- a) Deliver a Net-zero carbon precinct at time of delivery and throughout operational life.
- b) Ensure that the precinct does not use fossil fuels in regular precinct operations but ensures a reliable energy supply that also ensures energy affordability and minimises energy use.
- c) Deliver a precinct that is demand-responsive, and smart utility grid ready.

Provisions

1. All normally operating building and precinct systems must be electrified.
2. Buildings and public realm design must achieve high levels of energy efficiency through passive design and efficient services.
3. Development must demonstrate how it has reduced embodied carbon in all construction by 30% relative to 'Business as Usual' with a stretch target of 40% using Green Star LCA methodology.
4. Development must ensure that rooftops used are for energy generation (through Photovoltaic panels) where not otherwise used for resident or visitor amenity, or vegetation-based habitat. Where photovoltaic panels are located, development must also explore the opportunity for vegetation to sit beneath the panels.

5. Development applications are to consider and outline where future batteries could be suitable within future development design. This could include potential adaptive reuse of former basement / parking areas.
6. Development is to consider how energy, water, or other utilities are shared between buildings or across the precinct.
7. Development is to achieve the Performance Standards defined under Section 1.2.6 Sustainability Governance and Assurance.

1.2.3 Circular Economy, Materials and Waste Management

Objectives

- a) Achieve circularity in the construction, operational, and end-of-life stages of all buildings and other constructions throughout the Precinct.
- b) Minimise new resource and new product use.
- c) Protect natural resources that would otherwise be damaged through resource extraction or deposition.
- d) Protect from waste products littering the public realm and damaging the natural ecosystems.
- e) Divert operational waste from landfill.
- f) Eliminate single-use plastics from the upstream supply chain in both construction and operations.
- g) Establish high levels of recyclability in the upstream supply chain in both construction and operations.

Provisions

1. Building forms must promote longevity by allowing easy adaptive reuse to accommodate alternative occupancies.
2. Provide spaces that facilitate sharing economy programs like car share services, bicycle share services, and community tool libraries.
3. Provide ample space in buildings and public realm to facilitate collection and storage of multiple waste streams.
4. Organic waste diversion or capture must be provided for all buildings and all use types.
5. Development applications are to be accompanied by a Construction Management Plan demonstrating how:
 - a. recycled content is to be used in all construction in accordance with Green Star methodology or equivalent.
 - b. the majority of construction waste will be diverted from landfill to beneficial re-use (provisionally 90%, in line with Green Star benchmarks or equivalent).
6. Demonstrates a 60% quantity reduction (from business-as-usual) in operational waste to landfill, including thorough consideration of:
 - a. establishment of a Centralised Waste Management Network for storage and collection.
 - b. separation and recycling of recoverable waste by type.
 - c. The waste and recycling storage area is to be adequately ventilated by either:

1.2.4 Water Quality, Flooding and Stormwater

Objectives

- a) To be water positive through water efficiency, preservation of non-renewable water resources and reduction in consumption of mains potable water.
- b) To ensure evapotranspiration addresses water efficiency implications.
- c) To assist in the management of stormwater to minimise flooding and impacts to surrounding upstream and downstream areas.
- d) To reduce the effects of stormwater pollution on receiving waterways.

Provisions

1. Development provides for secure, recycled water supply for use in irrigating trees and vegetation.
2. Class A Recycled water (based on its intended purpose) is to be used for:
 - a. irrigation of vegetation
 - b. any proposed aquatic habitat.
3. All new development is to provide an Integrated Water Management Strategy that illustrates how buildings will be designed to maximise water efficiency and meet the requirements of this section. The strategy is to:

- a. include provision of dual plumbed water systems to enable utilisation of the recycled water network for permitted non-potable uses which may include flushing, irrigation, firefighting and certain industrial purposes.
 - b. WELS rating of fixtures to be according to Minimum Green Star requirements with shower heads being a minimum 3 star rating, taps, toilets and clothes washing machine at a minimum 4 star rating and Urinals and Dishwashers at a minimum 5 star rating.
 - c. identify how rainwater and / or stormwater will be harvested and reused on site to maximise sustainable water reuse.
 - d. demonstrate how the development will be designed to enable connection to future recycled water scheme.
 - e. integrate opportunities for water sensitive urban design including green walls and roofs
 - f. consider both sewer mining and provision for export of treated water to future recycled water scheme network (either in conjunction or separately).
4. As part of an Integrated Water Management Strategy (as required by Guidance 14.1(7), a Local Drainage Management Plan prepared by a suitably qualified engineer with experience in drainage design that addresses:
- a. the hydrology of the locality and its relationship to the drainage system
 - b. the distribution of soil types and the scope for on-site infiltration
 - c. any expected rise in ground water level due to development
 - d. the role of the principal landscape components on the site for water conservation and on-site detention
 - e. the scope for on-site stormwater detention and retention, including collection of water for re-use
 - f. how any detrimental impacts on the existing hydrology and water quality are proposed to be minimised
 - g. how pedestrian safety is to be ensured
 - h. integration of drainage management responses and open space areas.
 - i. Manages and mitigates flood risk
5. Civil drainage is to be designed for an RCP 8.5 climate change scenario.
6. Development is to integrate Water Sensitive Urban Design (WSUD) measures to slow stormwater runoff and improve stormwater quality flowing into waterways such as:
- a. gross pollutant traps
 - b. passive irrigation
 - c. bio-retention areas
 - d. rainwater harvesting.

1.2.5 Landscape, Canopy and Biodiversity

Objectives

- a) Recreate environmental values across the precinct consistent with Country, including native vegetation, water ways, water bodies and wetlands.
- b) Provide opportunities to increase biodiversity resilience to climate change and natural hazards.
- c) Improve water quality of the harbour while restoring and expanding the green and blue natural health systems.
- d) Deliver a renewal precinct that transforms the existing poor urban conditions on site to an ecologically diverse, sustainable, and dense planted urban canopy that connects learning environments and provides a level of habitat connectivity that is currently absent.
- e) Enable greater consultation in the future to align traditional knowledge and cultural views of biodiversity with those responsible for developing the future ecological opportunities for enhancement.
- f) Provide habitat connectivity for mobile species between key local and regional green and blue spaces.
- g) Establish a biophilic environment that provides a material connection for tenants and visitors to natural systems.
- h) Achieve a Net Positive Impact on biodiversity through support for off-site land projects that generate biodiversity offset credits aligned with negative emissions instruments (afforestation, reforestation and soil carbon sequestration).

Provisions

1. Design of private and public domain must ensure that 100% surface water runoff is filtered through landscape treatment before discharging to waterways.

2. Protect existing and create new urban habitat for terrestrial and aquatic species at multiple scales, including ecological pockets.
3. Provide opportunities to share knowledge of Country and reflect communities that may have existing prior to clearing.
4. Use native species in landscaping to reflect communities that may have existed prior to clearing.
5. Where appropriate, development is to enable augmented fauna habitats.
6. Green cover, canopy cover, and deep soil targets for Individual project typology to match or exceed the guidance under Section 6.1 Site targets of the Greener Neighbourhoods Guide (2023).

1.2.6 Sustainability Governance and Assurance

Objectives

Objectives for sustainability governance and assurance:

- a) Provide an objective governance framework to ensure that sustainability objectives are delivered in development.
- b) Provide an independent verification process to ensure that sustainability can be delivered and utilised by all.
- c) Ensure that sustainability measures in development are reviewed by an independent third party to provide consent authorities confidence in delivering objective sustainability outcomes.

Provisions

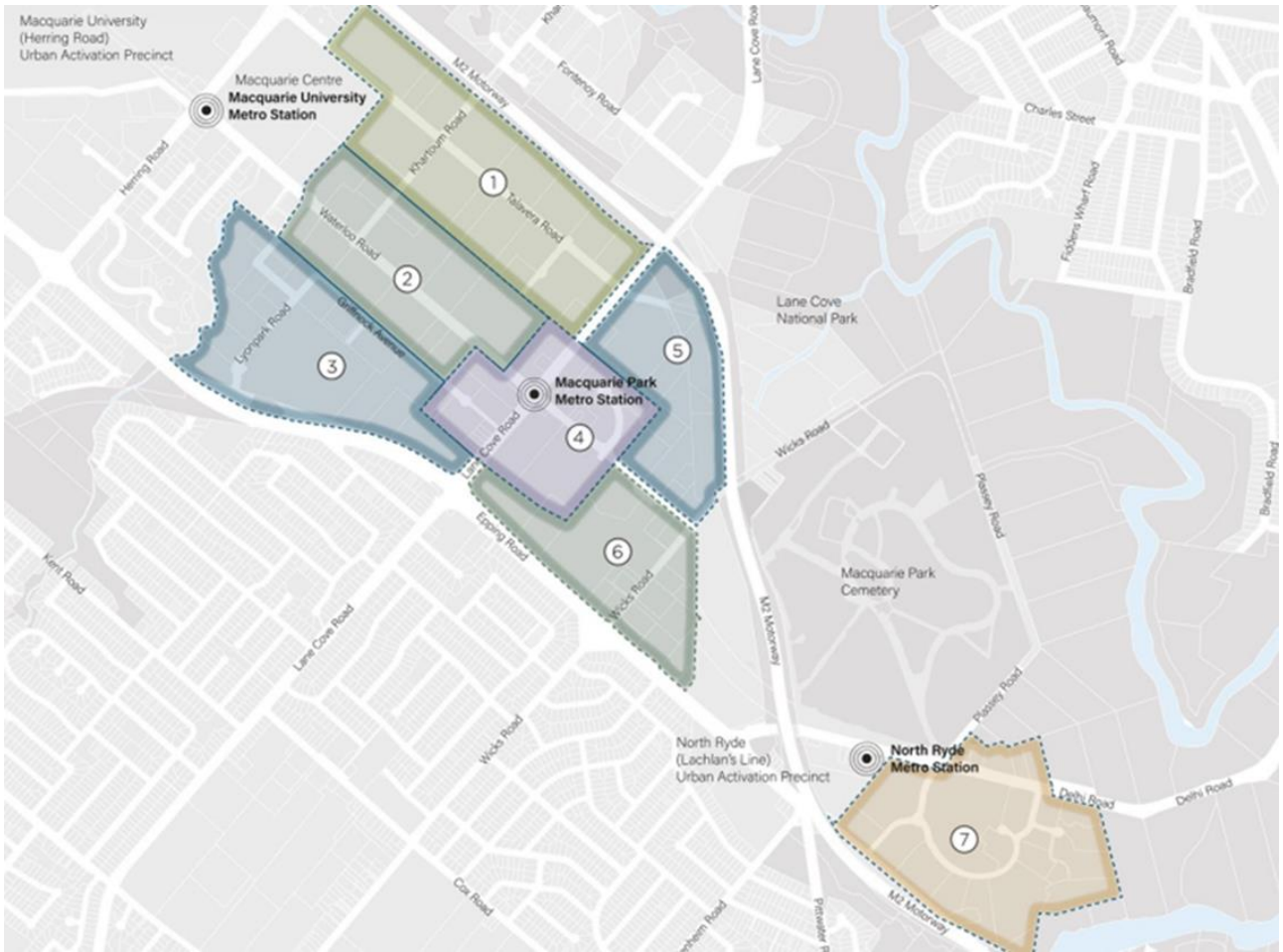
Development* is to achieve the targets provided at Table 3:

Development Type	Rating Tool	Rating Type	Target Rating
Public domain	Green Star	Communities	6 Star
All New and Refurbished Commercial buildings	Green Star	Buildings	6 Star
	NABERS	Energy	6 Star
		Water	5 Star
		Waste	5.5 Star
	WELL	Core & Shell	Silver
Shopping centre	Green Star	Buildings	5 Star
	NABERS	Energy	5 Star
Hotel	Green Star	Buildings	5 Star
	NABERS	Energy	4.5 Star
		Water	4 Star
Multi-residential buildings	Green Star	Buildings	5 Star
	Livable Housing Australia	Livable Housing Guidelines	Silver (60% of units)
			Gold (30% of units)
			Platinum (10% of units)

*Refurbishment means carrying out of works to an existing building where the works affect at least half the total volume of the building measured over its external roof and walls and where there is no increase in the gross floor area. In calculating the extent of the building's volume that is being changed, the proposed works and all other building work completed or authorised within the previous three years is to be included.

The office and shopping centre performance standards are for base building only. This means only the energy used in central services and common areas such as heating and cooling systems, lifts and lobby lighting is considered. For hotel and multi-unit residential development, the performance standards cover the entire building, which includes the base building, the individual hotel rooms and apartments, and other amenities like bars, cafes and pools.

04 APPENDIX A: CLIMATE ADAPTATION AND RESILIENCE PLAN



Macquarie Park Innovation Precinct

CLIMATE ADAPTATION PLAN

JULY 2023

Acknowledgment

We acknowledge the Traditional Owners of country throughout Australia and recognises their continuing connection to land, waters, skies, and community.

We are inspired by and learn from knowledge and stories of Country.

Atelier Ten pay our respect to Traditional Owners and their cultures, and to Elders past and present.

PROJECT INFORMATION

JOB TITLE: MACQUARIE PARK INNOVATION PRECINCT
JOB NUMBER: 1917
DOCUMENT TITLE: CLIMATE ADAPTATION PLAN
VERSION: 02

PREPARED

PREPARED BY: MANASA MARASANI
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DATE: 12/06/2023

CHECKED

CHECKED BY: STEWART MONTI
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REVISIONS

NO	DATE	CHECKED	APPROVED
00	23/05/2023	BR	PDS
01	14/06/2023	BR	PDS
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Glossary

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
AR4	The IPCC Fourth Assessment Report (2007)
AR5	The IPCC Fifth Assessment Report (2013)
AR6	The IPCC Sixth Assessment Report (2021)
ARI	Average Recurrence Interval
AS	Australian Standard
BoM	Bureau of Meteorology
CAP	Climate Adaptation Plan
CRA	Climate Risk Assessment
CSIRO	Commonwealth Scientific and Industrial Research
EIS	Environmental Impact Statement
ENSO	El Niño–Southern Oscillation
FFDI	Forest Fire Danger Index
FRM	Floodplain Risk Management
GBCA	Green Building Council of Australia
HAT	Highest Astronomical Tide
GCM	Global Climatic Models
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IP	Infrastructure and Place Division
ISCA	Infrastructure Sustainability Council Australia
NARcliM	NSW / ACT Regional Climate Modelling project
MPIP	Macquarie Park Innovation Precinct
OEH	NSW Office of Environment and Heritage
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RCPs	Representative Concentration Pathways
RCMs	Regional Climate Models
REF	Review of Environmental Factors
SDG	Sustainable Development Guidelines
SLR	Sea Level Rise

SS	Storm Surge
TERM	Transport for NSW Enterprise Risk Management
TfNSW	Transport for NSW
TSR	Transport for NSW Standard Requirements
WCRP	World Climate Research Program's
WRF	Weather Research and Forecasting model

Executive Summary

This Climate Adaptation Plan (CAP) has been prepared to support the master planning process and rezoning application for Macquarie Park Innovation Precinct (MPIP) and supports the recommendation for third-party sustainability rating tools (e.g., Green Star, ISCA, etc.). The CAP is the result of workshops and review with stakeholders. Results of the risk assessment and investigation process formed the basis for planning controls including assurance levels and the embedding of design scenario outcomes for sustainability.

Climate Trends

Climate change is having worldwide impacts on society, the economy, and the environment. In Australia, the CSIRO Climate Change in Australia 2020 publication, states that: “Observed climate information indicates that Australian average surface air temperature has increased by 0.9 °C since 1910, and many heat-related records have been broken in recent years. Sea level has risen about 20cm over the past century.”

Climate Projections

Across Australia the upward trend in temperature and sea level together with an increased intensity of rainfall and cyclonic activity pose an increasing humanitarian and financial risk to business over time.

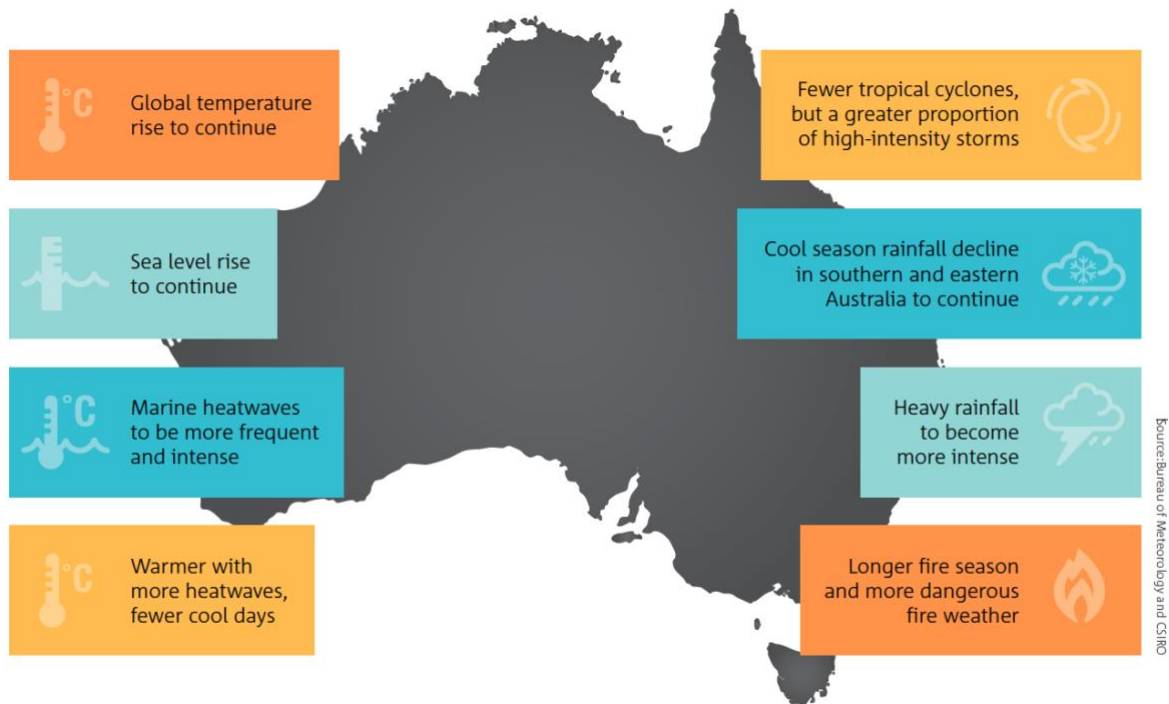


FIGURE 0.1: BOM AND CSIRO GENERAL SYNOPSIS (BOM & CSIRO 2020)

The climate projections for this CAP were selected using a conservative climate modelling pathway (representative concentration pathway (RCP) 8.5), so that practical and realistic design and operational action can be taken. This pathway represents not only the worst-case emissions scenario, but also the most likely case, and aligns with best practice industry expectations.

The risk assessment covers two timescales (2040 and 2090) and cover the following risk variables, the objective of this research is to better understand the environmental, social, and economic trends, which in turn will set the foundation for risk management decision making.

Key projections for this project cover the risk variables set out Table 0.1

TABLE 0.1: RISK VARIABLES CONSIDERED

Element	Variable
Sea surface temperature	Increase in sea level
	Increase in water temperature
	Increase in adjacent air temperature and humidity
Air Temperature	Increase in mean maximum temperature
	Increased annual mean temperature
	Increased number of hot days over 35 °C
Precipitation	Greater frequency of higher intensity rainfall events
Drought	Decrease in annual total rainfall
Wind	Increased wind speeds
Extreme storms	Increase in frequency and severity of storms
	Increasing frequency of electrical storms and lightning strikes
Humidity	Changes to relative humidity
Bushfire	Increase in risk of bushfires
Solar radiation	Increase in level of UV
Waterway Health	Declining Waterway Health
Soil Health	Soil Health
Seismic	Earthquake
	Tsunami
Civil Disturbance	Attack
	Civil unrest
	Pandemic
	Financial crisis
	Transport and logistics network
Critical Infrastructure Failure	Electrical network
	Water network
	Waste network
	Digital network
Shift in Business Models	Demographic shifts
	Economic models
Social Stresses	Geopolitical environment
	Local economic environment

Summary of reassessed climate risks

The climate risks identified for the infrastructure within the scope of this CAP following the application of adaptation measures, are summarised below.

TABLE 0.2: SUMMARY OF INITIAL AND REASSESSED RISKS FOR SHORT-TERM (2040) TIME SCALE

Risk Rating	Extreme	High	Medium	Low	Total
Number of Risks	1	31	38	5	75
Number of Reassessed Risks	0	2	29	44	75

All 75 potential climate change risks identified received adaptation measures which help to mitigate and reduce the likelihood of that event occurring.

All 1 extreme risk have been mitigated, all but 2 high risks have been mitigated to medium or low-level risks and 26 medium risks have been mitigated to low level risks through adaptation measures.

Adaptation measures and Implementation

The site area is flood affected which highlights the importance of flood modelling for RCP 8.5 future sea level rise with overland flow integrated into the landscape design and providing a combination of flood mitigation and stormwater infrastructure as proposed in the Stormwater report. Climate change factors impact the threatened and endangered species as per the ecology and biodiversity report, the built form is to integrate and respond to ecology. All building design is for account for future climate scenario of RCP 8.5, be passively designed and incorporate world's best practice sustainability measure through assurance tools. Importance of sheltering in place and regular monitoring, evaluation and review of climate adaptation plans will ensure the identified adaptation measures are implemented.

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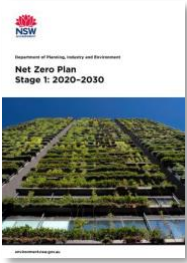
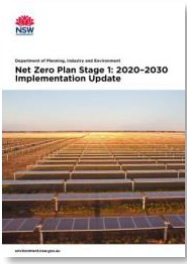
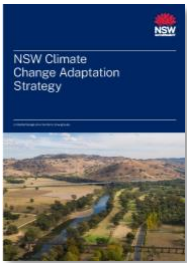
1.0 Introduction

Meteorological records show that since the 1950s the duration, frequency and intensity of heatwaves have increased across many parts of Australia including NSW. Australia’s warmest year on record was 2019, and the seven years from 2013 to 2019 all rank in the nine warmest years (BoM & CSIRO 2020). In parallel with rising temperatures, over the past 30 years the number of fire days has also continued to rise across NSW. Throughout the state, the fire season is starting earlier and lasting longer with fire weather often extending into spring and autumn (Climate Council 2014a). In addition to temperature related risks, impacts from flooding and sea level rise have the capacity for widespread damage and disruption. Across Sydney, flooding events became three times more frequent during the 20th century as a result of sea-level rise. By 2100 it is likely that today’s 1-in-100 year flood will occur every day or so (Climate Council 2014b).

Recognising that the impacts from climate change pose a significant risk to its business, infrastructure assets, and the communities it serves, NSW Government is committed to building climate resilience across its communities, assets, and network of current and future projects.

Addressing climate risk is highlighted within several NSW Government’s guiding strategic documents including:

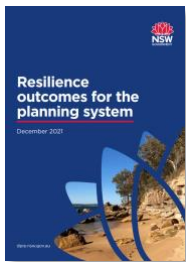
TABLE 1.1: NSW GOVERNMENT CLIMATE RISK-RELATED STRATEGIC DOCUMENTS

Document	Description
	<p>Net Zero Plan Stage 1: 2020–2030 (DPIE 2020a)</p> <p>This plan is the foundation for NSW’s action on climate change and goal to reach net zero emissions by 2050. It outlines the governments approach to protect our future by growing the economy, creating jobs, and reducing emissions over the next decade. The plan supports a range of initiatives targeting energy, electric vehicles, hydrogen, primary industries, technology, built environment, carbon financing and organic waste.</p>
	<p>Net Zero Plan Stage 1: 2020–2030 Implementation Update (DPIE 2020b)</p> <p>Following the foundation laid in March 2020, the update outlines NSW’s government work and partnerships with communities, businesses, and industry to progress to our net zero future.</p>
	<p>NSW Climate Change Adaptation Strategy (DPE 2022)</p> <p>Sets out an ambitious approach to climate change adaptation. The strategy provides a framework that will strengthen and expand action to adapt to climate change now and over the long-term setting out key decision-making principles and objectives and a suite of actions.</p>



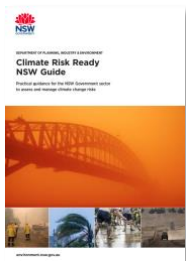
Planning for a more resilient NSW: A strategic guide to planning for natural hazards (DPE 2021)

The guide is intended to prompt consideration of relevant natural hazards in an integrated and multi-disciplinary way. It discusses high level existing policies, identify natural hazards relevant to NSW to be considered in strategic planning and sets out guiding principles to inform land-use planning decisions and manage natural hazard risk.



Resilience outcomes for the planning system (DPIE 2021b)

This project presents a series of outcomes to promote resilience in the land use planning system and ensures that resilience and support for rebuilding/recovery are embedded at all levels, including in the legislation, strategic planning, precinct planning, and statutory planning provisions.



Climate Risk Ready NSW Guide (DPIE 2021a)

The guide helps NSW Government staff to lead, influence and enable their organisations to better understand their exposure to climate change risks and opportunities. It outlines steps to consider the potential climate risks to an enterprise, program or project and encourages integration of these risks into enterprise risk management frameworks and procedures.



Managing climate risks to assets and services (Audit Office of New South Wales 2021)

This report assessed how effectively the Department of Planning, Industry and Environment (DPIE) and NSW Treasury have supported state agencies to manage climate risks to their assets and services. Climate risks that can impact on state agencies' assets and services include flooding, bushfires, and extreme temperatures. Impacts can include damage to transport, communications, and energy infrastructure, increases in hospital admissions, and making social housing or school buildings unsuitable



Future Transport 2056 (TfNSW 2020)

The 40-year vision, directions and principles for customer mobility in NSW, guiding transport investment over the longer term identifies 'moving to an environmentally, economically and socially sustainable transport system is essential to tackle climate change...'



NSW Long term Transport Masterplan (TfNSW 2012)

The plan identifies responding to climate change as a state-wide action of priority, with Action 8.8.3 focused on boosting our resilience to climate change and natural disasters by assessing climate resilience.

1.1 Purpose of this plan

This CAP has been prepared to support the development of the MPIP and will form part of the Planning Controls submission for the project.

The purpose of the CAP is to:

- Define the climate change projections over the design life of the infrastructure.
- Define the risk assessment process.
- Outline the project management approach to demonstrate compliance with recognised standards and guiding instruments.
- Manage risk through:
 - identification of climate change and natural hazard related risk and assign risk rating.
 - where necessary mitigate risk through adaptation measures and re-assess risk
- Enhance resilience through design and operational action.
- Define roles and responsibilities.

1.2 Document structure

To reduce the risk to vulnerable populations from climate change and minimise the effects of climate change on the City of Ryde, this climate change adaptation report has been prepared. The report is structured as follows:

1. **Introduction** | Outlines the study context and Study Requirements addressed by this report.
2. **Methodology** | Outlines the risk management process and stakeholder engagement undertaken.
3. **Context** | Outlines the context of the project, and the scope and boundaries of the assessment.
4. **Climate change** | Provides the current and future climate context that forms the assessment.
5. **Risk assessment** | Provides a summary of the risk assessment undertaken.
6. **Adaptation plan** | Provides the adaptation actions that have been integrated and considered in early planning.
7. **Monitoring and review** | Outlines next steps for consideration in subsequent planning and design phases.
8. **Assurance** | Summarises the key requirements for compliance with Green Star Communities.
9. **Implementation** | Proposes several priority outcomes and strategic initiatives to deliver holistic resilience.

2.0 Methodology

2.1 Risk management process

This CAP is the result of a collaborative and iterative risk management process engaging all relevant areas of the business as presented below in Figure 2.1.




FIGURE 2.1: CAP PROCESS

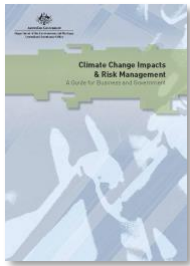
The purpose of the risk assessment is to help mitigate the potential for climate change induced risks through informed decision making, which in turn enables the design and operation of climate resilient infrastructure.

2.2 Guiding instruments

The climate change risk assessment provided in this report has been undertaken in line with the following relevant standards and guidelines.

TABLE 2.1: STANDARDS AND SUSTAINABILITY BENCHMARKING FRAMEWORKS

Document	Description
	<p>AS 5334-2013 Climate change adaptation for settlements and infrastructure – A risk based approach (Standards Australia 2013)</p> <p>Provides principles and generic guidelines on the management of the risks that settlements and infrastructure face from the impacts of climate change. In particular it describes a systematic approach to planning the adaptation of settlements and infrastructure based on the risk management process given in AS/NZS ISO 31000:2009.</p>



Climate Change Impacts & Risk Management: A Guide for Business and Government (AGO 2006)

The Guide provides a framework for managing the increased risk to organisations due to climate change impacts. The prime focus of the Guide is on the initial assessment and prioritisation of these risks.



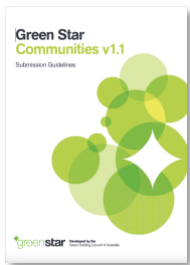
ISO 31000-2018 - Risk Management - Principles and Guidance (ISO 2018)

Adopted in Australia and New Zealand as AS/NZS ISO 31000:2009, provides a set of internationally endorsed principles and guidance on how organisations can integrate decisions about risks and responses into their existing management and decision-making processes.



NSW Climate Change Policy Framework (OEH 2016)

Aims to maximise the economic, social, and environmental wellbeing of NSW in the context of a changing climate and current and emerging international and national policy settings and actions to address climate change.



Green Star Communities v1.1 (GBCA 2016)

Assesses the planning, design and construction of large-scale development projects at a precinct, neighbourhood and/or community scale. It provides a rigorous and holistic rating across five impact categories – including Adaptation and Resilience (Credit 04).



Infrastructure Sustainability Rating Tool Technical Manual v1.2 (ISCA 2016)

The IS rating scheme evaluates sustainability initiatives and potential environmental, social, and economic impacts of infrastructure projects and assets – including Climate Change Adaptation.



GRESB Real Estate Scoring Methodology (GRESB 2016)

The GRESB Real Estate Assessment provides the basis for the systematic reporting, objective scoring, and peer benchmarking of ESG management and performance for property companies and funds around the world.

2.3 Data sources

Recent advances in climate science, and the release of the Intergovernmental Panel on Climate Change (IPCC) Fourth and Fifth Assessment Reports (AR4 and AR5) have given rise to a wealth of climate data being made publicly available.

The following (Figure 2.2) provides a hierarchy of data sources to be referenced as part of the climate risk assessment.

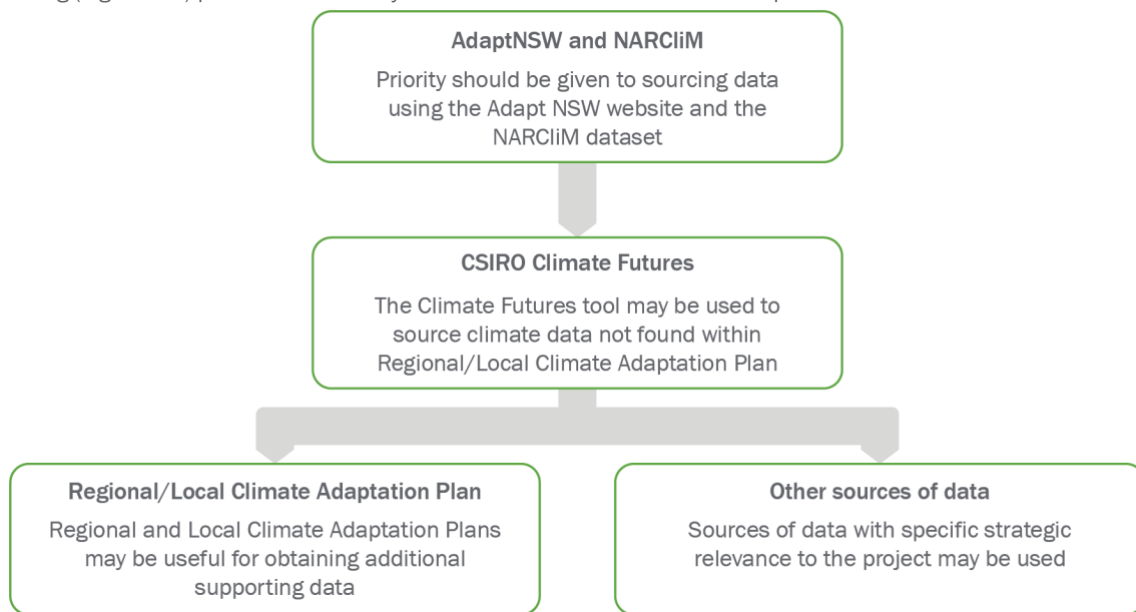


FIGURE 2.2: HIERARCHY OF CLIMATE DATA SOURCES

Adapt NSW and NARcliM: The NSW Office of Environment and Heritage (OEH 2014) has developed a range of information and tools to help government, businesses and communities build resilience in the face of future extreme events and hazards by helping them understand and minimise the impacts of climate change. NARcliM data (NSW/ACT Regional Climate Modelling project) (ARC Centre of Excellence for Climate System Science 2012) produces an ensemble of regional climate projections for south-east Australia designed to provide robust projections that span the range of likely future changes in climate.

CSIRO - Climate Futures (Clarke, Whetton & Hennessy 2011; Whetton et al. 2012): provides a selection of both AR4 and AR5 projections that enables users to explore, and obtain data for, projected monthly, 3-monthly, 6-monthly, and annual changes in up to 14 climate variables (extreme temperature, precipitation, sea level rise etc).

Regional/Local Climate Adaptation Plan: Where an overarching CAP has been developed at a regional or local authority level, climate projections from this may be used.

Other sources of climate projections may be used if they are deemed to provide specific strategic relevance.

2.4 Stakeholder engagement

A preliminary risk assessment was prepared based on the findings of a desktop review. A risk register was developed, identifying climate risks and initial likelihood and consequence ratings were allocated for each risk statement in line with criteria outlined by the Australian Greenhouse Office (AGO 2006).

The preliminary risk assessment was followed by series of stakeholder engagement activities. During the engagement activities workshops were conducted with project team members and stakeholders to inform the assessment, validate climate risks with the stakeholders, and identify appropriate adaptation responses. A summary of these activities is outlined in Table 2.2.

TABLE 2.2: STAKEHOLDER ENGAGEMENT ACTIVITIES

Workshop	Date	Description
Scoping Workshop	01/03/2023	Participants established the context for risk assessment and reviewed the preliminary risk assessment.
Adaptation Workshop	29/03/2023	Participants reviewed the context and proposed adaptation measures with a focus on those ranked highest.
Strategy Workshop	19/04/2023	Focused workshop on reviewing and refining a small number of strategic initiatives which could be implemented to deliver holistic resilience.

The stakeholder organisations engaged as a part of the CAP process and providing inputs to the risk allocation and adaptation actions are listed in Table 2.3.

TABLE 2.3: CAP RISK WORKSHOP ORGANISATION

NSW Department of Planning and Environment	WSP, Connecting with Country engagement
Ryde Council	Arcadis, Utilities
Atelier Ten, Sustainability	Tract, Landscape Architecture
AJC Architects	Aurecon, Social Infrastructure
Ecological Australia, Ecology and Biodiversity	TTW, Civil, Flood and Stormwater
Atlas, Housing affordability & Economic assessment	Transport for NSW and Sydney Metro

3.0 Context

3.1 Project

MPIP will become an exciting new place for homeowners, residents, business, and the community by planning in such a way to celebrate country and aid biodiversity. Department of Planning and Environment (DPE) and Ryde Council is leading the rezoning of Macquarie Park and this new Precinct will drive the success of the project by:

- Create public spaces that use traditional language, embody cultural stories, and create locally native ecologies and habitat for keystone species
- Protect and enhance the local flora and fauna and achieve a net-positive impact on biodiversity
- Maintain safety of visitors, and the public during disruption, and not contribute further to ongoing disturbance.
- Infrastructure and service continue during disruption, or bounces back immediately following, and requires little to no remedial works
- planning for Country by incorporating Country-centred planning principles and actions that respect the surrounding diverse communities
- delivering a socially and environmentally sustainable precinct
- Mitigate the threat of potential financial loss from direct and indirect climate related disruptions
- Enabling active mobility to the site and supporting future mobility transitions

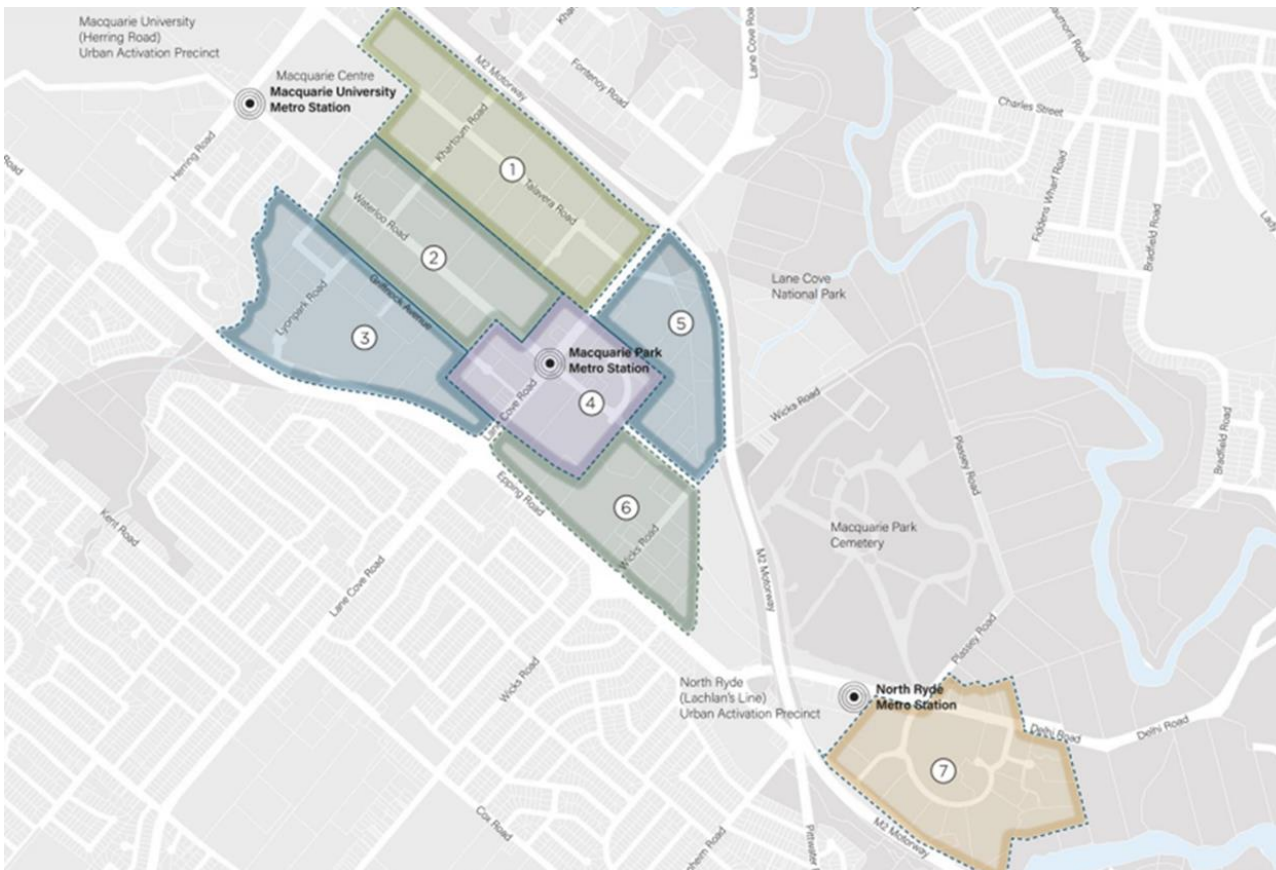


FIGURE 3.1: MACQUARIE PARK INNOVATION PRECINCT STRATEGIC USES MASTER PLAN

3.2 Scope

The process considers all matters associated with maintaining operations and meeting future development requirements for any potential tenants, their workforce, and visitors while onsite or commuting, and surrounding community within the Ryde Council and local government areas over the design life of the precinct (<120 years).

3.3 Success criteria

Success criteria are essentially a summary of the organisation’s long-term objectives. By combining success criteria with a consequence scale, it is possible to describe the level of consequence to an organisation of a risk associated with climate change, should it happen.

Success criteria for MPIP includes:

TABLE 3.1: SUCCESS CRITERIA FOR MPIP

Success Criteria	NSW Government	Asset Owner	Tenants and residents	Community
• Contribute to NSW state economic resilience to grow a critical hub for business, innovation, research and education	✓			
• Maintain adaptive capacity long-term	✓	✓		
• Retain asset value long-term	✓	✓		
• Infrastructure and service continue during disruption, or bounce back immediately following, and require little to no remedial works.	✓	✓		
• Mitigate the threat of potential financial loss from direct and indirect climate related disruptions	✓	✓	✓	
• Support an 18-hour economy	✓	✓	✓	✓
• Continuity of operations through disruption, or bounce back immediately following, and requires little to no remedial works	✓	✓	✓	✓
• Maintain safety of occupants, visitors, and the public during disruption, and not contribute further to ongoing disturbance	✓	✓	✓	✓
• Eliminate negative environmental effects	✓	✓	✓	✓

3.4 Geographic boundaries

The process considers all new and existing buildings, public domain, and enabling infrastructure within the boundaries of the 7 individual sub-precincts, while also taking into account neighbouring buildings, downstream infrastructure, all transport networks (metro, bus, pedestrian and active mobility routes) that converge at the site, and regional considerations related to climate change.

TABLE 3.2: GEOGRAPHIC BOUNDARIES

Consideration	Boundaries
Primary	All buildings, landscapes, infrastructure, and public domain within project boundaries.
Secondary	Neighbouring community, buildings, parks, and infrastructure.
Tertiary	Public transport networks (pedestrian, bike, bus, train, tram/light rail, and metro) that pass through and by the site, and regional considerations related to climate change.

3.5 Stakeholders

Beyond those who participated in the risk management workshops this CAP considered additional stakeholders who will be affected by the projects ability to respond to climate related disruption and may form part of any future review.

TABLE 3.3: ADDITIONAL STAKEHOLDERS CONSIDERED

Stakeholder	Summary of objectives and concerns
City of Ryde Council (acting as developer / development partner)	Continuity of operations; community cohesion; safety, security and accessibility of workers, residents and visitors; integrity of infrastructure.
Department of Planning NSW	Continuity of operations; community cohesion; safety, security and accessibility of workers, residents and visitors; integrity of infrastructure.
Transport for NSW (Sydney Buses, Metro)	Continuity of operations (transport, commercial, institutional, residential); safety and accessibility of workers, residents, and visitors; integrity of infrastructure.
Building owner(s)	Earnings, long term viability of the asset; integrity of infrastructure.
Residents	Safety, security and accessibility.
Commercial tenants	Continuity of business operations; safety and accessibility of staff, residents and visitors.
Workforce	Security of employment, safety and accessibility.
Visitors	Safety and accessibility.
Existing community	Community cohesion and safety; integrity of infrastructure.
Transit riders	Continuity of operations; infrastructure protection.
Government agencies (such as Police, Fire, Ambulance, Resilience NSW)	Public safety; integrity of infrastructure; emergency access.

3.6 Identified assets or asset classes

The following Identified assets or asset classes, as identified in AS 533 and referred to as Settlements and Infrastructure Sectors are covered by this Climate Adaptation Plan.

TABLE 3.4: ASSET OR ASSET CLASS – AS 5334-2013 (STANDARDS AUSTRALIA 2013)

Sector	Component (indicative)	Notes	Covered
	Cities		<input checked="" type="checkbox"/>
Places	Towns		<input checked="" type="checkbox"/>
	Villages		<input checked="" type="checkbox"/>

Sector	Component (indicative)	Notes	Covered
	Hamlets		<input type="checkbox"/>
Buildings	Residential	All housing types including mixed use centres, multiple dwellings and public and community housing such as boarding houses	<input checked="" type="checkbox"/>
	Commercial	Includes all facilities that facilitate professional services, banking, administration centres, call centres, resorts, etc.	<input checked="" type="checkbox"/>
	Industrial	Includes processing, manufacturing and warehousing	<input checked="" type="checkbox"/>
	Recreational	Includes major event facilities	<input checked="" type="checkbox"/>
	Retail	Includes shopping malls, bulky goods centres and mixed use centres	<input checked="" type="checkbox"/>
	Public	Includes schools, hospitals, universities and courts	<input checked="" type="checkbox"/>
	Historic	Heritage listed and state significant	<input type="checkbox"/>
	Tourism	Public and private facilities	<input checked="" type="checkbox"/>
OSD enabling infrastructure	Deck		<input checked="" type="checkbox"/>
	Tunnels		<input checked="" type="checkbox"/>
Energy	Electricity generation		<input checked="" type="checkbox"/>
	Electricity transmission and distribution		<input checked="" type="checkbox"/>
	Oil and gas storage, transmission and distribution		<input type="checkbox"/>
	Liquid fuels storage and distribution		<input type="checkbox"/>
Water	Water storage	Includes dams and header tanks	<input checked="" type="checkbox"/>
	Water supply and distribution	Includes pipes and pumps	<input checked="" type="checkbox"/>
	Sewerage	Includes pipes, pumps and sewerage treatment plants	<input checked="" type="checkbox"/>
	Irrigation	Includes pipes and pumps	<input checked="" type="checkbox"/>
	Drainage	Includes pipes and pumps, open drains such as swales, concrete formed structures, bio-filtration systems and other water sensitive urban design elements	<input checked="" type="checkbox"/>

Sector	Component (indicative)	Notes	Covered
Green infrastructure	Public open space and private domain landscapes	Includes regional, district and local parks, streetscapes, trees and gardens, private open space	✓
	Natural landscape systems	Includes conserved systems such as river corridors, urban National Parks and State Forests, vegetation and habitat reserves, foreshores and cliffs	✓
	Cultural landscapes	Includes urban public lands such as botanic gardens, archaeological (indigenous and settlement) sites and monuments	✓
	Urban agriculture	Includes community gardens, urban farms for food production and/or commercial plant production	✓
Transport	Roads	Includes all gazetted roads, sealed or unsealed, formed and unformed	✓
	Tunnels	All transport tunnels	✓
	Bridges	All transport bridges	✓
	Rail	Includes railway stations, fixed structures and rolling stock	✓
	Airports		✗
	Ports	Includes jetties, wharves, sea walls, navigational aids	✗
	Pedestrian and cycle	Includes footpaths and cycle ways	✓
Communication	Fixed line	Includes all overhead lines	✓
	Underground		✓
	Transmission facilities	Includes data, radio, TV and phone systems	✓
ICT	Critical systems and data		✓
Resource development	Mining, oil and gas extraction		✗
	Forestry		✗
	Fisheries	Includes aquaculture	✗

3.7 Design life

Design life is defined as the period within which an element of the works must continue to meet the performance and technical requirements for the project and remain within specified limits of reliability, availability and maintainability without major renewal beyond normal cyclic maintenance activities. It also benchmarks the requirements for durability.

Preliminary design life of asset elements are defined below:

TABLE 3.5: DESIGN WORKING LIFE

Asset	Design life
Structural elements	
Building structures and other common structures	60 years
Civil and hydraulic elements	
Drainage (inaccessible elements)	100 years
Drainage (accessible elements)	50 years
Building pavement	50 years
Road pavement	15 years
Mechanical and electrical elements	
Critical infrastructure systems – security & communications	25 years
Critical system equipment (cameras, access control, etc.)	15 years
HVAC - heat pumps	15 to 25 years
HVAC – split systems	7 to 10 years
HAVC – fans	15 to 20 years
Architectural elements	
Materials and finishes	20 years
Facades	30 years

4.0 Climate change

4.1 Emissions scenarios

The Intergovernmental Panel on Climate Change (IPCC (Intergovernmental Panel on Climate Change) 2014) publishes four greenhouse gas concentration trajectories known as Representative Concentration Pathways (RCPs) which are used for climate modelling and research as detailed below:

TABLE 4.1: RCPS AND GLOBAL WARMING

Scenario		Global warming mean and likely range (°C)
RCP 2.6	Emissions peak 2010-2020, then decline substantially	1.0°C (0.3 to 1.7)
RCP 4.5	Emissions in RCP 4.5 peak around 2040, then decline	1.8°C (1.1 to 2.6)
RCP 6.0	Emissions peak around 2080, then decline	2.2°C (1.4 to 3.1)
RCP 8.5	Emissions continue to rise throughout the 21 st century	3.7°C (2.6 to 4.8)

Recognising the degree of uncertainty that exists regarding future climate, the latest IPCC report (AR5) introduced a series of Representative Concentration Pathways (RCPs) to help provide parameters around varying greenhouse gas (GHG) emission trajectories. The RCPs represent four plausible climate futures that may eventuate over the coming years. The most conservative scenario is represented by RCP 8.5 which assumes a high emissions pathway with global GHG emissions continuing to rise throughout the 21st century. Currently, RCP 8.5 represents not only the worst-case emissions scenario, but also the most likely case. As such, until further climate data revises this prediction, we recommended that RCP 8.5 is used when sourcing relevant climate projections.

4.2 Time scales

Given the scale of the proposed development and enabling infrastructure, the expected design life of the development (>120 years), the timeframe for the proposed construction works and the available climate data, three time periods have been used for the assessment. These time periods and the rationale for their selection are summarised in Table 4.2 below.

TABLE 4.2: DEVELOPMENT TIME SCALES DESCRIPTIONS

Time scale	Year	Rationale
Medium-term	2040	Development settling into operations with current systems and current design intent/use, relatively similar climate settings.
Long-term	2070	Development inhabited by future use scenarios, possibly adapted to future use types, significantly advanced climate change scenario.

4.3 Risk variables

The following risk variables are initially covered for potential risk consideration, however the geographical and topographical site context together with the findings of the risk workshop(s) will ultimately determine the salient risks to the project. Key variables for this project cover environmental, social, and economic risks. Economic and social related variables represent the key acute shocks and chronic stresses identified in Resilient Sydney (2018) and the stakeholder engagement process.

TABLE 4.3: RISK VARIABLES CONSIDERED

Element	Variable
Sea surface temperature	Increase in sea level
	Increase in water temperature
	Increase in adjacent air temperature and humidity
Air Temperature	Increase in mean maximum temperature
	Increased annual mean temperature
	Increased number of hot days over 35°C
Precipitation	Greater frequency of higher intensity rainfall events
Drought	Decrease in annual total rainfall
Wind	Increased wind speeds
Extreme storms	Increase in frequency and severity of storms
	Increasing frequency of electrical storms and lightning strikes
Humidity	Changes to relative humidity
Bushfire	Increase in risk of bushfires
Solar radiation	Increase in level of UV
Waterway Health	Declining Waterway Health
Soil Health	Soil Health
Seismic	Earthquake
	Tsunami
Civil Disturbance	Attack
	Civil unrest
	Pandemic
	Financial crisis
Critical Infrastructure Failure	Transport and logistics network
	Electrical network
	Water network
	Waste network
Shift in Business Models	Digital network
	Demographic shifts
Social Stresses	Economic models
	Geopolitical environment
	Local economic environment

4.4 Observed Climate

Local climate for the region is predominantly temperate, which typically results in warm to hot wet summers/autumn and mild, damp winter/spring. The coastal location of the development also influences local climate, with generally lower temperatures experienced when compared with inland areas (e.g. Western Sydney). Rainfall patterns are typically seasonal, with higher rainfall experienced during late summer and early autumn months and lower rainfall in winter through early spring (Table 4.4). Trends indicate variability in the amount of rainfall received from year to year. Storms result in periods of heavy rainfall and strong winds and may lead to flood events.

TABLE 4.4: CLIMATE EXPOSURE (BOM 2023B)

Climate variable	Averages (1967-2023)
Average maximum daily temperature	Ranging from 28.6°C (January), to 17.5°C (July)
Average minimum daily temperature	Ranging from 17.7°C (January), to 6.1°C (July)
Extreme temperatures above 35°C	11 days per year over 35°C, typically in summer months
Average monthly rainfall	Ranging from 128.2 mm (February) to 50.2mm (September)

4.4.1 Mean temperature

The local area typically experiences average maximum daily temperatures ranging from 28.2°C in January to 17.5°C in July, and average minimum daily temperatures ranging from 17.7°C in January to 6.1°C in July. Given its coastal location, the average temperatures for the local area are typically milder than those experienced by the Greater Sydney region, particularly Western Sydney which can experience significantly higher averages (e.g. Penrith Lakes Automatic Weather Station shows a January average maximum daily temperature of 31.0°C (BoM 2023A).

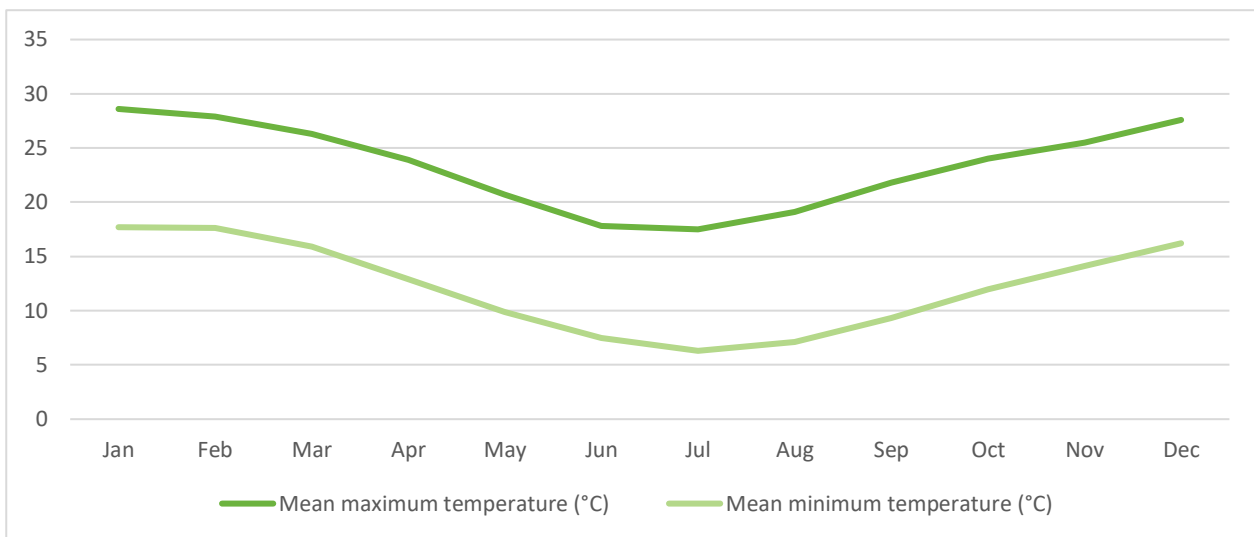


Figure 4.1: Mean maximum and minimum temperatures recorded at PARRAMATTA NORTH (MASONS DRIVE) (1967 -2023) (BoM 2023B)

4.4.2 Urban heat island

Urban heat islands occur in urban areas such as cities or industrial sites and lead to consistently higher temperatures than surrounding areas driven by a greater retention of heat. This is caused by the sun’s heat being absorbed by hard surfaces with high thermal mass such as buildings, dark roofs, car parks, paved surfaces, and roads. Human activities, such as motorised transport and using air conditioning also increase these impacts due to their generation of waste heat.

Figure 4.2 shows thermal imagery for Macquarie Park and the surrounding area. Higher temperatures are seen in parts of the map that are heavily urbanised and/or characterised by large areas of paved and roofed surfaces, such as industrial areas around Silverwater, while areas of green space (such as national parkland) generally experience lower temperatures.

Macquarie Park is similar to the rest of the City of Ryde, which is currently shown to have average exposure to urban heat island effects, likely driven by limited permeable land cover and asphalt/concrete paved roads. OEH (2015b) notes that changes in land use from industrial/commercial to medium or high density is likely to result in a reduction in average temperatures. For the Macquarie University area, the cooler temperatures are likely due to the increases in vegetation and parking lot cover.



FIGURE 4.2: URBAN HEAT MAPPING, EXISTING CONDITION (SEED NSW 2019)

4.4.3 Extreme heat

The local area historically experiences an average of 11 days above 35°C per year, lower than other areas of Greater Sydney (e.g. Penrith Lakes AWS historically records 22.7 days per year on average). Like the mean temperature averages, this is probably driven by the site’s coastal setting. Temperature records for nearby Parramatta North show highest maximum temperatures can typically exceed 40°C between October and March.

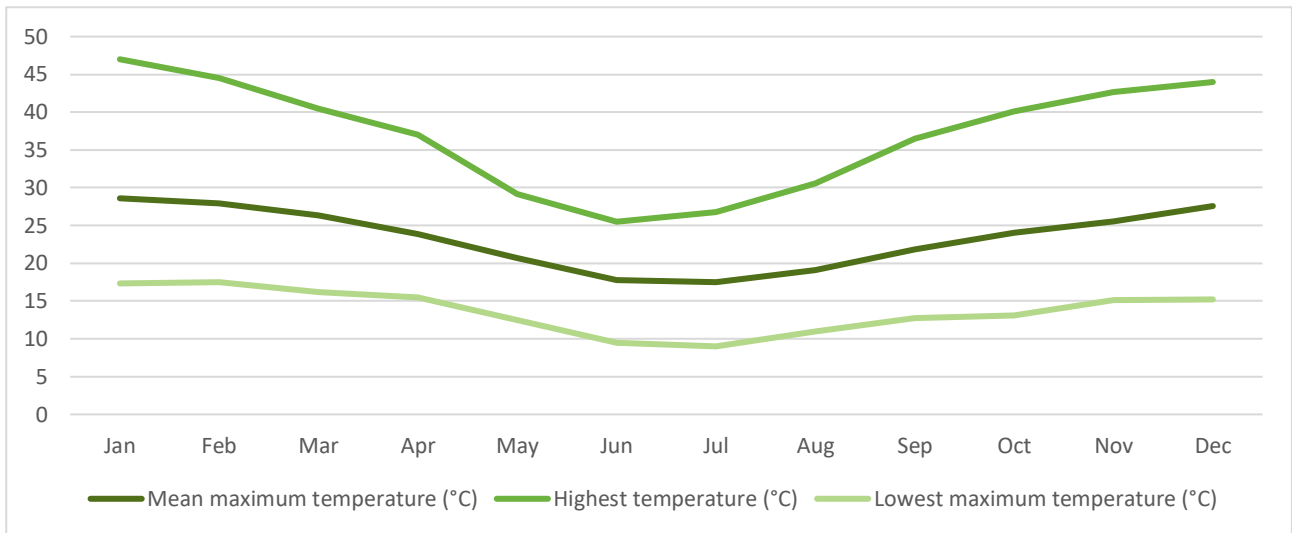


FIGURE 4.3: AVERAGE MAXIMUM TEMPERATURES AND HISTORICAL MAXIMUM TEMPERATURES RECORDED AT PARRAMATTA NORTH (MASON'S DRIVE) (1967 -2023) (BOM 2023B)

4.4.4 Mean rainfall

Annual rainfall for the local area has averaged 984.9mm over the period 1965-2023. Typically, January to June are the wettest months of the year, while July to December receive the lowest average rainfall.



Figure 4.4: AVERAGE RAINFALL RECORDED AT PARRAMATTA NORTH (MASONS DRIVE) (1965 -2023) (BoM 2023B)

4.4.5 Extreme rainfall and flooding

The Macquarie Park catchment covers the suburbs of Marsfield, Macquarie Park, Ryde and North Ryde and includes Mars Creek, Shrimptons Creek, Industrial Creek, Porters Creek and Lane Cove catchments as well as the floodplain of the Lane Cove River itself downstream from Fullers Bridge next to River Avenue. The total catchment area is approximately 1558 hectares and flooding of the area, including the inundation of properties, has been documented in several events.

The Macquarie Park Floodplain Risk Management Study and Plan (2011) was carried to define existing flood behaviour for the catchment in terms of flood levels, flood depths, and flood velocities and to show the extent of flood inundation.

The study modelled design floods with 5 year, 20 year, 50 year, and 100 year Average Recurrence Intervals (ARIs) as well as the probable maximum flood (PMF). The study also undertook sensitivity testing and considered the impact of future climate change on design events.

These maps (figure 4.5 and 4.6) illustrate that the impact on the 1% AEP (100-year ARI) of:

- 10% increase in rainfall intensities. The Practical Consideration of Climate Change Floodplain Risk Management Guideline (DECC, 2007) reports that extreme rainfall (40 year 1 day rainfall total) could increase by 10% for Sydney Metropolitan catchments by 2070.
- 2100 (+ 0.9m sea level rise) impacts per the Year 2100 Sea Level Rise planning benchmark

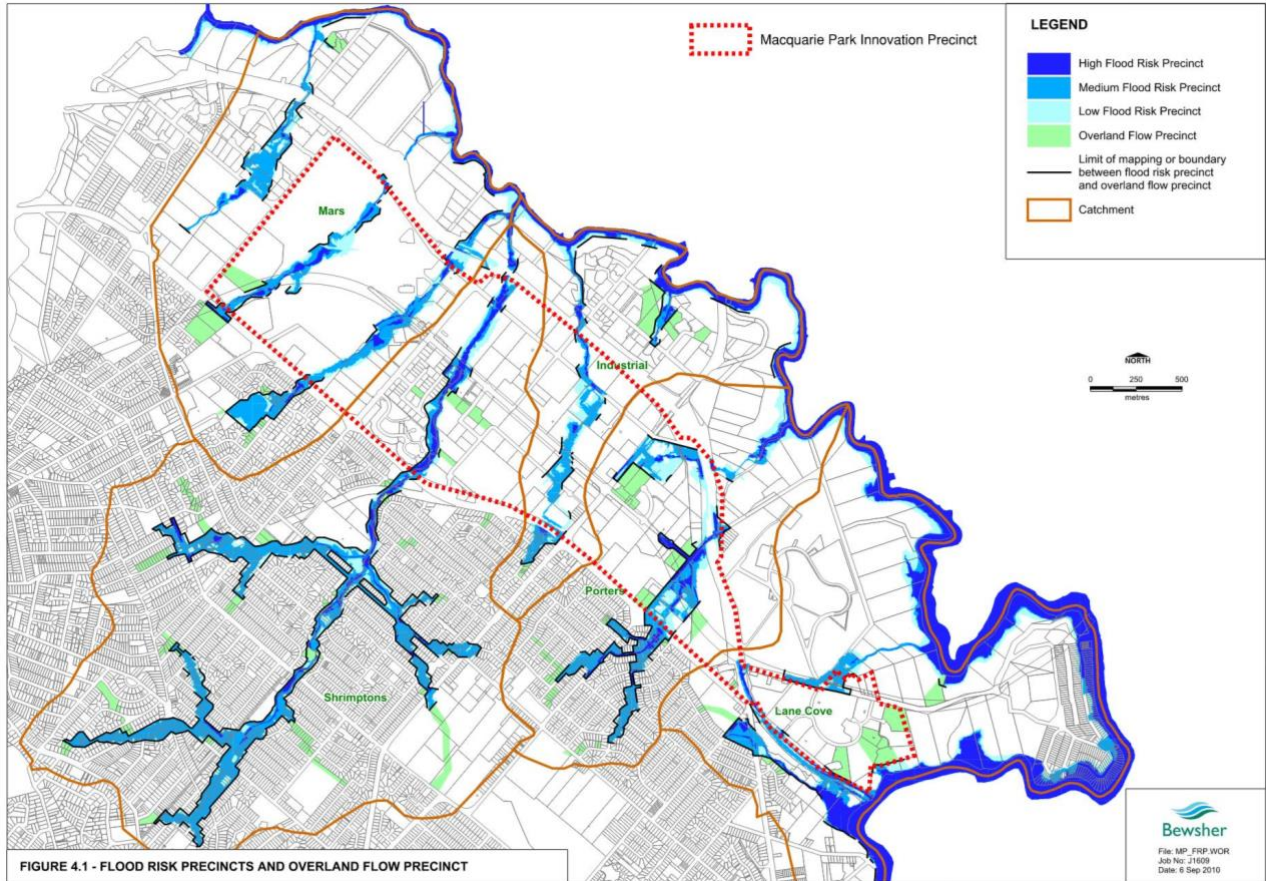


FIGURE 4.5: FLOOD RISK PRECINCTS (CITY OF RYDE 2011)

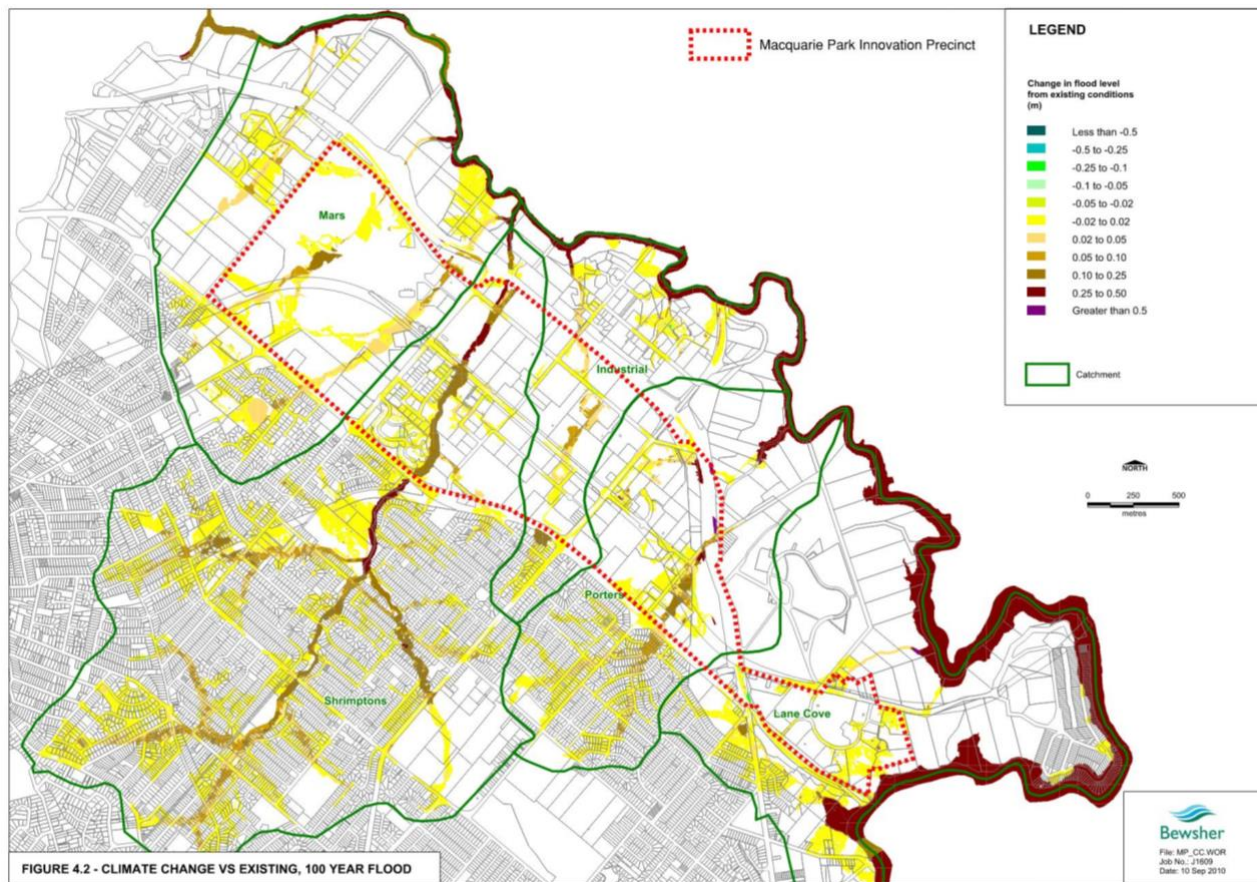


FIGURE 4.6: CLIMATE CHANGE IMPACTS VS 100 YEAR FLOOD MAP (CITY OF RYDE 2011)

4.4.6 Storm events

The Sydney region is susceptible to storm events, predominantly in the form of east coast lows (ECLs) that develop as a result of ex-tropical cyclones that decay as they move south or interactions between troughs of low pressures/cold fronts with warmer sea surface temperatures. Within the Greater Sydney area, several recent storm events (BoM 2023c) have been recently observed:

- In June 2016, the East Coast Storms and Flood events resulted in flash flooding and property damage across Sydney
- In March 2017 a severe thunderstorm resulted in 33,000 homes without power across western Sydney and road closures
- In December 2018 a severe thunderstorm impacted Sydney's northwest, leading to 3788 calls for assistance to the NSW State Emergency Service, and left 55,000 homes without power throughout nearby Castle Hill, North Parramatta, Winston Hills, and Carlingford
- In February 2019 45,000 homes in Sydney's northwest lost power due to a storm event, with up to 5,000 homes without power for multiple days
- In February 2020 Sydney experienced two east coast lows (8th and 18th February) with rain up to 400mm falling over three days and winds exceeding 100km/h
- In March 2021, extreme rain fall lead to widespread flooding in NSW, affecting the North Coast to Sydney. Suburbs in the Sydney Metropolitan area experienced the worst flooding in 60 years
- In March 2022, thousands were evacuated in Western Sydney due to rising rivers after intense rainfall. Major flooding submerged parts of rural suburbs. Areas near the Manly Dam were placed under evacuation order by the State Emergency Service
- In February 2023, a severe windstorm in Sydney left 60,000 people without power

In addition to gale force winds and heavy widespread flooding, ECLs also generate rough seas and storm tides. Storm tides can lead to coastal flooding, particularly when they combine with astronomical high tides or king tides. This was evidenced in 2016 when an east coast low-driven storm tide combined with a king tide affected areas of Greater Sydney such as Collaroy which experienced severe inundation and erosion.

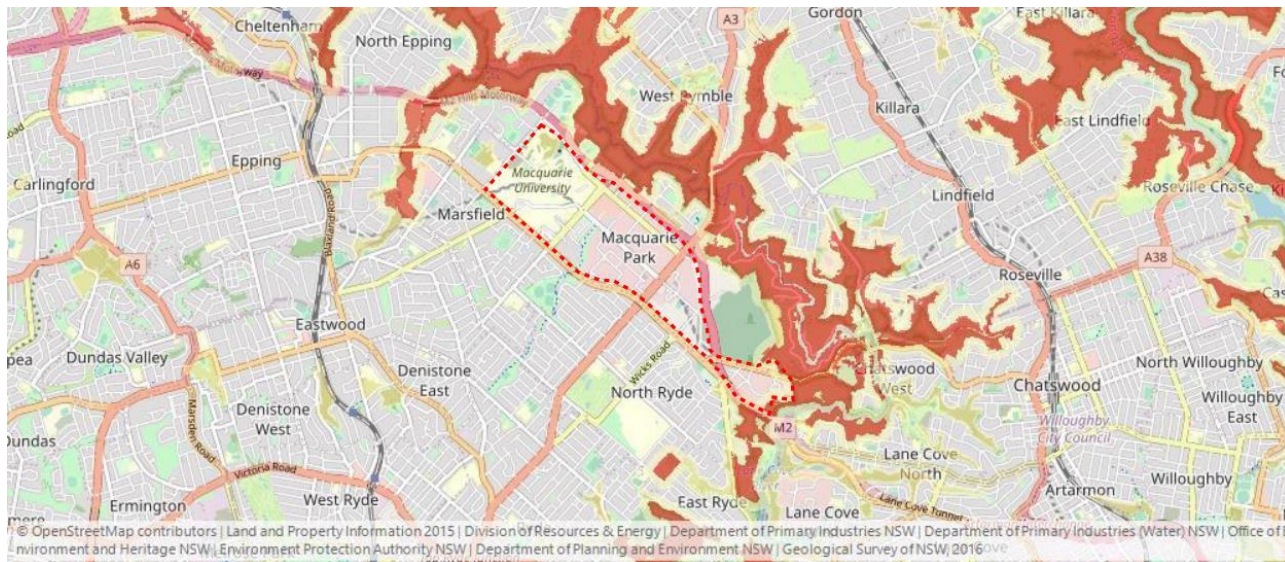


FIGURE 4.7: PROXIMITY OF MACQUARIE PARK TO BUSHFIRE PRONE LAND (NSW RURAL FIRE SERVICE 2022)

4.4.7 Bushfires

The development is within proximity of bushfire prone land (figure 4.7). While the precinct is not itself considered bushfire prone land, recent experience has shown that the indirect impacts of bushfire – including poor air quality and infrastructure failure – pose significant risks for all communities in the Greater Sydney region.

The Forest Fire Danger Index (FFDI) is used in NSW to quantify fire weather. The FFDI combines observations of temperature, humidity, and wind speed with an estimate of the fuel state. AdaptNSW (2015a) notes that long-term FFDI estimates are available for two weather stations in the region, Sydney Airport and Richmond. The average annual FFDI for the period 1990 – 2009 is 5.5 at Sydney Airport and 7.1 at Richmond.

Fire weather is classified as ‘severe’ when the FFDI is above 50, and most of the property loss from major fires in Australia has occurred when the FFDI reached this level. FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Severe fire weather conditions are estimated to occur on average one day per year at Sydney Airport and 1.8 days per year at Richmond. These days are more likely to occur in summer and spring months.

4.5 Climate projection snapshot

A summary of the key climate related effects relevant to the Macquarie Park Innovation District can be found below in Table 4.5. This data has been taken from the Transport for NSW *Climate Risk Assessment Tool 1: Climate Data* (2021). This tool provides a summary of the CRA model results. The CCRA model is built in Matlab using parametrization and optimisation algorithms applied to gridded NARCIIM1.5 data combined with other sources.

Original NARCIIM data containing projections from four Global Circulation Models and three downscaling techniques, thus, providing a total of 6 projection scenarios. This CCRA model combines all 6 ensembles (gridded raw data) and selects the most extreme values for each climate variable and a unique graphical location, thus, creating a new data set that is more suitable for climate change risk assessment. This data is not representative of the exact climate future, and it is built for risk estimation only.

This tool can be used to get information about the changes in the near future (2021-2050), mid (2051-2080) and far (2071-2100) future. In addition, the tool provides data for sea level rise based on Climate Analytics data (using (Bamber et al. 2019)) as well as Urban Heat Island Effect, Heat Vulnerability Index and Disaster Resilience Index based on SEED and BNHCRC data as well as locations of the water bodies and bushfire risk zones.

In-depth details of relevant climate data, projections, and commentary from AdaptNSW (OEH 2014) and NARCIIM (ARC Centre of Excellence for Climate System Science 2012) can be found in **Error! Reference source not found. Error! Reference source not found.**, page 53.

Table 4.5: Climate projection snapshot (TfNSW 2021)

	2040	2070
Maximum temperatures	+0.7°C	+1.9°C
Minimum temperatures	+0.6°C	+2.0°C
Days above 35°C	+4 days	+11 days
Days above 40°C	+1 day	+4 days
Cold nights	-5 nights	-12 nights
Average annual rainfall	-13% to +18%	-9% to +24%
Extreme rainfall	-3 to +12%	-7 to +10%
Evaporation	+1 to +8%	+2 to +24%
No. of droughts per decade	2 - 5	1 - 9
Extreme winds	-5 to +8%	-16 to +24%
No. of fire days	9 - 11	10 - 15

5.0 Risk assessment

5.1 Risk assessment process

Based on the project context and climate projections an initial risk assessment was drafted by Atelier Ten incorporating potential impacts, and estimated levels of consequence and likelihood for both 2040 and 2070. These were drawn from prior experience in climate adaptation and resilience planning on projects of a similar nature, and/or location with comparable context.

The initial risk assessment assumes a business-as-usual approach to development not incorporating any formal risk assessment or adaptation measures.

The measures of consequences were taken from AS5334-2013 and can be seen in Table 5.1: Risk Criteria – Qualitative Measures of Consequences (AS5334 2013). The level of consequence in the risk assessment is influenced by both the level of occupancy of the subject development (assumed fully occupied at both 2040 and 2070 time periods), and the surrounding precinct (assumed increasingly developed and occupied at both time periods).

TABLE 5.1: RISK CRITERIA – QUALITATIVE MEASURES OF CONSEQUENCES (AS5334 2013)

Consequence	Adaptive Capacity	Infrastructure	Social	Governance	Financial	Environmental	Economy
Insignificant	No change	No infrastructure damage, no change to service	No adverse human health effects	No changes to management required	Little financial loss or increase in operating expenses	No adverse effects on natural environment	No effects on the broader economy
Minor	Minor decrease to the adaptive capacity of the asset. Capacity easily restored.	Localised infrastructure service disruption. No permanent damage. Some minor restoration work required. Early renewal of infrastructure by 10-20%. Need for new/modified ancillary equipment.	Short-term disruption to employees, customers or neighbours. Slight adverse human health effects or general amenity issues.	General concern raised by regulators, requiring response action	Additional operational costs Financial loss small, <10%	Minimal effects on the natural environment	Minor effect on the broader economy due to disruption of service provided by the asset
Moderate	Some change in adaptive capacity. Renewal or repair may need new design to improve adaptive capacity.	Limited infrastructure damage and loss of service. Damage recoverable by maintenance and minor repair. Early renewal of infrastructure by 20-50%.	Frequent disruptions to employees, customers or neighbours. Adverse human health effects	Investigation by regulators. Changes to management actions required	Moderate financial loss 10-50%	Some damage to the environment, including local ecosystems. Some remedial action may be required	High impact on the local economy, with some effect on the wider economy
Major	Major loss in adaptive capacity. Renewal or repair would	Extensive infrastructure damage requiring major repair.	Permanent physical injuries and fatalities may occur.	Notices issued by regulators for corrective actions. Changes	Major financial loss 50-90%	Significant effect on the environment and local ecosystems.	Serious effect on the local economy spreading to

Consequence	Adaptive Capacity	Infrastructure	Social	Governance	Financial	Environmental	Economy
	need new design to improve adaptive capacity.	Major loss of infrastructure service. Early renewal of infrastructure by 50-90%.	Severe disruptions to employees, customers, or neighbours.	required in management. Senior management responsibility questionable.		Remedial action likely to be required.	the wider economy
Catastrophic	Capacity destroyed, redesign required when repairing or renewing asset.	Significant permanent damage and/or complete loss of the infrastructure and the infrastructure service. Loss of infrastructure support and translocation of service to other sites. Early renewal of infrastructure by 90%.	Severe adverse human health effects, leading to multiple events of total disability or fatalities. Total disruption to employees, customers, or neighbours. Emergency response at a major level.	Major policy shifts. Change to legislative requirements	Extreme financial loss > 90%	Very significant loss to the environment. May include localised loss of species, habitats, or ecosystems. Extensive remedial action essential to prevent further degradation. Restoration likely to be required.	Major effect on the local, regional, and state economies.

The measures of likelihood were also taken from AS5334-2013 and can be seen in Table 5.2: Risk Criteria – Qualitative Measures of Likelihood (AS5334 2013). The level of likelihood in the risk assessment is influenced by the RCP8.5 emissions scenario and increase over the two time periods (2040 and 2070).

TABLE 5.2: RISK CRITERIA – QUALITATIVE MEASURES OF LIKELIHOOD (AS5334 2013)

Likelihood	Description	Recurrent Or Event Risks	Long Term Risks
Almost Certain	Could occur several times per year	Has happened several times in the past year and in each of the previous 5 years or Could occur several times per year	Has a greater than 90% chance of occurring in the identified time period if the risk is not mitigated
Likely	May arise about once per year	Has happened at least once in the past year and in each of the previous 5 years or May arise about once per year	Has a 60–90% chance of occurring in the identified time period if the risk is not mitigated
Moderate	Maybe a couple of times in a generation	Has happened during the past 5 years but not in every year or May arise once in 25 years	Has a 40–60% chance of occurring in the identified time period if the risk is not mitigated
Unlikely	Maybe once in a generation	May have occurred once in the last 5 years or May arise once in 25 to 50 years	Has a 10–30% chance of occurring in the future if the risk is not mitigated
Very Unlikely (Rare)	Maybe once in a lifetime	Has not occurred in the past 5 years	May occur in exceptional circumstances, i.e. less than 10%

or
Unlikely during the next 50 years

chance of occurring in the
identified time period if the risk is
not mitigated

Consequences and likelihoods are combined to develop a risk rating matrix based on AS5334-2013 and can be seen in Table 5.3: Risk Rating Matrix (AS5334 2013). This matrix acts as criteria for the organisation to use when evaluating risks as part of the risk assessment process.

TABLE 5.3: RISK RATING MATRIX (AS5334 2013)

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	Medium	High	Extreme
Moderate	Low	Low	Medium	High	Extreme
Unlikely	Low	Low	Medium	Medium	High
Very Unlikely	Low	Low	Low	Medium	Medium

The level of **acceptable** risk will depend on a series of factors including the particular project, context, potential impacts, and organisation's appetite for risk. In some cases, it may be deemed necessary to mitigate all high and extreme risks to medium or low. In other cases, it may be impossible to mitigate an extreme risk entirely, yet the scope of adaptation measures may be deemed acceptable.

Given the inherent uncertainty in climate change projections and the potential for serious or irreversible damage to settlements and infrastructure, it is entirely appropriate that organisations adopt a prudent and conservative risk attitude for risks from climate change. Organisations should also adopt a proactive attitude to maximising opportunities and benefits associated with a changing climate.

This draft risk assessment was reviewed at both workshops. In detail at the Scoping Workshop dated 01/04/2022, and at a high-level during the Adaptation Workshop dated 29/04/2022. During both workshops participants reviewed the levels of consequence and likelihood, and suggested additional potential impacts.

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Sea surface temperature	Increase in sea level	Direct	Inundation Direct: Potential for inundation of infrastructure during storms resulting in flood damage and safety risk from backed up overland flow.	Place-based	Financial Infrastructure Economy	Major	Very Unlikely	Medium	Major	Very Unlikely	Medium
Sea surface temperature	Increase in sea level	Direct	Intrusion Direct: Saltwater intrusion, contaminating water sources, impacting groundwater resources and landscaping, and/or increasing degradation of building materials (e.g. foundations)	Place-based	Financial Infrastructure	Major	Very Unlikely	Medium	Major	Very Unlikely	Medium
Sea surface temperature	Increase in water temperature	Direct	Warming water Direct: increase in water temperature degrades habitat quality for sea life currently resident in creeks	Place-based	Social Environmental	Moderate	Likely	Medium	Major	Likely	High
Sea surface temperature	Increase in adjacent air temperature and humidity	Direct	Warming water Direct: warmer water increases nearby air temperature and humidity	Place-based	Social Financial	Moderate	Likely	Medium	Moderate	Likely	Medium
Air Temperature	Increase in mean maximum temperature	Direct	Electrical assets - power supply on site Direct: Extended high temperatures may have an adverse impact on the operation of some electrical equipment, such as components in kiosks or sub-stations or external control cabinets or switchboards or LED's used in street lighting leading to system failure or service interruptions.	Integrated	Financial Infrastructure	Major	Moderate	High	Major	Moderate	High
Air Temperature	Increased annual mean temperature	Direct	Landscapes Direct: Combined with lower rainfall will result in the loss of many plant species and less vigorous growth of many of the survivors, issues with management of pest plants and animals, loss of landscape amenity.	Place-based	Financial Infrastructure Environmental	Moderate	Almost Certain	High	Moderate	Almost Certain	High
Air Temperature	Increased annual mean temperature	Indirect	Energy costs Indirect: Increase in average temperatures may lead to an increase in energy demand and associated utility costs.	Integrated	Financial Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Air Temperature	Increased number of hot days over 35 °C	Direct	Heat Islands Direct: Increases in number of days above 35 °C may contribute towards urban heat island effects, leading to reduced comfort and increased complaints from building occupants and pedestrians	Integrated	Financial Social	Moderate	Almost Certain	High	Moderate	Almost Certain	High
Air Temperature	Increased number of hot days over 35 °C	Direct	Thermal comfort Direct: HVAC system may experience overload, affecting thermal comfort for building occupants, and increasing HVAC maintenance and operating costs.	Integrated	Financial Infrastructure Social	Minor	Likely	Medium	Moderate	Almost Certain	High
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Flood immunity Direct: Greater frequency of higher intensity rainfall events may lead to changes in flood immunity levels.	Place-based	Financial Infrastructure	Major	Moderate	High	Major	Moderate	High

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Building structures - floor levels and roof drainage Direct: Greater frequency of higher intensity rainfall events may lead to localised flooding, damage due to scour and less safe operating conditions.	Place-based	Financial Infrastructure	Moderate	Likely	Medium	Moderate	Likely	Medium
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Emergency Egress Direct: Greater frequency of higher intensity rainfall events may increase events that limit access and egress, resulting in tenants being stranded at the development.	Place-based	Financial Social	Moderate	Moderate	Medium	Major	Moderate	High
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Civil drainage Direct: Greater frequency of higher intensity rainfall events may lead to inundation of drainage infrastructure as a result of insufficient system capacity, with resulting damage on site or adjacent, service disruption and safety risk.	Process-oriented	Financial Infrastructure	Major	Moderate	High	Major	Likely	High
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Landscapes Direct: Greater frequency of higher intensity rainfall events may affect health of plants and lead to tree and tall plant instability due to saturated soils	Place-based	Financial Infrastructure	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Marine habitat Direct: Greater frequency of higher intensity rainfall events may affect water quality and salinity, compromising habitat quality for species resident in the creeks	Place-based	Social Environmental	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Heritage assets Direct: Greater frequency of higher intensity rainfall events will accelerate building fabric aging, increase likelihood of water damage from roof and wall leaks	Place-based	Financial Infrastructure	Minor	Likely	Medium	Moderate	Likely	Medium
Drought	Decrease in annual total rainfall	Indirect	Landscapes Indirect: Decrease in annual total rainfall leading to a reduction in regional water storages and reduce water supplies making it difficult to water landscaping.	Place-based	Financial Environmental Social	Minor	Likely	Medium	Minor	Almost Certain	Medium
Drought	Decrease in annual total rainfall	Indirect	Potable water availability Indirect: Decrease in annual total rainfall may result in water restrictions prohibiting water use in heat rejection, irrigation, human consumption.	Process-oriented	Infrastructure	Moderate	Likely	Medium	Moderate	Likely	Medium
Drought	Decrease in annual total rainfall	Indirect	Potable water pricing Indirect: Decrease in annual total rainfall may result in water restrictions and pricing impacts on tenants, running costs of water-cooled systems for building owners.	Process-oriented	Financial Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Wind	Increased wind speeds	Direct	Debris Direct: Increasing wind speeds may dislodge loose furniture or equipment (including vegetation) damaging exposed plant equipment and facades or make the public domain unsafe.	Integrated	Financial Infrastructure	Major	Moderate	High	Major	Likely	High

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Wind	Increased wind speeds	Direct	Wind driven rain Direct: Increasing wind speeds coupled with greater frequency of higher intensity rainfall events may lead to wind driven rain flooding upper levels and penetrating facades.	Place-based	Financial Infrastructure	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Wind	Increased wind speeds	Direct	Pedestrian and bicyclist comfort and safety - wind tunnels Direct: Increasing wind speeds exacerbated by tall buildings and the elevated deck may lead to wind tunnel conditions making the public realm uncomfortable, inaccessible, and potentially unsafe.	Place-based	Financial Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Wind	Increased wind speeds	Direct	Electrical assets Direct: Wind damage to electrical circuitry (overhead wiring) may result in disruption to services and increase maintenance costs.	Process-oriented	Financial Infrastructure	Major	Moderate	High	Major	Likely	High
Wind	Increased wind speeds	Direct	Public realm assets Direct: Wind damage to shade structures, kiosks, and other items in the parks and public domain.	Place-based	Financial Infrastructure	Moderate	Moderate	Medium	Major	Likely	High
Wind	Increased wind speeds	Direct	Landscape Direct: Wind damage to shade trees, including downed branches and whole trees.	Place-based	Financial Infrastructure	Moderate	Moderate	Medium	Major	Likely	High
Air Quality	Increased wind speeds / Industrial and commercial	Integrated	Air quality Direct: Exposure to smoke and particulate pollution for workers and visitors, that may cause respiratory distress, as well as reduced visibility.	Integrated	Social Infrastructure	Moderate	Likely	Medium	Moderate	Likely	Medium
Extreme storms	Increase in frequency and severity of storms	Direct	Hail storms Direct: Increase in extreme hailstorm events may damage to cladding, exposed plant and services, landscapes, entryways and horizontal/sloped glazing.	Integrated	Financial Infrastructure	Moderate	Almost Certain	High	Major	Almost Certain	Extreme
Extreme storms	Increase in frequency and severity of storms	Direct	Dust storms Direct: Last major dust storm 2009, combination of drought, hot weather and westerly wind. Increased risk of systems damage and occupant respiratory illness	Integrated	Financial Social	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Extreme storms	Increase in frequency and severity of storms	Direct	Tornados Direct: Increase in micro-burst windstorms small tornados, compromising life-safety of anyone in public realm and in buildings insufficiently resistant to extreme winds.	Integrated	Financial Infrastructure	Major	Unlikely	Medium	Major	Unlikely	Medium
Extreme storms	Increase in frequency and severity of storms	Indirect	Displacement Indirect: Increase in frequency and severity of storms may result in damage to properties, causing displacement and disruption of tenant / business activity during clean up and repair.	Process-oriented	Financial	Minor	Unlikely	Low	Major	Likely	High
Extreme storms	Increasing frequency of electrical storms and lightning strikes	Direct	Lightning strike Direct: Increasing frequency of electrical storms and lightning strikes can damage building elements, public infrastructure, and electrical systems either directly or indirectly through fire.	Process-oriented	Financial Infrastructure	Moderate	Likely	Medium	Major	Likely	High

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Humidity	Changes to relative humidity	Direct	Maintenance Direct: Build-up of mould and condensation leading to increased operations and maintenance requirements and costs.	Integrated	Financial Infrastructure	Minor	Likely	Medium	Minor	Almost Certain	Medium
Humidity	Changes to relative humidity	Direct	Heritage assets Direct: Accelerated building aging, build-up of mould and condensation leading to increased operations and maintenance requirements and costs.	Integrated	Financial Infrastructure	Minor	Likely	Medium	Minor	Almost Certain	Medium
Humidity	Changes to relative humidity	Direct	Deterioration Direct: Accelerated carbonation of concrete structures.	Process-oriented	Financial Infrastructure	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Humidity	Changes to relative humidity	Direct	Thermal comfort Direct: Changes in relative humidity resulting in decreasing thermal comfort resulting in health impacts or decreased productivity.		Financial Infrastructure Social	Moderate	Likely	Medium	Moderate	Almost Certain	High
Humidity	Changes to relative humidity	Indirect	Pest distribution Indirect: Changes in humidity may increase encroachment pest species.	Integrated	Financial Environmental Social	Minor	Likely	Medium	Minor	Almost Certain	Medium
Humidity	Changes to relative humidity	Indirect	Disease transmission Indirect: Changes in humidity may increase the spread of waterborne diseases.	Place-based	Financial Environmental Social	Moderate	Moderate	Medium	Major	Moderate	High
Humidity	Changes to relative humidity	Indirect	Energy costs Indirect: Increase in relative humidity may lead to an increase in energy demand and associated utility costs.	Place-based	Financial Infrastructure	Moderate	Likely	Medium	Moderate	Likely	Medium
Bushfire	Increase in risk of bushfires	Direct	Air quality Direct: Increase in number of severe fire weather risk days leading to exposure to smoke and particulate pollution for workers and visitors, that may cause respiratory distress, as well as reduced visibility.	Integrated	Social	Moderate	Almost Certain	High	Moderate	Almost Certain	High
Bushfire	Increase in risk of bushfires	Direct	Ash and debris Direct: airborne ash and debris from bushfires around Sydney could foul waterways, degrade landscape, impose maintenance burden on built environment.	Integrated	Financial Infrastructure Environmental	Moderate	Likely	Medium	Moderate	Almost Certain	High
Bushfire	Increase in risk of bushfires	Direct	Trees as fire risk Direct: Tree species in new parklands vulnerable to heat and drought, creating local fire hazard especially with its proximity to Lane Cove National Park	Integrated	Environmental Infrastructure	Moderate	Almost Certain	High	Moderate	Almost Certain	High
Bushfire	Increase in risk of bushfires	Direct	Small vegetation as fire risk Direct: Understorey and ground cover planting in new parklands and on rooftops vulnerable to heat and drought, creating local fire hazards	Integrated	Environmental Infrastructure	Moderate	Almost Certain	High	Moderate	Almost Certain	High
Bushfire	Increase risk of bushfires	Direct	Emergency egress Direct: Physical damage to buildings and infrastructure requiring planned egress.	Integrated	Environmental Infrastructure	Major	Moderate	High	Moderate	Likely	Medium
Solar radiation	Increase in level of UV	Direct	Life cycle Direct: Increased levels of UV could contribute to the increased rate of photo-oxidation and result in a shorter expected life of materials, especially polymer-based products.	Process-oriented	Financial Infrastructure	Insignificant	Almost Certain	Low	Insignificant	Almost Certain	Low
Solar radiation	Increase in level of UV	Direct	Human health Direct: Increased levels of UV could contribute to increased skin damage and increased skin cancer risks for people in parks and public realm	Integrated	Social	Moderate	Likely	Medium	Moderate	Almost Certain	High

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Waterway Health	Declining Waterway Health	Direct	Infrastructure Direct: The increasing extreme weather conditions over time, rainfall intensity, drought, rising temperature, and UV radiation is likely to lead to declining waterway health and could result in the need to retrofit additional hydraulic infrastructure.	Process-oriented	Financial Infrastructure Environmental	Major	Unlikely	Medium	Major	Unlikely	Medium
Waterway Health	Declining Waterway Health	Indirect	Discharge Licence Indirect: The increasing extreme weather conditions over time, rainfall intensity, drought, rising temperature and UV radiation is likely to lead to declining waterway health and could result in increasing and more stringent discharge obligations with greater operational cost implications.	Process-oriented	Financial Environmental	Minor	Moderate	Low	Minor	Likely	Medium
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Terror attack - physical damage Direct: Physical damage to buildings and infrastructure from targeted blasts or explosions.	Integrated	Financial Infrastructure Social Economy	Catastrophic	Unlikely	High	Catastrophic	Unlikely	High
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Terror attack - pathological damage Direct: Potential public health effects from chemical or other biological attack requiring isolation, quarantine, decontamination.	Integrated	Financial Infrastructure Social Economy	Catastrophic	Unlikely	High	Catastrophic	Unlikely	High
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Civil unrest Direct: Localised effects of lawlessness around the asset leading to the need to temporarily shelter in place for building occupants and business interruption to tenants.	Integrated	Financial Infrastructure Social Economy	Moderate	Unlikely	Medium	Moderate	Unlikely	Medium
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Cyber attack Direct: Data connections to the asset or tenant become compromised and may lead to Building Control Management System being compromised and interrupting business operations.	Process-oriented	Financial Infrastructure Economy	Major	Moderate	High	Major	Moderate	High
Civil Disturbance	Stresses identified by Resilient Sydney	Direct	Disease pandemic Direct: Interruptions to use of commercial offices during public health movement controls affecting business continuity leading to inefficient building operations at part loads and low occupancy.	Integrated	Financial Social Economy	Major	Likely	High	Major	Likely	High
Civil Disturbance	Stresses identified by Resilient Sydney	Indirect	Diminishing community Cohesion Indirect: People more at risk when they don't know each other.	Integrated	Social	Minor	Unlikely	Low	Moderate	Unlikely	Medium
Civil Disturbance	Stresses identified by Resilient Sydney	Indirect	Financial crisis Indirect: Local or global economic disturbance can lead to negative effects on asset value and utility and becoming stranded.	Integrated	Financial Social Economy	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Critical Infrastructure Failure	Additional acute shocks	Direct	Logistics failure Direct: Closure of loading docks and access roads limiting supply of goods and services to public and private tenants and users.	Integrated	Financial Economy Social	Major	Moderate	High	Major	Moderate	High
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Electrical network outages Direct: As utility transitions to a smart grid and away from baseload coal and gas generation more grid instability is likely in the short to medium term as involuntary load shedding occurs over peak days.	Integrated	Financial Infrastructure Economy	Major	Moderate	High	Major	Moderate	High
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Water quality Direct: Drinking water quality can be affected by periods of low rain or bushfire smoke and runoff into dams leading to 'boil water' alerts to prevent water borne infections.	Integrated	Financial Social	Moderate	Moderate	Medium	Moderate	Moderate	Medium

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Transport network failures Direct: Road, public transport, or airport services are interrupted leading to commuters being stranded.	Place-based	Financial Infrastructure Economy	Major	Likely	High	Moderate	Almost Certain	High
Critical Infrastructure Failure	Additional acute shocks	Direct	Stormwater system failure Direct: localised flooding resulting from failing stormwater infrastructure.	Place-based	Financial Infrastructure Economy	Moderate	Unlikely	Medium	Moderate	Moderate	Medium
Critical Infrastructure Failure	Additional acute shocks	Direct	Sewer system failure Direct: Public health compromised by failure of sewer system to remove waste, or failure of water supply system to provide water to remove waste.	Place-based	Financial Infrastructure Economy	Moderate	Very Unlikely	Low	Moderate	Very Unlikely	Low
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Digital network outages Direct: As business and social models shift, the reliance on internet infrastructure for work and social communication will increase. Failure of this network could result in stranded residents.	Integrated	Infrastructure Social	Major	Moderate	High	Moderate	Likely	Medium
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Waste Direct: Critical infrastructure to deal with residential waste when the municipal garbage trucks fail to collect them on schedule.	Integrated	Infrastructure Financial Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Critical Infrastructure Failure	Commercial Operational Shocks	Direct	Liquid fuels storage for data centres Direct: Business interruption triggered through shock and threats to security	Integrated	Financial Infrastructure	Moderate	Likely	Medium	Moderate	Likely	Medium
Shift in Business Models	Shocks identified by Resilient Sydney	Indirect	Shift in mobility systems Indirect: Electrification of personal transport results in large shift demand profiles on electricity grid.	Integrated	Financial Infrastructure	Moderate	Almost Certain	High	Minor	Almost Certain	Medium
Shift in Business Models	Stresses related to social changes	Indirect	Cultural backgrounds Indirect: Increased immigration leads to different and unpredictable expectations for and uses of public space and amenity type.	Integrated	Financial Economy Social	Minor	Likely	Medium	Minor	Almost Certain	Medium
Shift in Business Models	Stresses related to social changes	Indirect	Changing demographics Indirect: Changes in expected or projected demographics for the precinct, city or region result in shift in job market and programmatic needs.	Integrated	Financial Infrastructure Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Shift in Business Models	Stresses related to social changes	Indirect	Shift in workplace needs Indirect: Long term changes in business models and operations leads to major changes in workplace requirements and buildings requiring substantial retrofits to be fit for purpose.	Place-based	Financial Infrastructure Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Shift in Business Models	Stresses related to social changes	Indirect	Ageing population Indirect: Ageing population leads to increasing demand for healthcare and allied wellbeing services along with potential reductions in workforce.	Place-based	Financial Economy Social	Moderate	Likely	Medium	Moderate	Likely	Medium
Shift in Business Models	Stresses related to social changes	Indirect	Carbon pricing Indirect: The introduction of carbon pricing for business operations leads to elevated operational costs for businesses who may seek alternative accommodation with reduced carbon footprints.	Process-oriented	Financial Economy Social	Moderate	Likely	Medium	Moderate	Almost Certain	High
Shift in Business Models	Stresses related to social changes	Indirect	Changing residential models Indirect: Shifts in demand for housing types leads to increased vacancies and stranded assets.	Process-oriented	Financial Economy Social	Moderate	Moderate	Medium	Moderate	Moderate	Medium
Social Stresses	Stresses related to social changes	Indirect	Changing political environment Indirect: Political extremism, or unstable governments, could compromise project delivery or operations.	Process-oriented	Financial Economy Social	Minor	Unlikely	Low	Minor	Unlikely	Low
Social Stresses	Stresses related to social changes	Indirect	Increasing inequality Indirect: Increasing economic inequality leads to reciprocal problems of increased vacancy rates and crime.	Integrated	FinancialEconomySocial	Minor	Moderate	Low	Minor	Moderate	Low
Social Stresses	Stresses related to social changes	Indirect	Housing affordability Indirect: Decreasing housing affordability leads to increased vacancy rates for residential buildings and population shift to other cities.	Integrated	Financial Economy Social	Moderate	Moderate	Medium	Moderate	Moderate	Medium

Element	Variable	Exposure	Potential Impact	Response required	Key Criteria (AS 5334)	Consequence	Likelihood	Initial Risk	Consequence	Likelihood	Initial Risk
Social Stresses	Stresses related to social changes	Indirect	War Indirect: Conflict directly or indirectly involving the region or population which has a consequential effect on potential precinct use.	Integrated	Financial Economy Social	Major	Moderate	High	Major	Moderate	High
Social Stresses	Stresses related to social changes	Indirect	Homelessness Indirect: Increasing homelessness results in reduced demand for residential programs and increasing pressure on public domain services.	Place-based	Financial Infrastructure Social	Minor	Moderate	Low	Minor	Moderate	Low
Social Stresses	Stresses related to social changes	Indirect	Economic collapse Indirect: Global or National financial and economic downturn leads to increased vacancy rates from reduced capital inflows. Organisation collapse of bespoke third-party service providers	Integrated	Financial Economy Social	Major	Moderate	High	Major	Moderate	High
Social Stresses	Stresses related to social changes	Indirect	Financial collapse Indirect: Organisational collapse of bespoke third-party service provider leaves precinct without critical service(s), and additional pressure on public services to fill the gap.	Integrated	Financial Infrastructure Economy	Major	Moderate	High	Major	Unlikely	Medium
Governance	Changes related to delivery of mitigation measures	Indirect	Overarching governance Indirect: Lack of an overarching governance structure at the MPIP will prove difficult to track and deliver mitigation measures identified through the various stages of the project.	Process-oriented	Financial Infrastructure Economy	Major	Likely	High	Major	Unlikely	Medium

6.0 Adaptation plan

6.1 Approach

The following Adaptation Plan is the result of a focused Adaptation Workshop and ongoing work throughout the master planning phase. During the workshop participants compiled all adaptation measures incumbent in the design and potential future adaptation measures. These potential future adaptation measures took two forms: potential additional design approaches for exploration throughout the Detailed Design phase; and operational responses for consideration at later stages that warrant remaining on the table for subsequent revisions.

Adaptation measures were proposed for all potential impacts regardless of risk level and range from minor additions to the existing design, to major amendments. At this time a reassessment of the 2040 consequences and likelihood took place with a view to reducing the overall risk rating. The expectation being that a reduction in the 2040 risk level would also result in a reduction in the 2090 risk level.

Throughout the Detailed Design phase the potential additional design responses were assessed and either moved to incumbent adaptation measures or ruled out.

6.2 Adaptation measures and reassessed risk

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Sea surface temperature	Increase in sea level	Direct	Inundation Direct: Potential for inundation of infrastructure during storms resulting in flood damage and safety risk from backed up overland flow.	Place-based	<ul style="list-style-type: none"> – Flood modelling takes into account RCP 8.5 future sea level at high tide. – Street levels and building thresholds consider this. – Overland flow integrated into landscape design. - A combination of flood mitigation and stormwater infrastructure are proposed in the Stormwater report to mitigate these issues 	<ul style="list-style-type: none"> – New drains empty into harbour at higher level than existing 	TTW Tract	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			Minor	Very Unlikely	Low
Sea surface temperature	Increase in sea level	Direct	Intrusion Direct: Saltwater intrusion, contaminating water sources, impacting groundwater resources and landscaping, and/or increasing degradation of building materials (e.g. foundations)	Place-based	<ul style="list-style-type: none"> – Flood modelling to take into account RCP 8.5 future sea level. - A combination of flood mitigation and stormwater infrastructure are proposed in the Stormwater report to mitigate these issues 	<ul style="list-style-type: none"> – Alignment with Metro. – Consideration of contaminated fill (physical barrier between contamination) 	TTW Tract	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			Minor	Very Unlikely	Low
Sea surface temperature	Increase in water temperature	Direct	Warming water Direct: increase in water temperature degrades habitat quality for sea life currently resident in creeks	Place-based	<ul style="list-style-type: none"> -The ecology and biodiversity report outlines The impact of The development on threatened and endangered species. Design to consider these challenges and enable The built form to integrate and respond to The ecology 	<ul style="list-style-type: none"> – Shading over habitat (natural or constructed). – Confirmation of presence of species. 	Tract Ryde Council /DPE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			Minor	Very Unlikely	Low
Sea surface temperature	Increase in adjacent air temperature and humidity	Direct	Warming water Direct: warmer water increases nearby air temperature and humidity	Place-based	<ul style="list-style-type: none"> - Design building HVAC systems to control humidity levels 	<ul style="list-style-type: none"> - Design building HVAC systems to control humidity levels 	Ryde Council /DPE	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			Minor	Very Unlikely	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Air Temperature	Increase in mean maximum temperature	Direct	Electrical assets - power supply on site Direct: Extended high temperatures may have an adverse impact on the operation of some electrical equipment, such as components in kiosks or sub-stations or external control cabinets or switchboards or LED's used in street lighting leading to system failure or service interruptions.	Integrated	<ul style="list-style-type: none"> -HVAC loads - increasing capacity. - Substation footprints take into account increased loads. - Building designs minimise loads. - Energy demand modelling includes future temperature projections to allow adequate planning for power infrastructure upgrades associated with the precinct's redevelopment. - All equipment and materials consider RCP 8.5 conditions. 		Ryde Council /DPE Atelier Ten	☑	☑	☑		Moderate	Unlikely	Medium
Air Temperature	Increased annual mean temperature	Direct	Landscapes Direct: Combined with lower rainfall will result in the loss of many plant species and less vigorous growth of many of the survivors, issues with management of pest plants and animals, loss of landscape amenity.	Place-based	<ul style="list-style-type: none"> - Balance of high- and low-evapotranspirative plant species takes into account RCP 8.5 climate predictions. - Recycled water supply for reliable irrigation. -The ecology and biodiversity report outlines the impact of the development on threatened and endangered species. Design to consider these challenges and enable the built form to integrate and respond to the ecology 		TTW Tract	☑	☑			Minor	Almost Certain	Medium
Air Temperature	Increased annual mean temperature	Indirect	Energy costs Indirect: Increase in average temperatures may lead to an increase in energy demand and associated utility costs.	Integrated	<ul style="list-style-type: none"> - Building design prioritises passive design and world's best practice energy efficiency. - Precinct and building energy storage. 	<ul style="list-style-type: none"> - Embedded network(s), virtual power plant(s), microgrid, precinct-scale systems 	Atelier Ten Ryde Council /DPE	☑	☑			Insignificant	Likely	Low
Air Temperature	Increased number of hot days over 35°C	Direct	Heat Islands Direct: Increases in number of days above 35°C may contribute towards urban heat island effects, leading to reduced comfort and increased complaints from building occupants and pedestrians	Integrated	<ul style="list-style-type: none"> Delivery of tree canopy targets in line with those outlined in the Macquarie Park SISA, Ryde Council's Draft Urban Forest Strategy and DPE's Greener Neighbourhoods Guide. - Smaller evapotranspiration gardens for urban cooling provide local areas of respite for visitors. - Passive naturally ventilated buildings - floor plates and wintergardens; timber construction reducing thermal mass; adaptive comfort - Provision of mechanically cooled, freely accessible community facilities (such as 	<ul style="list-style-type: none"> - Green roofs/walls/facades - Materials - light coloured roofing, concrete, asphalt, high-reflectivity - Interim/permanent public shading structures. - Active public cooling infrastructure/instruments (mistlers, fans) late/24hours 	TTW Tract Ryde Council /DPE Atelier Ten	☑	☑			Minor	Almost Certain	Medium

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk	
					play areas, libraries etc) and commercial areas provides a place of refuge during extreme heat days that are welcoming. - WSUD strategies proposed in the Stormwater report										
Air Temperature	Increased number of hot days over 35°C	Direct	Thermal comfort Direct: HVAC system may experience overload, affecting thermal comfort for building occupants, and increasing HVAC maintenance and operating costs.	Integrated	- World's best practice energy efficiency assured through Green Star and NABERS - All new buildings to have the capacity for at least 80% of GFA to be naturally ventilated - Building design controls require passive performance through 80W/m ² max solar load in perimeter zones		Ryde Council /DPE Atelier Ten	☑	☑	☑		Insignificant	Likely	Low	
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Flood immunity Direct: Greater frequency of higher intensity rainfall events may lead to changes in flood immunity levels.	Place-based	- Rainwater collection tanks on buildings - A combination of flood mitigation and stormwater infrastructure are proposed in the Stormwater report to mitigate these issues	- Increase basement threshold height.	TTW Ryde Council /DPE	☑	☑			Minor	Moderate	Low	
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Building structures - floor levels and roof drainage Direct: Greater frequency of higher intensity rainfall events may lead to localised flooding, damage due to scour and less safe operating conditions.	Place-based	- Embed requirement to design for RCP 8.5 climate scenarios in each package. - WSUD as per stormwater report to reduce pressure on municipal systems		Ryde Council /DPE	☑	☑			Minor	Likely	Medium	
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Emergency Egress Direct: Greater frequency of higher intensity rainfall events may increase events that limit access and egress, resulting in tenants being stranded at the development.	Place-based	- Ensure multiple emergency egress routes from precinct in all directions at varying RLs.		Ryde Council /DPE	☑	☑			Minor	Unlikely	Low	
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Civil drainage Direct: Greater frequency of higher intensity rainfall events may lead to inundation of drainage infrastructure as a result of insufficient system capacity, with resulting damage	Process-oriented	- Embed requirement to design for RCP 8.5 climate scenarios in each package. - WSUD to as per stormwater report reduce pressure on municipal systems		TTW Ryde Council /DPE	☑	☑			Minor	Moderate	Low	

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
			on site or adjacent, service disruption and safety risk.											
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Landscapes Direct: Greater frequency of higher intensity rainfall events may affect health of plants and lead to tree and tall plant instability due to saturated soils	Place-based	– Embed requirement to design for RCP 8.5 climate scenarios in each package. – WSUD to reduce pressure on municipal systems		TTW Ryde Council /DPE	☑	☑			Minor	Moderate	Low
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Marine habitat Direct: Greater frequency of higher intensity rainfall events may affect water quality and salinity, compromising habitat quality for species resident in the creeks	Place-based	– Embed requirement to design for RCP 8.5 climate scenarios in each package. – WSUD to reduce pressure on municipal systems -The ecology and biodiversity report outlines the impact of the development on threatened and endangered species. Design to consider these challenges and enable the built form to integrate and respond to the ecology		Tract	☑	☑			Minor	Moderate	Low
Precipitation	Greater frequency of higher intensity rainfall events	Direct	Heritage assets Direct: Greater frequency of higher intensity rainfall events will accelerate building fabric aging, increase likelihood of water damage from roof and wall leaks	Place-based	– Embed requirement to design for RCP 8.5 climate scenarios in each package.		AJC	☑	☑			Minor	Moderate	Low
Drought	Decrease in annual total rainfall	Indirect	Landscapes Indirect: Decrease in annual total rainfall leading to a reduction in regional water storages and reduce water supplies making it difficult to water landscaping.	Place-based	– Recycled water supply ensures reliable irrigation. – Onsite rainwater storage. -The stormwater report outlines opportunities to improve water quality on site through introduction of Bio-swales, Bio retention/ rainwater gardens, centralised rainwater tanks, gross pollutant traps and Storm filters		TTW Ryde Council /DPE	☑	☑			Minor	Likely	Medium
Drought	Decrease in annual total rainfall	Indirect	Potable water availability Indirect: Decrease in annual total rainfall may result in water restrictions prohibiting water use in heat rejection, irrigation, human consumption.	Process-oriented	– World's best practice water efficiency assured through Green Star and NABERS reduce pressure on municipal water systems. – Onsite recycling ensures full water allotment from Sydney Water can be used for potable needs.		Ryde Council /DPE		☑			Minor	Likely	Medium

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Drought	Decrease in annual total rainfall	Indirect	Potable water pricing Indirect: Decrease in annual total rainfall may result in water restrictions and pricing impacts on tenants, running costs of water-cooled systems for building owners.	Process-oriented	– Cost risk minimised through potable water conservation.		Ryde Council /DPE		☑			Minor	Likely	Medium
Wind	Increased wind speeds	Direct	Debris Direct: Increasing wind speeds may dislodge loose furniture or equipment (including vegetation) damaging exposed plant equipment and facades or make the public domain unsafe.	Integrated	– Design control require appropriate façade performance. – Tree species selected for appropriateness to wind environments.	– Public domain furniture design to be considered	Ryde Council /DPE Atelier Ten Tract	☑	☑			Moderate	Unlikely	Medium
Wind	Increased wind speeds	Direct	Wind driven rain Direct: Increasing wind speeds coupled with greater frequency of higher intensity rainfall events may lead to wind driven rain flooding upper levels and penetrating facades.	Place-based	– High performance facades eliminate thermal bridging, condensation, and water penetration.		Ryde Council /DPE Atelier Ten		☑			Insignificant	Moderate	Low
Wind	Increased wind speeds	Direct	Pedestrian and bicyclist comfort and safety - wind tunnels Direct: Increasing wind speeds exacerbated by tall buildings and the elevated deck may lead to wind tunnel conditions making the public realm uncomfortable, inaccessible, and potentially unsafe.	Place-based	– Building arrangement optimised to mitigate against wind tunnels and reduce the impact of high winds resulting from extreme storms.	– Additional localised protection from structures or vegetation.	Ryde Council /DPE	☑	☑			Minor	Likely	Medium
Wind	Increased wind speeds	Direct	Electrical assets Direct: Wind damage to electrical circuitry (overhead wiring) may result in disruption to services and increase	Process-oriented	– All electrical and ICT wiring is underground. – Above ground electrical assets/structures designed to withstand RCP 8.5 wind scenarios.		Ryde Council /DPE	☑	☑			Minor	Moderate	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
			maintenance costs.											
Wind	Increased wind speeds	Direct	Public realm assets Direct: Wind damage to shade structures, kiosks, and other items in the parks and public domain.	Place-based	– Structures designed to withstand RCP 8.5 wind scenarios.		Ryde Council /DPE	☑	☑			Minor	Moderate	Low
Wind	Increased wind speeds	Direct	Landscape Direct: Wind damage to shade trees, including downed branches and whole trees.	Place-based	– Trees selected for resilience to wind when mature. – Trees provided with support while growing. – Trees not located over critical infrastructure or shelter.		Tract	☑	☑			Minor	Moderate	Low
Wind	Increased wind speeds	Direct	Air quality Direct: reduction in air quality due to dust.	Place based	- Increase in urban greening will increase air quality by removing airborne pollutants. - Best practice indoor environment quality assured through Green Star.		Ryde Council /DPE Tract	☑	☑			Minor	Moderate	Low
Extreme storms	Increase in frequency and severity of storms	Direct	Hailstorms Direct: Increase in extreme hailstorm events may damage to cladding, exposed plant and services, landscapes, entryways and horizontal/sloped glazing.	Integrated	– Shelter in public domain	– Covered access throughout public domain.	Aurecon	☑	☑			Minor	Almost Certain	Medium
Extreme storms	Increase in frequency and severity of storms	Direct	Dust storms Direct: Last major dust storm 2009, combination of drought, hot weather and westerly wind. Increased risk of systems damage and occupant respiratory illness	Integrated	– Significant public domain landscaping to capture particulate matter – Building airtightness detailing to prevent uncontrolled dust ingress – Improved HVAC intake filtration		Ryde Council /DPE	☑	☑			Minor	Almost Certain	Medium
Extreme storms	Increase in frequency and severity of storms	Direct	Tornados Direct: Increase in micro-burst windstorms small tornados, compromising life-safety of anyone in public realm and in buildings insufficiently	Integrated	– Obviously located and easily accessible shelter in place facilities. – Extreme wind design criteria for public buildings.		Ryde Council /DPE TTW	☑	☑			Minor	Almost Certain	Medium

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
			resistant to extreme winds.											
Extreme storms	Increase in frequency and severity of storms	Indirect	Displacement Indirect: Increase in frequency and severity of storms may result in damage to properties, causing displacement and disruption of tenant / business activity during clean up and repair.	Process-oriented	<ul style="list-style-type: none"> Place-based adaptation measures mitigate potential effects on tenants, residents, and businesses. Short term shelter in place ability. Regular monitoring, evaluation and review of CAP and Community Resilience Plan to ensure it remains valid. 	<ul style="list-style-type: none"> Develop a Community Resilience Plan in line with Green Star Communities requirements that addresses preparation, during- and post disaster communication, safety, and response. 	Aurecon NSW Government Atelier Ten	☑	☑	☑	☑	Minor	Unlikely	Low
Extreme storms	Increasing frequency of electrical storms and lightning strikes	Direct	Lightning strike Direct: Increasing frequency of electrical storms and lightning strikes can damage building elements, public infrastructure, and electrical systems either directly or indirectly through fire.	Process-oriented	<ul style="list-style-type: none"> Earthing of all structures Surge protection for all power supply and ICT cabling. Surge protection for all public domain structures (i.e. lighting, security, sensing). Surge protection for all on electricity site generation and power storage. 		Ryde Council /DPE	☑	☑			Minor	Likely	Medium
Humidity	Changes to relative humidity	Direct	Maintenance Direct: Build-up of mould and condensation leading to increased operations and maintenance requirements and costs.	Integrated	<ul style="list-style-type: none"> Design of public domain ensures adequate drainage of excess water, no standing water, and enhances evaporation from sun and wind. All new buildings provide enhanced ventilation capability for indoor spaces including natural ventilation, high rate of outdoor air supply, and highly filtered recirculated air. High performance facades eliminate thermal bridging, condensation, and water penetration. Specify mould resistant materials in areas prone to increased humidity. 		Ryde Council /DPE Atelier Ten	☑	☑	☑		Insignificant	Likely	Low
Humidity	Changes to relative humidity	Direct	Heritage assets Direct: Accelerated building aging, build-up of mould and condensation leading to increased operations and maintenance requirements and costs.	Integrated	<ul style="list-style-type: none"> Embed requirement to design for RCP 8.5 climate scenarios in each package. 		AJC	☑	☑	☑		Insignificant	Likely	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Humidity	Changes to relative humidity	Direct	Deterioration Direct: Accelerated carbonation of concrete structures.	Process-oriented	<ul style="list-style-type: none"> – Design of concrete structures to consider RCP 8.5 climate scenarios. 	<ul style="list-style-type: none"> – Anti-carbonation coatings can be applied to the cleaned surface of the concrete to prevent the ingress of carbon dioxide and other pollutants. – Decrease water/cement ratio, water/binder ratio, and/or slump value in concrete structures. – Increase strength and porosity of concrete structures with admixtures, ground granulated blast furnace slag (GGBS), and/or silica fume (SF). – Apply substantial cover to reinforcement. – Increase curing periods. 	Ryde Council /DPE	☑	☑			Minor	Moderate	Low
Humidity	Changes to relative humidity	Direct	Thermal comfort Direct: Changes in relative humidity resulting in decreasing thermal comfort resulting in health impacts or decreased productivity.		<ul style="list-style-type: none"> – Extensive shading in the public realm from tree canopy and buildings. – High performance facades eliminate thermal bridging, condensation, and water penetration. 	<ul style="list-style-type: none"> – Design buildings and public domain to capture cool breezes during summer months when relative humidity is highest. – Integrate fans and other methods of mechanically moving air in the public domain. 	Ryde Council /DPE Atelier Ten	☑	☑			Minor	Likely	Medium
Humidity	Changes to relative humidity	Indirect	Pest distribution Indirect: Changes in humidity may increase encroachment pest species.	Integrated	<ul style="list-style-type: none"> – Regular landscape maintenance and monitoring to ensure optimal growth and health of landscapes, and identification of any issues. – Specify durable, pest resistant materials in the public domain and other areas prone to pest encroachment. – Design landscapes and infrastructure for easy inspection. – Effectively seal or screen off all openings to exclude pests and eliminate potential harbourage. – Engineer slabs and foundations to minimise pest entry. – Design buildings to be unattractive to pests. 	<ul style="list-style-type: none"> – Prioritise cultural, mechanical, biological, and biorational management of pests in the landscape so as not to encourage the development of pesticide resistance. 	Ryde Council /DPE	☑	☑	☑	☑	Minor	Unlikely	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Humidity	Changes to relative humidity	Indirect	Disease transmission Indirect: Changes in humidity may increase the spread of waterborne diseases.	Place-based	– Design of public domain ensures adequate drainage of excess water and enhances evaporation from sun and wind. – All new buildings provide enhanced ventilation capability for indoor spaces including natural ventilation, high rate of outdoor air supply, and highly filtered recirculated air.		TTW Ryde Council /DPE	☑	☑			Minor	Unlikely	Low
Humidity	Changes to relative humidity	Indirect	Energy costs Indirect: Increase in relative humidity may lead to an increase in energy demand and associated utility costs.	Place-based	– Building design prioritises passive design and world's best practice energy efficiency. – Precinct and buildings incorporate energy storage.	– Onsite renewable energy generation.	Ryde Council /DPE	☑	☑			Minor	Likely	Medium
Bushfire	Increase in risk of bushfires	Direct	Air quality Direct: Increase in number of severe fire weather risk days leading to exposure to smoke and particulate pollution for workers and visitors, that may cause respiratory distress, as well as reduced visibility.	Integrated	– Design Guide requirement for HVAC systems to be able to either shut-off outdoor air supply and/or provide space allowance for additional filters to be able to be dropped in when required. – Areas of respite for visitors. – Public help points for people requiring medical assistance.	– Emergency medical equipment (defibrillators) in building lobbies.	Ryde Council /DPE Atelier Ten	☑	☑	☑		Minor	Almost Certain	Medium
Bushfire	Increase in risk of bushfires	Direct	Ash and debris Direct: airborne ash and debris from bushfires around Sydney could foul waterways, degrade landscape, impose maintenance burden on built environment.	Integrated	– Design Guide requirement for HVAC systems to be able to either shut-off outdoor air supply and/or provide space allowance for additional filters to be able to be dropped in when required. – Areas of respite for visitors. – Public help points for people requiring medical assistance.	– Emergency medical equipment (defibrillators) in building lobbies.	Ryde Council /DPE	☑	☑	☑		Minor	Almost Certain	Medium
Bushfire	Increase in risk of bushfires	Direct	Trees as fire risk Direct: Tree species in new parklands vulnerable to heat and drought, creating local fire hazard especially with its proximity to Lane Cove National Park	Integrated	– All vegetated areas easily accessible by Fire Department. – Passive surveillance to ensure fires are visible and can be responded to quickly.	– Careful selection of plant species to reduce fire risk.	Tract	☑	☑	☑		Minor	Almost Certain	Medium
Bushfire	Increase in risk of bushfires	Direct	Small vegetation as fire risk Direct: Understorey and ground cover planting in new parklands and on rooftops	Integrated	– All vegetated areas easily accessible by Fire Department. – Passive surveillance to ensure fires are visible and can be responded to quickly.	– Careful selection of plant species to reduce fire risk.	Tract	☑	☑	☑		Minor	Almost Certain	Medium

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
			vulnerable to heat and drought, creating local fire hazards											
Solar radiation	Increase in level of UV	Direct	Life cycle Direct: Increased levels of UV could contribute to the increased rate of photo-oxidation and result in a shorter expected life of materials, especially polymer-based products.	Process-oriented	– Membranes and any photosensitive exterior products, especially wiring, are protected from solar exposure.		Ryde Council /DPE	☑	☑			Insignificant	Almost Certain	Low
Solar radiation	Increase in level of UV	Direct	Human health Direct: Increased levels of UV could contribute to increased skin damage and increased skin cancer risks for people in parks and public realm	Integrated	– Significant constructed or natural shade throughout public domain. – Community and municipal facilities offer free sunscreen to public.		Aurecon Ryde Council /DPE	☑	☑			Insignificant	Almost Certain	Low
Waterway Health	Declining Waterway Health	Direct	Infrastructure Direct: The increasing extreme weather conditions over time, rainfall intensity, drought, rising temperature and UV radiation is likely to lead to declining waterway health and could result in the need to retrofit additional hydraulic infrastructure.	Process-oriented	– Design of hydraulic infrastructure takes into account RCP 8.5 climate scenarios. – Stormwater pollution flowing to Sydney Harbour cleaned beyond best practice guidelines. - A combination of flood mitigation and stormwater infrastructure are proposed in the Stormwater report to mitigate these issues		TTW Ryde Council /DPE	☑	☑			Minor	Unlikely	Low
Waterway Health	Declining Waterway Health	Indirect	Discharge Licence Indirect: The increasing extreme weather conditions over time, rainfall intensity, drought, rising temperature and UV radiation is likely to lead to declining waterway health and could result in increasing and more stringent discharge obligations with greater operational cost implications.	Process-oriented	– Stormwater pollution flowing to Sydney Harbour cleaned beyond best practice guidelines. WSUD incorporated -The stormwater report outlines opportunities to improve water quality on site through introduction of Bio-swales, Bio retention/ rainwater gardens, centralised rainwater tanks, gross pollutant traps and Storm filters		TTW	☑	☑			Insignificant	Moderate	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Terror attack - physical damage Direct: Physical damage to buildings and infrastructure from targeted blasts or explosions.	Integrated	<ul style="list-style-type: none"> – OSD deck designed to withstand blast-effects. – Car limited public domain minimises potential for blasts from vehicles. – Crime prevention through environmental design (CPTED) strategies. – Perimeter control devices and strategy pop up hardening. – Mitigated with Metro and Ports facilities. 	<ul style="list-style-type: none"> – Develop a Community Resilience Plan in line with Green Star Communities requirements that addresses preparation, during- and post disaster communication, safety, and response. 	Ryde Council /DPE	☑	☑			Major	Moderate	High
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Terror attack - pathological damage Direct: Potential public health effects from chemical or other biological attack requiring isolation, quarantine, decontamination. Emergency egress planning and delivery.	Integrated	<ul style="list-style-type: none"> – Air intakes servicing occupied areas placed as high as practically possible. – Physically isolate unsecured areas from secured areas. – Commission building throughout construction and prior to taking ownership. – Provide redundant, easily accessible shutdown capabilities. – In public access areas, use air diffusers and return air grills that are secure or under security observation. 	<ul style="list-style-type: none"> – Develop a Community Resilience Plan in line with Green Star Communities requirements that addresses preparation, during- and post disaster communication, safety, and response. – Restrict access to critical equipment. – Isolate separate HVAC zones and return air systems. – Use positive pressurisation of primary emergency egress routes, safe havens, and/or other critical areas. – Zone the building communication system so that it is capable of delivering explicit instructions, and has back-up power. 	Ryde Council /DPE	☑	☑	☑	☑	Major	Moderate	High
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Civil unrest Direct: Localised effects of lawlessness around the asset leading to the need to temporarily shelter in place for building occupants and business interruption to tenants.	Integrated	<ul style="list-style-type: none"> – Crime prevention through environmental design (CPTED) strategies. – Emergency egress routes lead to exits that are as far as possible from high-risk areas such as the lobby, mail room, and delivery entrance. – Create pressurized safe havens in elevator vestibules and stairwells using tightly constructed, air-tight enclosures placed in a protected core area of the building. – Emergency power provides sufficient lighting and or phosphorescence to lead 	<ul style="list-style-type: none"> – Crime Risk Assessment – Resilient power supply (see electrical infrastructure) or backup standby electricity. 	Ryde Council /DPE	☑	☑			Minor	Unlikely	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
					persons safely out of the building.									
Civil Disturbance	Shocks identified by Resilient Sydney	Direct	Cyber attack Direct: Data connections to the asset or tenant become compromised and may lead to Building Control Management System being compromised and interrupting business operations.	Process-oriented	<ul style="list-style-type: none"> – ICT infrastructure incorporates a diversity of entry points to the precinct and each building to support multiple service providers and redundancy of connection. – Easily accessible universal communication chambers. – Secure and dedicated space for service providers to terminate their equipment separated from that of other utilities, such as electricity, gas or water, to reduce the personnel able to access the telco equipment servicing tenants. 	<ul style="list-style-type: none"> – Develop a Cyber Security and Risk Mitigation Plan. – ICT Security of BCMS and other building systems that interface with online networks. – ICT infrastructure backbone that supports a diversity of hardwired and wireless methods of communications. 	Ryde Council /DPE	☑	☑			Minor	Moderate	Low
Civil Disturbance	Stresses identified by Resilient Sydney	Direct	Disease pandemic Direct: Interruptions to use of commercial offices during public health movement controls affecting business continuity leading to inefficient building operations at part loads and low occupancy.	Integrated	<ul style="list-style-type: none"> – Design control for enhanced ventilation. – Access to public space and shelter in place. – Active transport paths. – Flexibility of internal space for social distancing. 	<ul style="list-style-type: none"> – Contactless building access and sanitary facilities. – Floor by floor air-handling to prevent cross-floor transmission of airborne contaminants. – Building design to incorporate occupancy sensors and partial floor shut-downs. – Very low turndown HVAC equipment, including screw chiller and smart controls. – Double air lock building entries allow potential for sanitisation / public health screening. 	Ryde Council /DPE	☑	☑			Minor	Likely	Medium
Civil Disturbance	Stresses identified by Resilient Sydney	Indirect	Diminishing community Cohesion Indirect: People more at risk when they don't know each other.	Integrated	<ul style="list-style-type: none"> – Social infrastructure for shelter – Water fountains in public domain – Shading – Local social connectedness – casual social connection – Mitigating rising local inequality – deliver initiative to address disadvantage 	<ul style="list-style-type: none"> – Community building a key outcome 	Aurecon Ryde Council /DPE Atlas	☑	☑	☑	☑	Minor	Unlikely	Low
Civil Disturbance	Stresses identified by Resilient Sydney	Indirect	Financial crisis Indirect: Local or global economic disturbance can lead to negative effects on asset value and utility	Integrated	<ul style="list-style-type: none"> – Diversity of program types and associated users. – Buildings designed for second- and third life uses allow for easy retrofit or reconfiguration. – Commercial floorplates 		Atlas Ryde Council /DPE	☑	☑	☑	☑	Minor	Moderate	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
			and becoming stranded.		adaptable for big multi-floor tenants, or multiple single floor tenants.									
Critical Infrastructure Failure	Additional acute shocks	Direct	Logistics failure Direct: Closure of loading docks and access roads limiting supply of goods and services to public and private tenants and users.	Integrated	– Diversity in ingress and emergency egress routes for small and large freight access.	– Dynamic loading dock signage to advise status and procedures. – Consolidated servicing / hub, potentially below surface level.	Ryde Council /DPE	☑	☑		☑	Moderate	Moderate	Medium
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Electrical network outages Direct: As utility transitions to a smart grid and away from baseload coal and gas generation more grid instability is likely in the short to medium term as involuntary load shedding occurs over peak days.	Integrated	– Standby backup power generation per PCA A Grade requirement for 12 hour run on partial systems. – Passive strategies to reduce cooling demand of critical infrastructure and increase thermal autonomy. – Battery-ready buildings and/or precinct.		Ryde Council /DPE Atelier Ten	☑	☑			Minor	Moderate	Low
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Water quality Direct: Drinking water quality can be affected by periods of low rain or bushfire smoke and runoff into dams leading to 'boil water' alerts to prevent water borne infections.	Integrated	-The stormwater report outlines opportunities to improve water quality on site through introduction of Bio-swales, Bio retention/ rainwater gardens, centralised rainwater tanks, gross pollutant traps and Storm filters	– Precinct water treatment for potable use. – Monitor chemical and biological water quality. – Ability for tenants to install boilers.	Ryde Council /DPE TTW	☑	☑		☑	Minor	Likely	Medium
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Transport network failures Direct: Road, public transport, or airport services are interrupted leading to commuters being stranded.	Place-based	– Access to a diversity of public transport types (train, bus, metro, light rail). – End of trip facilities to encourage and facilitate active personal mobility. – All buildings accessible by pedestrian and cycle routes. – Significant comfortable public domain to provide respite to stranded commuters.	– Provision of mechanically cooled, freely accessible community facilities (such as play areas, libraries etc) and commercial areas to provide protected areas of respite for stranded commuters.	Ryde Council /DPE	☑	☑		☑	Minor	Almost Certain	Medium
Critical Infrastructure Failure	Additional acute shocks	Direct	Stormwater system failure Direct: localised flooding resulting from failing stormwater infrastructure.	Place-based	- Significant water sensitive urban design to reduce pressure on municipal infrastructure		Ryde Council /DPE	☑	☑		☑	Minor	Almost Certain	Medium

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Critical Infrastructure Failure	Additional acute shocks	Direct	Sewer system failure Direct: Public health compromised by failure of sewer system to remove waste, or failure of water supply system to provide water to remove waste.	Place-based	- New developments and refurbishments to utilise non-potable water for toilet flushing		Ryde Council /DPE	☑	☑		☑	Minor	Almost Certain	Medium
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Digital network outages Direct: As business and social models shift, the reliance on internet infrastructure for work and social communication will increase. Failure of this network could result in stranded residents.	Integrated	- Diversity of digital network access mediums (copper, fibre, satellite, 3G, 4G, and 5G)	- Multiple and secure cabling entry points to individual buildings and precinct.	Ryde Council /DPE	☑	☑		☑	Minor	Moderate	Low
Critical Infrastructure Failure	Shocks identified by Resilient Sydney	Direct	Waste Direct: Critical infrastructure to deal with residential waste when the municipal garbage trucks fail to collect them on schedule.	Integrated	- Waste collection rooms appropriately sized to collect multiple waste streams.	- Monitor chemical and biological water quality. - Engage with Sydney Water	TTW Ryde Council /DPE	☑	☑		☑	Moderate	Moderate	Medium
Shift in Business Models	Shocks identified by Resilient Sydney	Indirect	Shift in mobility systems Indirect: Electrification of personal transport results in large shift demand profiles on electricity grid.	Integrated	- Energy demand modelling includes increase EV charging loads.	- 100% of parking to EV charging. - Loading dock to have infrastructure for future charging of logistics vehicles. - EOT facilities to support charging of personal micro mobility.	Ryde Council /DPE	☑	☑			Insignificant	Likely	Low
Shift in Business Models	Stresses related to social changes	Indirect	Cultural backgrounds Indirect: Increased immigration leads to different and unpredictable expectations for and uses of public space and amenity type.	Integrated	- Flexible and diverse public domain. - Masterplan proposed various types of infrastructure that ties in with the community needs as assessed for the Ryde council in the Open Space Future Provision Technical Appendix - An engagement outcomes report has been produced for the precinct	- Other adaptation measures TBD based on population and demographic study.	Aurecon Astrolabe Group	☑				Insignificant	Likely	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
Shift in Business Models	Stresses related to social changes	Indirect	Changing demographics Indirect: Changes in expected or projected demographics for the precinct, city or region result in shift in job market and programmatic needs.	Integrated	<ul style="list-style-type: none"> – Diversity of program types and associated users. – Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration. – Commercial floorplates adaptable for big multi-floor tenants, or multiple single floor tenants. - Employment forecast and projections taken into account in the economic impact assessment report 	<ul style="list-style-type: none"> – Other adaptation measures TBD based on population and demographic study. 	Atlas	☑	☑			Insignificant	Likely	Low
Shift in Business Models	Stresses related to social changes	Indirect	Shift in workplace needs Indirect: Long term changes in business models and operations leads to major changes in workplace requirements and buildings requiring substantial retrofits to be fit for purpose.	Place-based	<ul style="list-style-type: none"> – Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration. – Commercial floorplates adaptable for big multi-floor tenants, or multiple single floor tenants. - Employment forecast and projections taken into account in the economic impact assessment report. 		Atlas	☑	☑			Insignificant	Likely	Low
Shift in Business Models	Stresses related to social changes	Indirect	Ageing population Indirect: Ageing population leads to increasing demand for healthcare and allied wellbeing services along with potential reductions in workforce.	Place-based	<ul style="list-style-type: none"> – Social infrastructure including healthcare services and allied community support services. – Public domain supports formal and informal community use. - Masterplan proposed various types of infrastructure that ties in with the community needs as assessed in the social infrastructure report 	<ul style="list-style-type: none"> – Housing supports ageing in place and multigenerational families. – Diversity of commercial space types supports variety of health and wellbeing tenants. 	Ryde Council /DPE Aurecon	☑	☑	☑	☑	Insignificant	Likely	Low
Shift in Business Models	Stresses related to social changes	Indirect	Carbon pricing Indirect: The introduction of carbon pricing for business operations leads to elevated operational costs for businesses who may seek alternative accommodation with reduced carbon footprints.	Process-oriented	<ul style="list-style-type: none"> – Net zero carbon requirement mitigates risk. – All-electric building operations eliminates gas price risk. – Space for future energy storage to replace diesel generators. 	<ul style="list-style-type: none"> – Carbon offset mechanism built into leasing structure. 	Ryde Council /DPE	☑	☑		☑	Insignificant	Likely	Low
Shift in Business Models	Stresses related to social changes	Indirect	Changing residential models Indirect: Shifts in demand for housing types leads to increased vacancies and stranded assets.	Process-oriented	<ul style="list-style-type: none"> – Housing affordability study carried out by Atlas and to be incorporated into the residential model 	<ul style="list-style-type: none"> – Diversity of housing types supporting all stages of life, ageing in place, multigenerational families, social, affordable, and community housing, 	Ryde Council /DPE	☑	☑			Insignificant	Moderate	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
						build-to-rent, rent-to-buy.								
Social Stresses	Stresses related to social changes	Indirect	Changing political environment Indirect: Political extremism, or unstable governments, could compromise project delivery or operations	Process-oriented	– Diversity of program types and associated users. – Integrate diverse physical social infrastructure facilities (e.g. health, education, arts and culture) deemed desired by the local community and as noted in the social infrastructure analysis report – Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration.	– Stakeholder engagement. – Community development.	Ryde Council /DPE Aurecon Tract	✓	✓	✓	✓	Minor	Moderate	Low
Social Stresses	Stresses related to social changes	Indirect	Increasing inequality Indirect: Increasing economic inequality leads to reciprocal problems of increased vacancy rates and crime.	Integrated	– Diversity of program types and associated users.– Integrate diverse physical social infrastructure facilities (e.g. health, education, arts and culture) deemed desired by the local community and as noted in the social infrastructure analysis report.– Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration.	– Stakeholder engagement.– Community development.	Ryde Council /DPE AureconTract	✓	✓	✓	✓	Minor	Moderate	Low
Social Stresses	Stresses related to social changes	Indirect	Housing affordability Indirect: Decreasing housing affordability leads to increased vacancy rates for residential buildings and population shift to other cities.	Integrated	– Integrate diverse physical social infrastructure facilities (e.g. health, education, arts and culture). - Housing affordability study carried out by Atlas	– Diversity of housing types supporting all stages of life, ageing in place, multigenerational families, social, affordable, and community housing, build-to-rent, rent-to-buy.	Atlas Tract	✓	✓	✓	✓	Minor	Moderate	Low
Social Stresses	Stresses related to social changes	Indirect	War Indirect: Conflict directly or indirectly involving the region or population which has a consequential effect on potential precinct use.	Integrated	– Diversity of program types and associated users. – Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration.		Ryde Council /DPE	✓	✓			Moderate	Moderate	Medium
Social Stresses	Stresses related to social changes	Indirect	Homelessness Indirect: Increasing homelessness results in reduced demand for residential programs and increasing pressure on public domain services.	Place-based	– Inclusive public domain that intentionally does not integrate hostile architecture. – Integrate diverse physical social infrastructure facilities (e.g. health, education, arts and culture) deemed desired by the local community and as noted in the social infrastructure analysis report	– Diversity of housing types supporting all stages of life, ageing in place, multigenerational families, social, affordable, and community housing, build-to-rent, rent-to-buy. – Compassionate	Aurecon	✓	✓	✓	✓	Minor	Moderate	Low

Element	Variable	Exposure	Potential Impact	Response required	Incumbent adaptation measures	Potential additional adaptation measures	Design Measure Responsibility	Precinct Planning	Detailed Design	Procurement	Operations	Consequence	Likelihood	Reassessed Risk
						infrastructure support increased use by homeless people. – Durable materials and maintenance strategies to support increased use.								
Social Stresses	Stresses related to social changes	Indirect	Economic collapse Indirect: Global or National financial and economic downturn leads to increased vacancy rates from reduced capital inflows. Organisation collapse of bespoke third-party service providers	Integrated	– Diversity of program types and associated users. – Buildings designed for second- and third-life uses allow for easy retrofit or reconfiguration. - Employment forecast and projections taken into account in the economic impact assessment report - Assessed that the development will deliver positive impact greater Sydney's economy and increase visitation benefits from local, regional and international visitors alike		Atlas	☑	☑			Moderate	Moderate	Medium
Social Stresses	Stresses related to social changes	Indirect	Financial collapse Indirect: Organisational collapse of bespoke third-party service provider leaves precinct without critical service(s), and additional pressure on public services to fill the gap.	Integrated	- Existing public services and utilities designed to serve future development in case of collapse.	– Super-efficient building and public domain systems use as little external resources as possible, and prioritise passive systems. – Diversity and redundancy built into systems to allow for operation at a reduced scale. – Quick connects for external plug-and-play systems allows for temporary operations on separate systems.	Atlas	☑	☑	☑	☑	Minor	Moderate	Low
Governance	Changes related to delivery of mitigation measures	Indirect	Overarching governance Indirect: Lack of an overarching governance structure at the MPIP will prove difficult to track and deliver mitigation measures identified through the various stages of the project.	Process-oriented	- Multiple existing networks which could be leveraged and expanded to provide ongoing governance (including Connect Macquarie Park)		Ryde Council /DPE	☑	☑	☑	☑	Minor	Moderate	Low

7.0 Monitoring and review

This CAP is a living document and will continue to be revised as climate change risks and associated opportunities change over time. As this is the first adaptation plan for the development, many of the proposed actions focus on improving our understanding of climate risks and integrating climate change into existing activities.

To ensure that the development's adaptation responses and approaches remain valid and relevant to local priorities and climatic conditions, as a minimum:

- The risk assessment should be reviewed **annually** to ensure all potential threats and vulnerabilities have been captured and the consequential risk levels remain valid; and
- The entire CAP should be reviewed and updated through a collaborative process with relevant stakeholders **every five years** as per standard risk management process.

These reviews should also re-assess the development's risk profile in consideration of changes to climate change information, policy, assets, and activities. Consideration should also be given to the potential opportunities and benefits that may arise as a result of the changing climate and policy environment (e.g. new funding sources, opportunities for the development of renewable energy or green business precincts). Reviews may also cover monitoring on the progress of adaptation actions. Regular and ongoing reporting of the region's climate change adaptation performance is critical to inform decision making and motivate changes in behaviour. Consideration in annual budgets, internal reporting and communication is recommended to ensure that decision-makers, staff, and the community are aware of progress in implementing the adaptation actions outlined in this CAP.

8.0 Assurance

8.1 Green Star Communities

The following table indicates documentation requirements for Green Star Communities v1.1 Credit 04 – Adaption and Resilience:

Requirements	Included	Reference
4.1.1 The CAP must be developed in accordance with a recognised standard by a suitably qualified professional.		
Provide the name and contact details of the Suitably Qualified Professional with a formal tertiary environmental science or planning qualification	✓	11.2 STEWART MONTI - CV, p. 72
The Climate Adaptation Plan has been developed using one of the following recognised standards:		
<ul style="list-style-type: none"> – ISO 31000:2009 and the Australian Greenhouse Office (AGO) Climate Change Risks and Impacts: A Guide for Government and Business 2006. – Australian Standard AS 5334:2013 Climate change adaptation for settlements and infrastructure - A risk based approach. 	✓	2.2 Guiding instruments, p. 14
4.1.2 The CAP must and contain at least the following information:		
a. Summary of the project site's characteristics.	✓	3.1 Project, p. 18
b. A list of identified assets or asset classes.	✓	Table 3.4: Asset or Asset Class – AS 5334-2013 (Standards Australia 2013), p. 20
c. Assessment of climate change impacts on the project site using at least two time scales.	✓	Error! Reference source not found. Error! Reference source not found., p. 30
d. Identification of the potential risks (likelihood and consequence) for each identified asset or asset class and the potential risks to people.	✓	Error! Reference source not found. Error! Reference source not found., p. 30
e. A list of actions and responsibilities for all high and extreme risks identified.	✓	6.0 Error! Not a valid result for table., p. 43
f. Details of stakeholder consultation undertaken during plan preparation and how these issues have been incorporated.	✓	Table 2.2: Stakeholder engagement activities, p. 17
4.1.3 The risk identification has considered the resilience of key project assets and key infrastructure.	✓	
4.1.4 The CAP includes a timetable for regular review and requires updates where necessary. As a minimum the plan will be reviewed whenever the base information required to develop the relevant climate change scenarios is updated.	✓	7.0 Monitoring and review, p. 61
4.1.5 The climate change scenarios used were sourced from the Intergovernmental Panel on Climate Change (IPCC) endorsed	✓	2.3 Data sources, p. 16

Requirements	Included	Reference
Global Circulation Models (GCMs) and may include Commonwealth Scientific and Industrial Research Organisation (CSIRO), State or Federal climate projections or more detailed climate modelling software.		
Provide details of, and justify the use of ,the climate change scenarios used by the project for the Climate Adaptation Plan.	✓	Table 4.2: Development time scales descriptions, p. 24
4.1.6 The assessment of climate change impacts addresses a minimum of two appropriate time scales (e.g. 2030, 2040, 2050 and 2070) for the primary and secondary effects.	✓	Error! Reference source not found. Error! Reference source not found., p. 30
The following primary effects are addressed in the Climate Adaptation Plan for the two selected timescales:		
Air temperature	✓	6.0 Adaptation plan, p. 45-46
Solar radiation	✓	6.0 Adaptation plan, p. 53
Precipitation	✓	6.0 Adaptation plan, p. 46-47
Sea surface temperature	✓	6.0 Adaptation plan, p. 44
Humidity	✓	6.0 Adaptation plan, p. 50-52
Wind	✓	6.0 Adaptation plan, p. 48-49
The following secondary effects are addressed in the Climate Adaptation Plan for the two selected timescales:		
Relative humidity	✓	6.0 Adaptation plan, p. 50-52
Bushfire weather	✓	6.0 Adaptation plan, p. 52-53
Sea level rise	✓	6.0 Adaptation plan, p. 44
Coastal inundation	✓	6.0 Adaptation plan, p. 44
Cyclones	✓	6.0 Adaptation plan, p. 49-50
Flood	✓	6.0 Adaptation plan, p. 46-47
Heatwave	✓	6.0 Adaptation plan, p. 45-46
Drought	✓	6.0 Adaptation plan, p. 47-48
4.1.7 Implementation of the Climate Adaptation Plan.		
A minimum of two risk items identified in the risk assessment component of the Climate Adaptation Plan have been addressed by specific design responses.	✓	6.0 Adaptation plan, p. 43
All risk items identified as 'high' or 'extreme' have been addressed by specific design responses.	✓	6.0 Adaptation plan, p. 43
Copy of CV of suitably qualified professional who developed the plan	✓	11.2 STEWART MONTI - CV, p. 72
Evidence demonstrating the design responses to the Climate Adaptation Plan	✗	Not included

9.0 Implementation

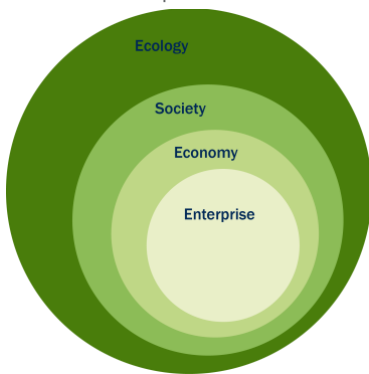
Beyond the 74 individual risk items identified and the numerous embedded and potential future adaptation measures for each, here we provide a more targeted exploration of holistic resilience outcomes and high value strategic initiatives for the NSW Government and the City of Ryde Council to deliver these at MPIP.

These resilience priorities are synthesised from the three objectives from the Macquarie Park Masterplan Objectives, which informed the Concepts from the Macquarie Park Sustainability Framework, Urban Design Principles and the Connection to Country Themes from the Master Plan, and the risk assessment informed by future climate scenarios contained herein.

9.1 Priorities

Based on an analysis of NSW Government and City of Ryde strategic documents, project-specific supporting technical reports, stakeholder engagement, and the risk assessment process documented herein we propose a series of four resilience priorities for MPIP. These priorities describe the outcomes of a place that is socially, environmentally, and economically resilient.

These resilience priorities are additionally influence by two key strategic approaches to sustainable development.



Ecological Economics

Ecological Economics is an interdisciplinary and transdisciplinary field dedicated to the science and management of sustainability that not only bridges across ecology and economics, and other social sciences, natural sciences, and humanities but it also includes other non-academic experiences and expertise in its holistic analyses to address complex environmental, social, and economic sustainability problems. It addresses the interdependence and coevolution of human economies and natural ecosystems, acknowledging that the economy is embedded in society which in turn is embedded within the biosphere of the Earth, and focuses on how the economy can serve humans to improve their quality of life, while maintaining a healthy and thriving ecological foundation on which humans and the rest of nature depend on to exist.

Doughnut Economics

Developed by University of Oxford economist Kate Raworth, the Doughnut Economics framework for sustainable development, combines the concept of planetary boundaries with the complementary concept of social needs. The framework regards the performance of an economy by the extent to which the needs of people are met without overshooting Earth's ecological ceiling. In this model, an economy is considered prosperous when all twelve social foundations are met without overshooting any of the nine ecological ceilings. This situation is represented by the area between the two rings, considered by its creator as the safe and just space for humanity.



The resilience priorities for MPIP are:

<p>REGENERATION</p>	<p>SOCIAL COHESION</p>	<p>COMMUNITY SAFETY</p>	<p>OPERATIONAL CONTINUITY</p>
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9.1.1 Regeneration

Rationale

Preservation of indigenous and novel ecosystems and the communities that inhabit them supports the built environment to adapt and respond to disruption naturally, while further mitigating future climate impacts, and celebrating tangible and intangible heritage supports sense of place, belonging, and collective identity.

Objectives

- Preserve and conserve all existing and remnant heritage sites, and terrestrial and aquatic ecologies.
- Actively regenerate and expand them for greater use by human and non-human communities.
- Communicate their history and value to residents, workers, and visitors to ensure ongoing stewardship.

9.1.2 Social cohesion

Rationale

Equitable and inclusive communities actively shaped by voluntary social participation are instrumental for identifying priorities and solutions that are more likely to be appropriate, lasting, and supported by the affected community during pre-disaster, acute, post-disaster, and recovery phases.

Objectives

- Deliver diverse, freely accessible indoor and outdoor space for community to congregate.
- Facilitate programming for diverse ages, cultures, and abilities.
- Engage with existing local communities to ensure spaces and programming meet community needs and expectations.
- Lead engagement with existing and incoming communities to foster the development of a new integrated community.

9.1.3 Community safety

Rationale

Protecting life, and physical and mental health and wellbeing during acute shocks and chronic stresses is paramount to the development of a successful place, and critical to foster trust between government, stakeholders, residents, and the wider public.

Objectives

- Residents, workers, visitors, and commuters remain safe in public during extreme weather.
- Buildings and infrastructure are designed to withstand extreme weather under future climate scenarios.
- Residents able to safely shelter in place in their homes for extended periods during environmental and or social disruption.

9.1.4 Operational continuity

Rationale

Developing a precinct that can continue operating, either fully or partially, during and immediately after disruption will ensure residents and visitors are protected, surrounding community can take refuge, businesses can continue to operate, and asset value is maintained long term.

Objectives

- Nature-based and passive solutions, coupled with world's best resource efficiency reduce reliance on mechanical infrastructure.
- Mechanical systems can operate independently of mains utilities (e.g. energy, water, waste).
- Precinct is able to provide support to community during local or regional, environmental or social disruption.

10.0 Conclusion

This MPIP CAP features a risk assessment in accordance with the Australian Standard AS 5334-2013 'Climate change adaptation for settlements and infrastructure' and with further guidance from ISO 31000-2009 – Risk Management – Principles and Guidance; and AGO, Climate Change Risks and Impacts: A Guide for Government and Business.

The assessment of climate change impacts has addressed two-time scales relevant to anticipated building lifespan for the primary effects of temperature, precipitation, and sea-level rise, mid future 2040 and far future 2070. The risk assessment has also considered the secondary effects of relative humidity, drought/flood, wind, cyclones, and bushfire. In addition to the climate related impacts a series of social, cultural, economic and political disturbances have been addressed, based on those identified in Resilient Sydney (2018).

All 75 potential risks identified in the risk assessment component of the CAP have been addressed by specific design and operational adaptation measures to reduce the likelihood of that event occurring, as detailed in 6.0 Adaptation plan. The 1 extreme risk has been mitigated, all but 2 high risks have been mitigated to medium or low-level risks and 26 medium risks have been mitigated to low level risks through adaptation measures.

11.0 Appendices

11.1 Climate Data

11.1.1 Temperature

Average annual temperature

Maximum temperatures are projected to rise by an average of 1.94°C by 2070. The greatest increases are occurring around Blackheath and the far southwest, while the remainder of Sydney will see an increase of maximum temperatures at least 1.57°C. All models show there are no declines in maximum temperatures across Metropolitan Sydney.

TABLE 11.1: NARCLIM MEAN MAX. AND MIN. TEMPERATURES

Parramatta North (Masons Drive) Lat:-33.79 Lon:151.02		Baseline 1990-2016		2020-2039		2060-2079	
		NARCLiM	BOM (local)	Average Change	Range	Average Change	Range
Mean Max Temperature (°C)	Period	22.60°C	23.4°C	+0.69°C	+0.35 to +0.98°C	+1.94°C	+1.57 to +2.48°C
	Highest Outright	47°C (4 th Jan 2020)					
Mean Min Temperature (°C)	Period	14.47°C	9.0°C	+0.64°C	+0.41 to +0.76°C	+2.02°C	+1.44 to +2.47°C
	Min. Outright	8.1°C (3 rd July 1984)					

In 2070 the mean maximum temperature will be approximately 23.74 °C based on the local baseline.

Minimum temperatures are also projected to rise by 2.02 °C by 2070. The greatest increases projected are from Campbelltown to north of Wiseman's Ferry, while large increases are also being seen around Mount Victoria and Blackheath. Sydney will see an increase in minimum temperature of at least 1.44 °C. All models show there are no declines in minimum temperatures across the Metropolitan Sydney.

In 2070 the mean minimum temperature will be approximately 15.8 °C based on the local baseline.

Extreme temperature events

Days in which the maximum temperature is over 35°C are projected to increase across Sydney by an average of 10 days per year by 2070. The greatest increases are seen in the central part of greater Sydney from Picton to north of Wiseman's Ferry and out to Katoomba. These regions are projected to have an additional 15 hot days per year. While the remainder of Sydney will see at least 4 additional hot days per year.

In 2070 the number of hot days will be approximately 13 based on the local baseline.

Nights in which the minimal temperature is under 2°C are projected to decrease across the Sydney by an average of 11 nights per year by 2070. The greatest decreases are seen in the Blue Mountains during winter. These regions are projected to experience more than 40 fewer cold nights per year.

Since cold nights are rarely seen along the coast of NSW there will be little to no impact for the project area.

TABLE 11.2: NARCLIM NUMBER OF HOT DAYS AND COLD NIGHTS

Parramatta North (Masons Drive) Lat:-33.79 Lon:151.02		Baseline		2020-2039		2060-2079	
		BOM (local)	Average Change	Range	Average Change	Range	
Number of Hot Days (Days max temp >35 °C)	Period yearly average	11 days	+3.90 days	+0.24 to +5.63 days	+10.40 days	+3.91 to +14.91 days	
Number of Cold Nights (Nights min temp <2 °C)	Period yearly average	2.2 days	-4.50 days	-5.85 to -3.42 days	-10.90 days	-12.36 to +8.97 days	

11.1.2 Precipitation

Average annual rainfall

As shown in Table 11.3 below, annual rainfall is projected to increase by an average of 8.90% by 2070. Large increases of around 18% are projected across the whole of Sydney throughout summer and autumn. Winter and spring rainfall is more variable and may see decreases of around 8%.

In 2070 the mean monthly rainfall will be approximately 110.08 mm based on the local baseline.

TABLE 11.3: NARCLIM MEAN MONTHLY RAINFALL

Parramatta North (Masons Drive) Lat:-33.79 Lon:151.02		Baseline		2020-2039		2060-2079	
		NARCLIM	BOM (local)	Average Change	Range	Average Change	Range
Mean Monthly Rainfall (mm)	Period yearly average	70.76 mm	82.07 mm	+1.70%	-12.99 to +18.03 %	8.90%	-8.67 to +24.18%
	Highest Rainfall	673 (February 1990)					

Extreme rainfall events

The Floodplain Risk Management Guidelines Practical Consideration of Climate Change (DECC 2007) recommends hydraulic modelling sensitivity analyses for the following rainfall intensities: +10%, +20% and +30% in peak rainfall and storm volume. Climate change related sensitivity analyses should be in addition to the usual sensitivity analyses involved in food and FRM studies undertaken in accordance with the Manual.

These parameters for modelling purposes are further supported by Book 1 of the ARR (Ball et al. 2019) where following the relationship between temperature and humidity a 5% increase in rainfall intensity per degree of projected surface temperature increase is recommended. Therefore, an average increase of approximately 2 °C relates to 10% increase in rainfall intensity (the range projected for the Sydney Metro region is 1.57 to 2.48 °C by 2070 NARCLim).

Drought

Drought occurrence is measured using the rainfall-based metric known as the Standardised Precipitation Index (SPI) and duration of time spent in drought and changes to the duration and frequency of drought were calculated for different levels of severity (mild, moderate, severe, and extreme) for projections collated out by the CSIRO (Dowdy et al. 2015).

Projected changes to drought share much of the uncertainty of mean rainfall change, and there is no clear indication on changes to drought conditions for the East Coast region, particularly for RCP4.5 projections (Dowdy et al. 2015).

Meteorological drought will continue to be a regular feature of regional climate for the East Coast region, and while it may change its characteristics as the climate warms, there is low confidence in projecting how the frequency and duration of extreme drought may change (Dowdy et al. 2015).

11.1.3 Extreme storms

Gales and extreme wind events

As shown in Table 11.4 below projections show a decreasing trend and that there is a very small likelihood of any increases in wind speed. The reductions in East Coast South are likely related to a projected southward movement of storm tracks and the sub-tropical ridge. This would lead to a weakening of westerly winds in the East Coast South sub-cluster. In 2090 the mean 9am and 3pm wind speed will be approximately 10.6 km/h and 16.6 km/h respectively based on the local baseline.

TABLE 11.4: CHANGE IN WIND SPEED

Parramatta North (Masons Drive) Lat:-33.79 Lon:151.02		Baseline			2030, RCP 4.5		2090, RCP 4.5	
		BOM (local)			Average Change	Range	Average Change	Range
		max wind gust speed	mean 9am wind speed	mean 3pm wind speed				
Wind Speed (%) Change	Annual	150 km/h	7.8 km/h	12.9 km/h	-0.5 %	-2 to +1.2%	0%	-2.1 to +1.6%

Storms (cyclones)

Tropical cyclones in the Australian region are influenced by a number of factors, and in particular variations in the El Niño – Southern Oscillation (ENSO). In general, more tropical cyclones cross the coast during La Niña years, and fewer during El Niño years (BoM 2016). Cyclones have a complex link to ocean surface temperatures, characteristics of a region and global climate patterns such as the El-Niño Southern Oscillation, meaning that predicting frequency of cyclone and other extreme weather events can be difficult. This results in discrepancies in cyclone frequencies between different climate models (DERM 2009).

The Australian Bureau of Meteorology states (2007):

While tropical cyclones do not impact NSW very often, they have caused flooding, destructive winds, storm surges and loss of life. When a tropical cyclone is affecting NSW the Brisbane Tropical Cyclone Warning Centre (TCWC) will issue a TC Advice for NSW and a Tropical Cyclone Forecast Track Map. Both these products will appear under [Current Warnings for NSW](#) on the Bureau's Website. Information is also available via the Bureau's Telephone Weather Services: [Tropical Cyclone Warnings 1300 659 212](#).

It is likely that [Severe Weather Warnings](#) and [Flood Warnings](#) will also be current before, during and after tropical cyclone warnings.

Hail size and location

Hail severity may increase in most regions of the world while Australia and Europe are expected to experience more hailstorms as a result of climate change (Raupach et al. 2021). A global summary of hail trends from past observations and projected future trends from simulations and models led to the general expectation that hailstorm frequency will decrease in East Asia and North America, while increasing in Australia and Europe, and that hailstorm severity will increase in most regions.

On balance, the hail threat is likely to increase in Australia, especially in Australia's south-east including the Sydney area (Raupach et al. 2021).

However, current and future climate change effects on hailstorms remain highly uncertain, in part due to a lack of long-term observations and limited modelling studies.

Dust storms

Dust storms occur in a very sporadic nature across Australia depending on the amount of rainfall that the arid and semi-arid parts of the country have received (BoM 2006). In prolonged dry periods, dust storms are a frequent occurrence, whilst in the

wetter periods dust storms are very uncommon due to the increase in vegetation and soil moisture binding dust particles to the surface.

The most recent dust storms to hit the eastern states occurred on (BoM 2019, 2021):

- **3 February 2005.** A strong cold front brought very cold air up from the south breaking many minimum temperature records. As well as the extreme temperatures, dust storms were recorded in many places west of the divide due to the intense winds. At Bourke, visibility was reduced to 500m, and Moree, visibility reduced to 600m.
- **23 October 2002.** This storm was one of the most severe on record. It was also caused by the passage of a strong cold front. This, combined with high temperatures and the prolonged drought in the region, resulted in a massive dust storm which swept across the eastern states. In Sydney, visibility was reduced to a few kilometres and pilots reported that the dust extended up 3km into the atmosphere. West of the divide experienced the most severe conditions, with many areas experiencing visibilities of just 300m. In the suburb of Roma, in southwestern Queensland, visibility was reduced to just 100m.
- **23 September 2009.** Sydney residents awoke to a thick red haze blanketing the city—it was a huge dust storm that was quickly dubbed 'Red Dawn'. The dust was so thick that visibility was reduced to below 1 km for four hours, and at the peak of the storm you could only see 400 m. The massive dust storm was 3000 km long and 2500 m high. It affected as far north as Cairns and dust from it settled as far away as New Zealand! The storm is estimated to have carried approximately 15 million tonnes of dust at its peak.
- **20 January 2020.** An intense dust storm swept through a very large area of South Australia, New South Wales, and Victoria during 23 and 24 January. Visibility was severely reduced with many locations reporting less than 200 m.

11.1.4 Bushfire

Fire danger index

Fire weather is classified as 'severe' when the FFDI is above 50, and most of the property loss from major fires in Australia has occurred when the FFDI reached this level (Blanchi et al. 2010). FFDI values below 12 indicate low to moderate fire weather, 12-25 high, 25-49 very high, 50-74 severe, 75-99 extreme and above 100 catastrophic.

Long-term FFDI estimates are available for two weather stations in the region, Sydney Airport and Richmond. The average annual FFDI for the period 1990–2009 is 5.5 at Sydney Airport and 7.1 at Richmond.

TABLE 11.5: NARCLIM SEVERE FIRE WEATHER RISK

	1990–2009		2020-2039		2060-2079	
	Baseline Average annual		Average Change	Range	Average Change	Range
Severe Fire Weather Risk (FFDI >50)	5.5 days Sydney Airport		0	-0.78 to +1.15	0.6	-0.72 to +2.03
	7.1 days Richmond					
	Summer		0.1	-0.28 to +0.92	0.1	-0.25 to +0.45
	Autumn		0	-0.03 to 0.00	0	-0.02 to +0.01
	Winter		0	-0.01 to +0.01	0	-0.01 to 0.00
	Spring		0	-0.50 to 0.24	0.5	-0.48 to 1.83

11.1.5 Radiation

Shown in the table below, solar Radiation projections show little change for 2030 and a slight increase of 1% for 2090. However, an Australian evaluation suggested that some models are not able to adequately reproduce the climatology of solar radiation. CMIP2 and CMIP5 models appear to underestimate trends in certain regions of southeast coast.

TABLE 11.6: NARCLIM SEVERE FIRE WEATHER RISK

Parramatta North (Masons Drive) Lat:-33.79 Lon:151.02		Baseline	2030, RCP 4.5		2090, RCP 4.5	
		BOM (local) Mean daily solar exposure	Average Change	Range	Average Change	Range
Solar Radiation (%) Change	Annual	16.1 MJ/m2	0.6%	-0.6 to +1.6%	1%	-0.2 to +2.9%

11.1.6 Waterway health

Discharge runoff

Climate change may alter the current patterns of diffuse source water pollution due to projected changes in the seasonality, frequency, intensity and duration of rainfall (IPCC (Intergovernmental Panel on Climate Change) 2014). For example, more intense storms can lead to enlargement of streams through bed and bank erosion, thus releasing significant volumes of sediment downstream. The total annual load of sediment and contaminants that attach to sediment particles is frequently dominated by one or two large storms (Drewry, Newham & Croke 2005). Therefore, climate change could further exacerbate an already significant diffuse source water pollution problem, particularly in areas that become subject to more frequent and intense storms (DECC 2009).

The cumulative impact of frequent, low volume runoff is also significant and can contribute to long periods in which waterways are unfit for use (Harhcegani & Cornish 2003).

11.2 STEWART MONTI - CV

“My interest is in projects which combine local aspirations with global responsibility, seeking to regenerate places, ecologies, and communities, and contribute climate positive outcomes.”

Stewart Monti

Associate

Reimagining Broadmeadow Master Plan | Newcastle, NSW
NSW Department of Planning and Environment | Cox

Ultimo Campus Master Plan | Sydney, NSW
University of Technology Sydney

Indigenous Residential College (IRC) | Sydney, NSW
University of Technology Sydney | BVN | Well Silver Target

Western Sydney Aerotropolis - Agribusiness Precinct | Western Sydney, NSW
Western Parkland City Authority | Terroir

Macquarie Park Innovation Precinct Masterplan | Sydney, NSW
NSW Department of Planning & Environment | AJC

Sydney Olympic Park 2050 Masterplan | Sydney, NSW
Sydney Olympic Park Authority | SJB | Zero Carbon Net Target

Central Station Precinct Renewal Program | Sydney, NSW
Transport for NSW | Zero Carbon Net Target

Bays West Strategic Place Framework | Sydney, NSW
NSW Department of Planning, Industry & Environment | Terroir | Zero Carbon Net Target

Bays West Stage 1 Masterplan | Sydney, NSW
NSW Department of Planning & Environment | COX Architecture | Zero Carbon Net Target

BlueScope Port Kembla Masterplan | Port Kembla, NSW
BlueScope | BIG

Agribusiness Precinct Master Plan, Western Sydney Aerotropolis | Sydney NSW
Western Parkland City Authority | Zero Carbon Target

Publications:



Trained as an Architect and researcher, Stewart is an Environmental Designer at Atelier Ten focused on masterplans and multidisciplinary projects.

He has a varied history across design, construction, and research in the built environment both locally and internationally. Stew's passion and expertise lies in ecological urbanism and resilience.

Industry Leadership

Materials & Embodied Carbon Leaders' Alliance (MECLA)
Working Group Founding Partner

Circular Australia
Precincts & Infrastructure Taskforce Member

Green Building Council of Australia
Expert Reference Panel Member, Nature and Biodiversity

Green Building Council of Australia
Green Star Accredited Professional,
Buildings & Communities

Qualifications

M. Arch.
University of Technology Sydney

B. Des. (Arch.)
University of Technology Sydney

Dip. Des. (Visual Communication)
University of Technology Sydney,

TransFEWmation: Towards Design-led Food-Energy-Water Systems for Future Urbanization, Nature Driven Planning for the FEW-Nexus in Western Sydney | Springer, 2021

Where Do We Stand? A Survey of Resilient Design Measures for Building Envelope and HVAC&R Systems | ecolibrium, 2020

Contemporary Urban Design Thinking: Nature Driven Urbanism, Nature-Inclusive Cities: Concepts and Considerations | springer, 2020

Antifragile: What makes HVAC&R systems resilient? | ecolibrium, 2019

Experience

Atelier Ten Australia
Associate, 2019 – present

Hanze University of Applied Sciences
Research Associate, 2019 – 2020

University of Technology Sydney
Research Assistant, 2018 – 2019

Royal Zoological Society of NSW
Executive Officer, 2013 – 2019

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