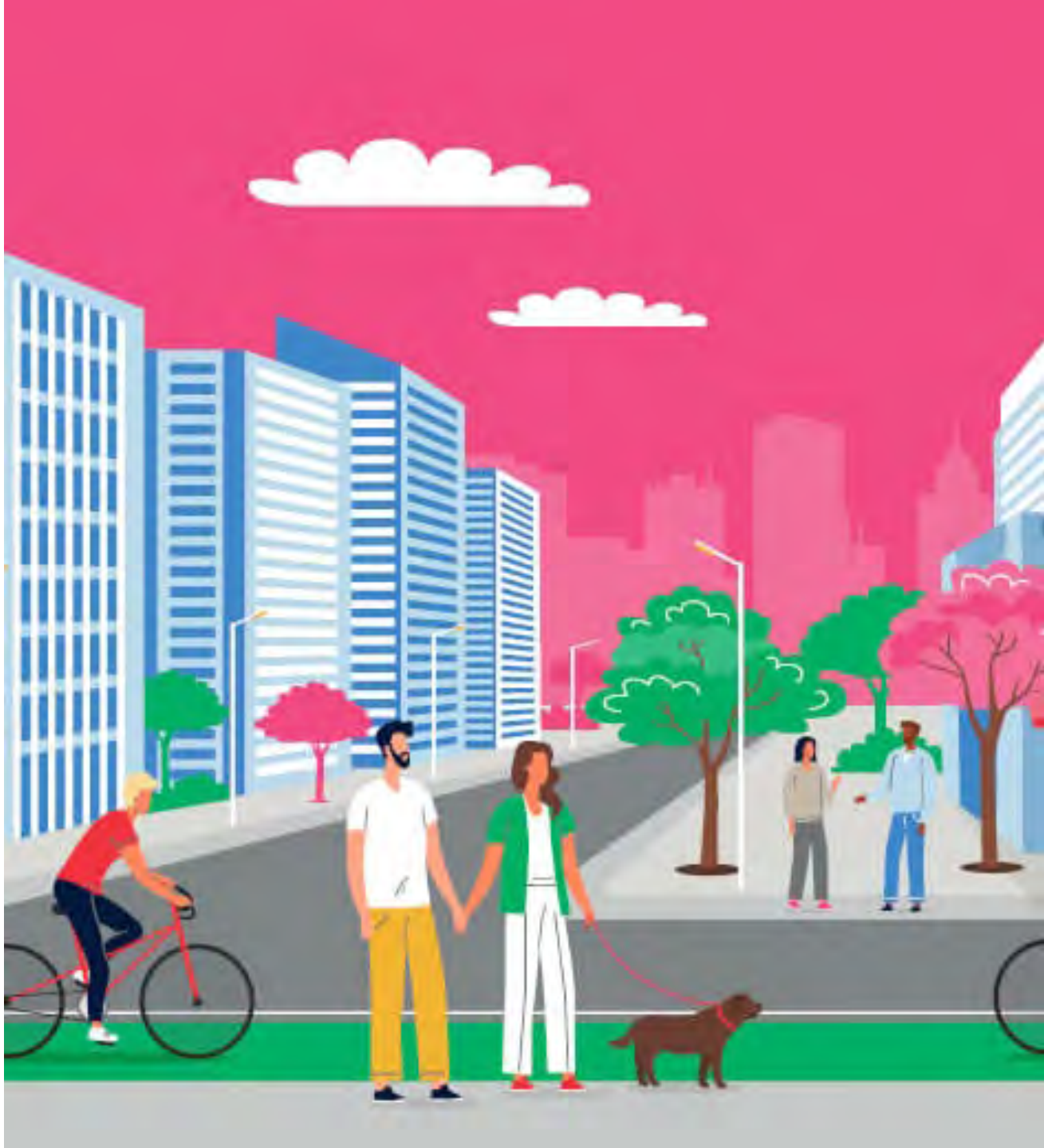
Westmead South Masterplan ESD Strategy

Cumberland City Council

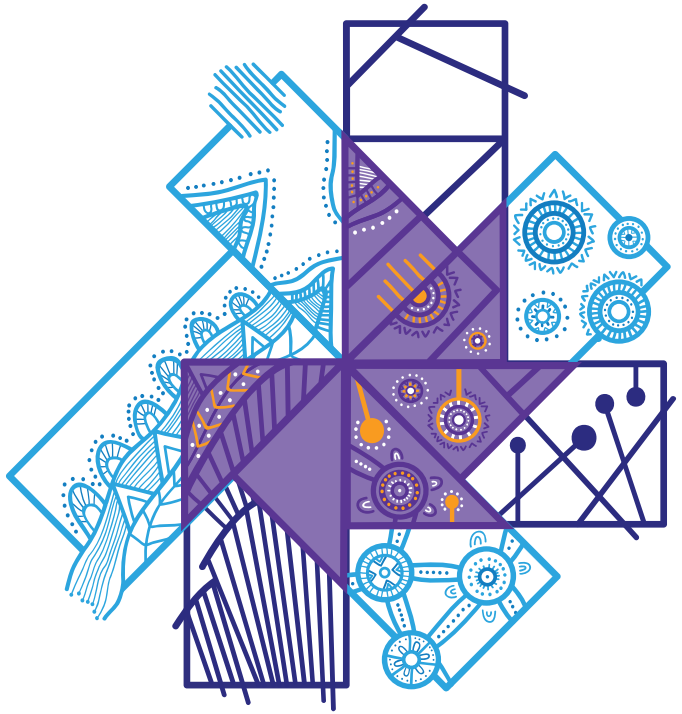
March 2024



Arup would like to acknowledge the Darug Nation and People as the Traditional Owners of the land on which Cumberland Local Government Area is situated.

We also wish to acknowledge the Gadigal people of the Eora Nation as the Traditional Owners of the land on which the Arup Sydney office is located.

We pay respect to Elders past and present, and recognise and celebrate the ongoing cultures, traditions and custodianship of First Nations peoples.



The artwork is *Shift to shape an even better world* by Gilimbaa Artist Tarni O'Shea.

Context

Introduction

How to use this document

The Ecologically Sustainable Development (ESD) Strategy works in concert with and doesn't supersede the NSW Sustainable Buildings State Environmental Planning Policy (SEPP) and other legislated requirements. This document outlines sustainability ambitions, objectives and initiatives. It also includes key information relevant to the delivery of sustainability and resilience for the Westmead South precinct (the Precinct). It should be used to define and drive sustainability in the design and delivery of the Precinct.

The structure of the document is outlined in the adjacent graphic.

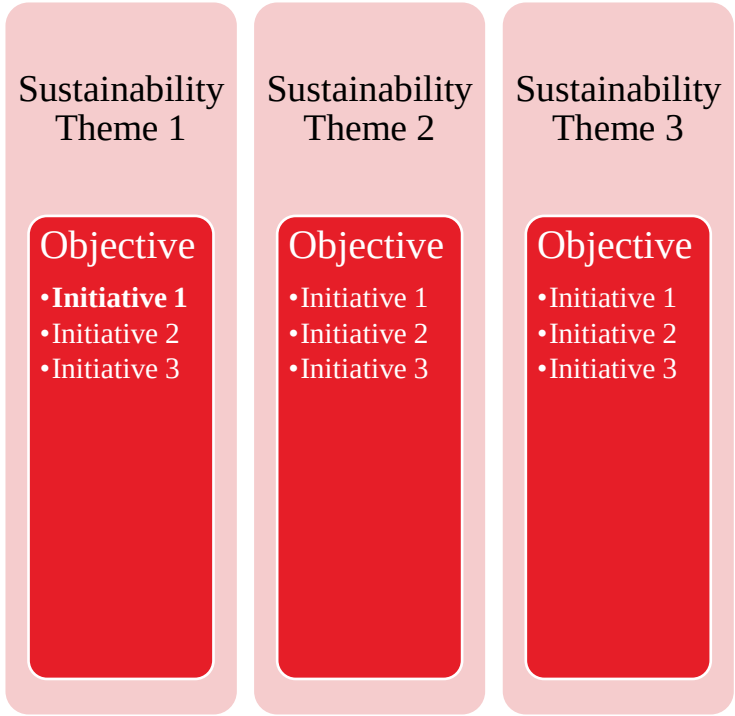
Document purpose

Ecologically Sustainable Development (ESD) is development that meets the needs of present generations without compromising the ability of future generations to meet their own needs. This value is reflected in the Cumberland City Council's Sustainability vision and is integrated into the master plan for the Westmead South precinct (The Precinct).

This ESD Strategy outlines the ESD approach for the Precinct. It has been developed during the masterplanning stage of the project with a level of detail appropriate to that project stage.

Key sustainability themes have been identified for the Precinct based on best practice and material issues for the area. The themes each identify a key outcome for the Precinct and have corresponding initiatives which contribute to the realization of these outcomes. Some initiatives are 'must-haves' (in **bold**) and others are 'nice-to-haves'. 'Must have' initiatives must be included in the delivery of the Precinct, however all initiatives listed in this document should be considered a jumping off point – a baseline from which additional initiatives can be delivered. The structure of the ESD Strategy is reflected in the diagram to the right.

This document also includes details of the Precinct's approach to being resilient to risks that may result from our changing climate. This approach should be incorporated into future design and development of the Precinct to ensure risks are adequately responded to, and the Precinct and its community are as resilient as possible.



ESD Strategy Structure

Westmead South Masterplan

Overview

Westmead South is a key centre of Cumberland City, located in the southern portion of the Westmead Precinct, 1.7km from the Parramatta Business District. It is bound to the north by a railway corridor, south by the Great Western Highway, east by the Mays Hill Precinct (Parramatta Park), and west by Bridge Road.

The Westmead Precinct is in the Central River City, one of Greater Sydney's three cities. It is poised to transform, with significant infrastructure investment including a future Metro station at Westmead, Parramatta Light Rail, rapid growth in health, education and innovation, and potential connection of the North-West T-way with the Liverpool-Parramatta T-way via Westmead South.

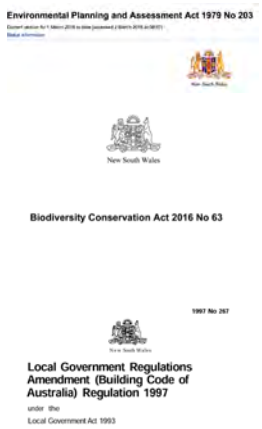
The precinct is expected to provide residents increased employment, services and recreation opportunities within 30 minutes. Westmead South is a gateway to the Westmead Precinct, the masterplan is well placed to provide specialised retail and commercial uses and diverse housing opportunities.

The integration of ESD into the Precinct's design, delivery and operation can deliver improved liveability, community experience and resilience now and in the Precinct's future.

Westmead South context map

Strategic Context

State


Environmental Planning and Assessment Act 1979 No 203

New South Wales

Biodiversity Conservation Act 2016 No 63

1997 No 267

New South Wales

Local Government Regulations Amendment (Building Code of Australia) Regulation 1997

under the

Local Government Act 1993

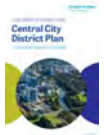
State Environmental Planning Policy 65 – Design Quality for Residential Apartment Developments

State Environmental Planning Policy (Housing) 2021

State Environmental Planning Policy (Sustainable Buildings)

State Environmental Planning Policy (Infrastructure)

Regional



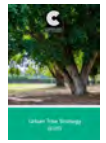
Transport

Smart

Local

Cumberland City Council Submission on the Sydney Metro West Stage 3 EIS

Nature



Community

Themes

Sustainability Themes

Sustainability themes have been identified for the Westmead South precinct through a review of industry best practice, legislative requirements and local needs. Objectives outline the desired outcome for each sustainability theme. Initiatives nested under each theme were developed in collaboration with the team involved in the design of the masterplan and were vetted and refined by Cumberland Council. Initiatives which are considered ‘must-haves’ by Council are highlighted in **bold** in this section. Other initiatives are ‘nice-to-have’ and should also be considered for inclusion in master plan design and delivery.

Energy, thermal comfort, and carbon

Objective: works towards being a net zero precinct, that understands its emissions sources and develops strategies to drive emissions reductions within its boundary of influence, whilst maintaining amenity

ET1. Retention of existing structures

ET2. Design for longevity, re-use, remanufacture and resource recovery

ET3. Renewable energy procurement

ET4. Renewable energy on-site generation

ET5. ISO14001 certification for Environmental Management Systems for contractors and sub-contractors.

ET6. Measure embodied emissions and lifecycle impacts.

ET7. 100% electric precinct.

ET8. Passive design for buildings.

ET9. Procure local and natural materials, such as timber , bamboo, straw, and biocomposites.

ET10. Modular off-site construction systems.

Energy, thermal comfort, and carbon

Initiatives

ET1. Retention of existing structures

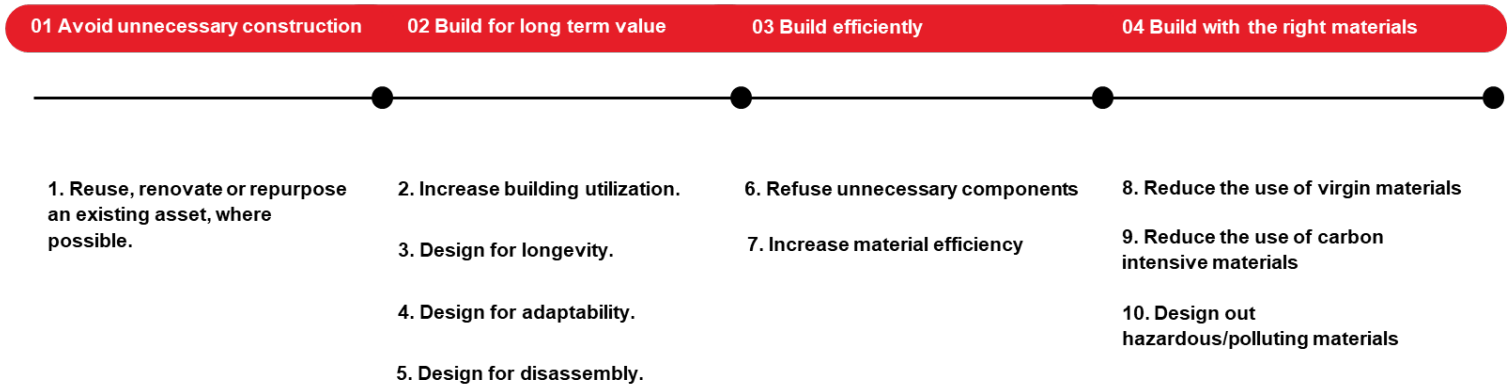
The circular economy framework below, illustrates key principles to minimise the level of embodied emissions in the Precinct.

During the construction of the precinct, various materials such as concrete, steel, aluminum, asphalt, timber, and others will be used. At early design stages, choices are available to consider material switching, durability or low emission options.

The retention of existing structures reduces the use of new materials as well as the emissions associated with design and construction.

ET2. Design for longevity, re-use, remanufacture and resource recovery

Emissions associated with waste and materials required for repair and replacement can be reduced through strategic design decision making. The lifetime of elements should be maximized wherever feasible, and the retention of components or materials in their highest order use possible should be prioritized. Prioritise retainment of existing structures, where possible.



Circular economy framework (Arup, 2023)

Energy, thermal comfort, and carbon

Initiatives

ET3. Renewable energy procurement

Two primary options for procurement of offsite renewable energy for the Precinct exist: power-purchase agreement (PPA) or similar with a centralised energy provider, or separate procurement for each building.

ET4. Renewable energy on-site generation

Maximises solar photovoltaics (PVs), wind, and geothermal renewable energy sources. These should be adequately provisioned for in design in terms of space allocation, connections, storage and other associated installation or maintenance requirements.

ET5. ISO14001 for contractors and sub-contractors

Require Environmental Management Systems for key delivery partners, in alignment with the ISO 14001 standard.

ET6. Measure embodied emissions and lifecycle impacts

Measure emissions and use emissions reduction targets to inform decision-making about design and materials choices.

ET7. 100% electric precinct

Electricity represents the only potential fully renewable, distributed energy source.

Consider opportunities to transition towards the use of 100% electricity on-site, including the exclusion of a connection to the gas network. Aligns with NSW's Net Zero Plan Stage 1: 2020–2030 targets and Green Star Building's requirements and tuning or rectified and assist in prioritising retrofit actions.

Use automated systems connected to a Building Management System (BMS) where possible, such as lighting control that includes occupant detection and daylight adjustment.

Integrate design features and technologies that support peak demand shifting and energy storage, helping shift demand away from both network peaks (resilience / cost) and fossil peaks (carbon intensity / baseload).

ET8. Passive design for buildings

Prioritise passive design measures for all buildings, including optimised orientation, taking advantage of natural wind movements, ambient lighting, shading devices, appropriate window to wall ratios (WWR), and using high performance insulation and glazing to reduce overall energy consumption.

ET9. Procure local and natural materials, such as timber, bamboo, straw, and biocomposites

Employ materials with lower extraction and transportation emissions.

ET10. Modular off-site construction systems

Minimise construction emissions by including modular components and making use of off-site construction practices where possible.

Waste

Objective: reduces waste going to landfill, maximise resource recovery, and minimise associated greenhouse gas emissions

WS1. E-waste disposal facilities

WS2. Organic waste separation

WS3. Resource recovery

Waste

Initiatives

WS1. E-waste disposal facilities

Allocate space and/or facilities for the disposal of e-waste in the Precinct and its buildings in order to enable e-waste separation, storage and disposal. This will promote the diversion of waste that is more complex and hazardous.

WS2. Organic waste separation

Promote and enable organic waste separation and disposal in order to increase diversion of waste from landfill, and minimise emissions associated with FOGO decomposition in landfill. Technologies that enable lower-emissions disposal of FOGO waste should be investigated and implemented where feasible.

WS3. Resource recovery

Enable resource recovery in the Precinct and its buildings during their operation and construction through setting waste diversion and reuse/recycling targets, providing waste separation facilities and enabling infrastructure and services. Design decisions and operational practices and policies can also enable resource recovery and waste minimisation.

Landscape, public realm, and biodiversity

Objective: aspire to be a nature positive and resilient precinct where residents and users can reconnect with historic local ecosystems and reap the benefits of nature

LP1. Green facades

LP2. Bio-solar and green roofs

LP3. Bioswale

Pocket habitat

Landscape, public realm, and biodiversity

Initiatives

LP1. Green facades

Create green facades and vegetated walls on buildings in the precinct, targeting the use of native and habitat-enabling vegetation where possible. This can enable localised cooling, reduce run-off and drainage management requirements, insulate buildings and foster connection to nature. Vegetation should maximise shading.

LP2. Bio-solar and green roofs

Integrate rooftop PV and green roofs to increase efficient use of roof space, improve cooling and biodiversity outcomes and increase efficacy of PV systems.

LP3. Bioswales

Maximise the use of bioswales for the collection, storage, filtration and conveyance of stormwater runoff.

Resilience

Landscape design and planning, public realm works, and biodiversity enhancement all hold significant opportunity to improve the resilience of the precinct to acute shocks and chronic stresses, including those arising from climate change, nature losses, and transitional risks.

For a suite of design and operational adaptations that may be implemented to improve Westmead South's climate change resilience, please refer to the Resilience Plan that accompanies this Report.

Smart City

Objective: the Precinct is part of a Smart City, which leverages data, innovation and digital technology to enhance the precinct and broader community's sustainability.

SC1. Digital tools for assessing urban heat island effect

SC2. Virtual Power Plants

SC3. Community Batteries

SC4. Intelligent Building Management Systems (BMS)

Smart City

Initiatives

SC1. Digital tools for assessing urban heat island effect

Apply feasible digital tools for mapping green areas in urban spaces and conducting evaluations of heat island effect and the efficacy of different urban heat island mitigations in combination.

SC2. Virtual Power Plants

Establish virtual power plants, decentralising energy production. This allows for a variety of energy producing methods, from PV systems to traditional heat pumps. The use of monitoring technology to bring these systems together also allows for finer control over power production, which can address demand peaks quickly and efficiently. It is noted that proper cost and feasibility analysis must be conducted to assess the suitability of this technology.

Opportunities exist to work with large energy users/generators to integrate into holistic energy masterplan.

SC3. Community Batteries

Use community batteries to store excess solar energy for households to use during peak hours. This can lead to reduced energy costs, increased grid resilience, and reduced inequalities by being accessible to households without a current solar PV system.

SC4. Intelligent Building Management Systems (BMS)

Intelligent BMS optimise total building's performance and allow users to track utilities' consumption data in real time, which ultimately enables rapid adaptive responses, reduced energy consumption and associated carbon emissions. BMS can be responsive to the smart power grid and interacts with the building operators and its occupants.

Smart City Strategy

The Cumberland City Council's *Smart Places Strategy and Action Plan 2023* identifies key smart technologies opportunities. This section builds on such opportunities, further highlighting the associated emissions reduction potential and community benefits. A *Smart Cities Study* was also developed for Westmead South Masterplan and should be reviewed for additional Smart Cities opportunities that can enable sustainable outcomes.

Residential virtual power plant (Arup, 2019)

Water

Objective: explores and implements integrated water management strategies to drive efficiency and regeneration of natural waterways

WT1. Water fixtures and fittings

WT2. Rainwater collection

WT3. Permeable paving integrated with bioretention systems

WT4. Smart rainwater tanks

WT5. Utilise harvested rainwater for toilet flushing and landscape irrigation

WT6. Water exporting. Export water from a location where a surplus exists to a demand point

Water

Initiatives

WT1. Water fixtures and fittings

Compliance with minimum Water Efficiency Labelling and Standards (WELS) requirements for toilets, urinals, taps, and showerheads in residential and non-residential buildings.

WT2. Rainwater collection

Maximise rainwater collection and reuse through initiatives such as installation of rainwater tanks for rainwater collection and reuse such as toilet flushing. Where necessary install treatment and reticulation systems to enable reuse.

WT3. Permeable paving integrated with a bioretention system for stormwater capture

Manage stormwater runoff quality and quantity through the use of permeable paving and bioretention to facilitate collection, storage and filtration.

WT4. Smart rainwater tanks

Utilise smart rainwater tanks in the Precinct to release stored water in advance of large rainfall events to minimise overflow, detect fullness levels to improve water reuse efficiency. Smart rainwater tanks can also be networked to manage peak outflow.

Utilise harvested rainwater for toilet flushing and landscape irrigation

WT5. Water exporting

Collaborate with Precinct stakeholders to enable export of water from locations on site where a surplus exists to a demand point

Movement and transport

Objective: highly accessible and interconnected, incentivises walking and the use of low-emissions transport modes

MT1. Electric vehicles infrastructure

MT2. Bicycle parking requirements

MT3. Promote walkability and cycling

Fast charging stations

Movement and transport

Initiatives

MT1. Electric vehicle (EV) infrastructure

Provide EV infrastructure, including allocation of parking spaces for EVs, space and connection provisioning for EV charging stations, EV charging stations themselves and grid infrastructure to support charging demand.

MT2. Bicycle parking requirements

Set and provide a % allocation of bicycle parking spaces for building use types, e.g., per resident, per worker, etc. Parking in buildings should include majority bicycle parking in safe, lockable storage locations, e.g., bike racks in safe locations, access-key accessible bike cages, or end-of-trip bike parking, etc. Non-residential buildings should also include end-of-trip facilities for post-trip amenity.

MT3. Promote walkability and cycling

Provide safe and convenient access to public spaces, ensure community amenities are available locally and within walking distance, provide adequate wayfinding and signage. Ensure that public spaces, footpaths and cycle paths are safe, free from hazards and enable comfortable movement.

Community, health and wellbeing

Objective: vibrant and features accessible, diverse and well-connected public spaces and places

CH1. Inclusive construction practices

CH2. Social procurement strategies

CH3. Inclusive design principles

CH4. Utilise Connecting with Country Framework (Starts with Country, Listens to Country, Designs with Country and Cares for Country)

CH5. Engage with First Nations businesses and communities to integrate design features, procure services, embed materials within supply chains, and provide employment opportunities

Community, health and wellbeing

Initiatives

CH1. Inclusive construction practices

Instigate practices such as providing gender inclusive facilities and protective equipment, on-site anti-discrimination policies, and peer support.

CH2. Social procurement strategies

Implement strategies during design, construction and maintenance of the Precinct that generate equal employment opportunities for disadvantaged and under-represented groups.

CH3. Inclusive design principles

Inclusiveness of a diverse range of stakeholders is a driving principles in design. This may include provisioning for equitable access, diverse wayfinding, and inclusive spaces and should be applied wherever possible to both public and private spaces.

Establishes a resilience meeting point to providing refuge for locals in the face of extreme weather events.

CH4. Utilise Connecting with Country Framework (2023)

The NSW Government has developed this framework which sets out an approach for built environment projects to be developed with a Country-centred approach and guided by Aboriginal people from the earliest project stages. This Framework must be applied to the design and development of the Westmead South precinct.

CH5. Engage with First Nations businesses and communities to integrate design features, procure services, embed materials within supply chains, and provide employment opportunities

Ensuring and enabling on-going First Nations economic participation in the Precinct.

Connecting with Country Draft Framework, NSW Government 2023

Initiatives for consideration

Summarised ESD initiatives

This section summarises sustainability initiatives discussed in previous sections of the document. Initiatives in **bold** have been identified by Cumberland Council as ‘must haves’ for the Precinct.

Themes	Proposed initiatives
Energy, thermal comfort, and carbon	**ET1. Retention of existing structures.**
	ET2. Design for longevity, re-use, remanufacture and resource recovery.
	ET3. Renewable energy procurement.
	ET4. Renewable energy on-site generation.
	ET5. ISO14001 for contractors and sub-contractors.
	ET6. Measure embodied emissions and lifecycle impacts.
	ET7. 100% electric precinct.
	ET8. Passive design for buildings.
	ET9. Procure local and natural materials, such as timber , bamboo, straw, and biocomposites.
	ET10. Modular off-site construction systems.
Waste	**WS1. E-waste disposal facilities.**
	WS2. Organic waste separation.
	WS3. Resource recovery.
Landscape, public realm, and biodiversity	**LP1. Green facades.**
	LP2. Bio-solar and green roofs.
	LP3. Bioswale.
Smart city	**SC1. Digital tools for assessing urban heat-island effect.**
	SC2. Virtual Power Plants.
	SC3. Community Batteries
	SC4. Intelligent Building Management Systems (BMS).

Initiatives for consideration

Continued

Themes	Proposed initiatives
Water	**WT1. Water fixtures and fittings.**
	WT2. Rainwater collection.
	WT3. Permeable paving integrated with bioretention systems.
	WT4. Smart rainwater tanks.
	WT5. Utilise harvested rainwater for toilet flushing and landscape irrigation.
	WT6. Water exporting. Export water from a location where a surplus exists to a demand point.
Movement and transport	**MT1. Electric vehicles infrastructure.**
	MT2. Bicycle parking requirements.
	MT3. Promote walkability and cycling.
Community, health and wellbeing	**CH1. Inclusive construction practices.**
	CH2. Social procurement strategies.
	CH3. Inclusive design principles.
	CH4. Utilise Connecting with Country Framework (Starts with Country, Listens to Country, Designs with Country and Cares for Country).
	CH5. Engage with First Nations businesses and communities to integrate design features, procure services, embed materials within supply chains, and provide employment opportunities.

ESD initiatives / Green Star Buildings v1 mapping

In this section ESD initiatives are mapped against Green Star Buildings v1 where there is an overlap in intent or means of achievement between the Green Star Buildings credits and the Westmead South precinct initiatives.

Themes	Proposed initiatives	Green Star Buildings v1 mapping
Energy, thermal comfort, and carbon	**ET1. Retention of existing structures.**	
	ET2. Design for longevity, re-use, remanufacture and resource recovery.	**Responsible Envelope (Cr) (Responsible)** **Responsible Systems (Cr) (Responsible)** **Responsible Finishes (Cr) (Responsible)**
	ET3. Renewable energy procurement.	
	ET4. Renewable energy on-site generation.	**Grid Resilience (Cr) (Resilient)**
	ET5. ISO14001 for contractors and sub-contractors.	
	ET6. Measure embodied emissions and lifecycle impacts.	
	ET7. 100% electric precinct.	
	ET8. Passive design for buildings.	
	ET9. Procure local and natural materials, such as timber , bamboo, straw, and biocomposites.	
	ET10. Modular off-site construction systems.	
Waste	**WS1. E-waste disposal facilities.**	
	WS2. Organic waste separation.	
	WS3. Resource recovery.	**Responsible Resource Management (Min.) (Responsible)**
Landscape, public realm, and biodiversity	**LP1. Green facades.**	**Heat Resilience (Cr) (Resilient)** **Biodiversity Enhancement (Cr) (Nature)**
	LP2. Bio-solar and green roofs.	**Heat Resilience (Cr) (Resilient)** **Biodiversity Enhancement (Cr) (Nature)**
	LP3. Bioswale.	
Smart city	**SC1. Digital tools for assessing urban heat-island effect.**	**Heat Resilience (Cr) (Resilient)**
	SC2. Virtual Power Plants.	
	SC3. Community Batteries	
	SC4. Intelligent Building Management Systems (BMS).	

ESD initiatives / Green Star Buildings v1 mapping

Continued

Themes	Proposed initiatives	Green Star Buildings v1 mapping
Water	**WT1. Water fixtures and fittings.**	**Water Use (Cr) (Positive)**
	WT2. Rainwater collection.	
	WT3. Permeable paving integrated with bioretention systems.	
	WT4. Smart rainwater tanks.	
	WT5. Utilise harvested rainwater for toilet flushing and landscape irrigation.	
	WT6. Water exporting. Export water from a location where a surplus exists to a demand point.	
Movement and transport	**MT1. Electric vehicles infrastructure.**	**Movement and Place (Cr) (Places)**
	MT2. Bicycle parking requirements.	**Movement and Place (Cr) (Places)**
	MT3. Promote walkability and cycling.	**Movement and Place (Cr) (Places)**
Community, health and wellbeing	**CH1. Inclusive construction practices.**	**Inclusive construction practices (People)**
	CH2. Social procurement strategies.	**Responsible Procurement (Credit) (Responsible)**
	CH3. Inclusive design principles.	**Design for inclusion (Cr) (People)** **Acoustic Comfort (Cr) (Healthy)** **Amenity and Comfort (Cr) (Healthy)** **Movement and Place (Min) (Places)** **Enjoyable Places (Cr) (Places)**
	CH4. Utilise Connecting with Country Framework (Starts with Country, Listens to Country, Designs with Country and Cares for Country).	**Culture, Heritage, and Identity (Cr) (Places)** **Indigenous Inclusion (Cr) (People)**
	CH5. Engage with First Nations businesses and communities to integrate design features, procure services, embed materials within supply chains, and provide employment opportunities.	

Resilience

Resilience

Key definitions

Adaptation: The process of adjustment to actual or expected climate and its effects. *(Source: Intergovernmental Panel on Climate Change)*

City resilience: The capacity of individuals, communities, businesses, and systems within a city to survive, adapt and thrive no matter what kinds of chronic stresses and acute shocks they experience. *(Source: Resilient Sydney Strategy)*

Climate hazards: The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. *(Source: Intergovernmental Panel on Climate Change)*

Exposure: [The] presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social or cultural assets in places and settings that could be affected [by climate hazards]. *(Source: ISO 14091 – Adaptation to climate change)*

Impacts: The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards..., exposure, and vulnerability. *(Source: Intergovernmental Panel on Climate Change)*

Shocks: Sudden short-term events that threaten a city e.g., major storms, floods, bushfires, heatwaves, disease outbreaks, terrorism, and cyber-attacks. *(Source: Resilient Sydney Strategy)*

Stresses: [Chronic weakening of] the fabric of a city on a day-to-day or cyclical basis [e.g.,] homelessness and housing affordability, lack of access to public transportation systems, family violence, climate change, structural inequity, and chronic food or water shortages. *(Source: Resilient Sydney Strategy)*

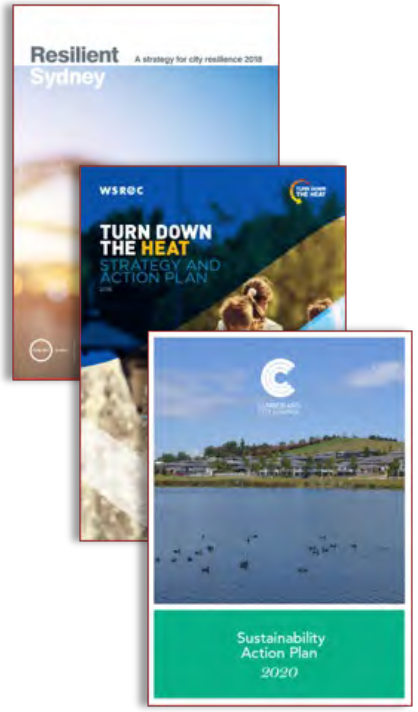
Vulnerability: [The] probability that an asset will fail given a climate impact. *(Source: Transport for NSW)*

Resilience drivers

Local, state & national drivers

The table below summarises some strategic and legislative context, relevant to Westmead South, that drives improved resilience to climate shocks and stresses in infrastructure and the urban built form:

Scale	Driver	Description	Link
Local & regional	Cumberland City Council's **Environmental Management Framework** (2019)	"[Summarises] Council's plans, strategies and policies to provide guidance and inform decision-making" on current and emerging environmental issues. Notes the "compound effects of climate change-related events, such as bushfires and the urban heat island effect; and increasing air pollution across Sydney, which could exacerbate respiratory problems". Identifies climate change adaptation as a key initiative for the Council in responding to energy demand, urban heat stress and biodiversity loss issues.	*Link*
	WSROC's **Turn Down the Heat Strategy and Action Plan** (2018) and initiatives	Comprehensive initiative focused on reducing urban heat and its associated risks by implementing measures such as urban greening, sustainable design, and community engagement.	*Link*
	WSROC's **Future Proofing Residential Development in Western Sydney** (2022)	Focuses on integrating climate change considerations such as extreme weather environments and rising temperatures into the planning and design of residential areas, enhancing climate resilience in communities.	*Link*
	City of Sydney **Resilient Sydney Strategy** (2018)	See page 10 below.	*Link*



Resilience drivers

Local, state & national drivers

Scale	Driver	Description	Link
State	**NSW Climate Change Policy Framework** (2016)	Policy driving climate change resilience by: • Reducing risks and damage to public and private assets • Reducing climate change impacts on health and wellbeing • Managing impacts on resources, ecosystems and communities.	*Link*
	NSW Climate Change Adaptation Strategy (2023)	Key decision-making principles and objectives for adaptation.	*Link*
	Transport for NSW Climate Risk Assessment Guidelines (2021)	Guiding TfNSW, teams, partners, contractors, and stakeholders with advice and requirements on conducting a climate risk assessments.	*Link*
	GANSW **Connecting with Country Framework** (2023)	Framework for collaboration and embedment of Aboriginal knowledge, perspectives and heritage in design and planning, including on climate resilience and adaptation.	*Link*
National & international	**National Climate Resilience and Adaptation Strategy 2021 – 2025** (2021)	Comprehensive plan focused on climate resilience and adaption to protect communities, ecosystems and industries from the rising effects of climate change.	*Link*
	PCA and GBCA's **Every Building Counts** (2023) policy recommendations	Policy recommendations for a roadmap to a greener, healthier, and more equitable built environment.	*Link*
	World Economic Forum **Global Risks Report** (2023)	Snapshot of risk perception, highlighting failure to mitigate climate change and to adapt to climate change as priority risks globally.	*Link*
	Resilient Cities Network	Network of 100 cities sharing resources on resilience and adaptive capacity in city communities, urban planning, and built forms.	*Link*

Climate context

Emissions scenario & timescales

Emissions scenario

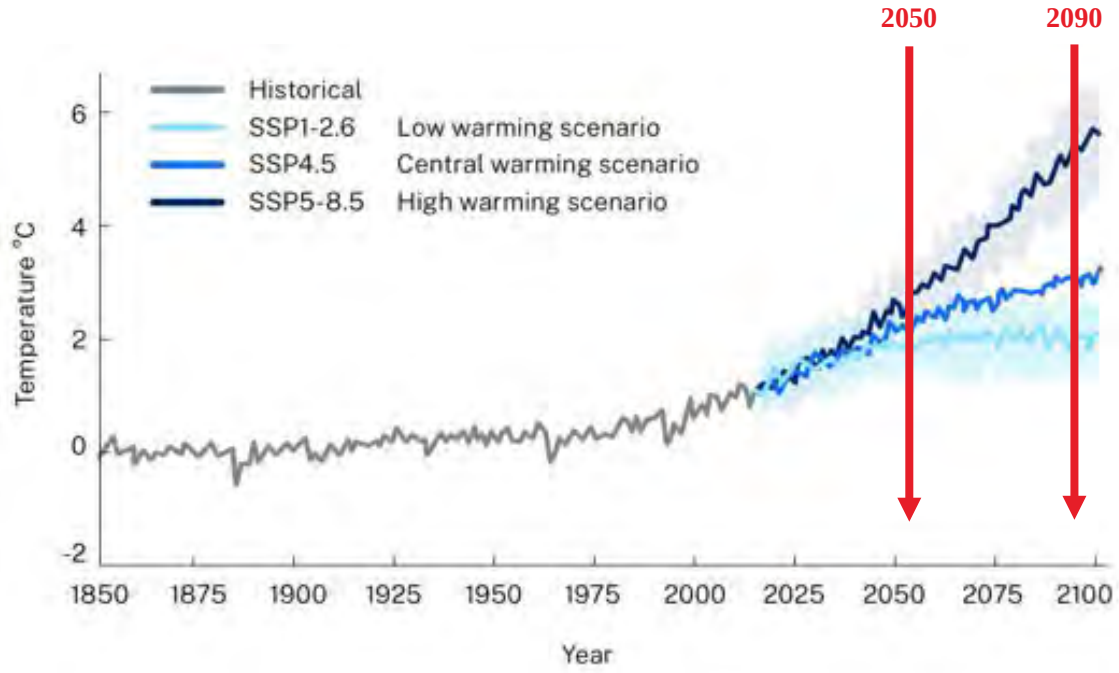
The Intergovernmental Panel on Climate Change (IPCC) publishes four greenhouse gas concentration trajectories, or Representative Concentration Pathways (RCPs), for use in climate modelling and research:

- **RCP 8.5** – very high emissions scenario: Little global action taken to reduce emissions.
- **RCP 4.5 and 6.0** – intermediate emissions scenarios: Strong global action taken to reduce emissions towards end of century.
- **RCP 2.6** – stringent emissions mitigation scenario: Ambitious and immediate global action.

Of these, RCP 8.5 has been adopted for this Resilience Plan. This emissions scenario offers a conservative approach for climate impact assessment; it also most closely aligns with the global current trajectory of observed anthropogenic emissions and surface warming. It also aligns with NSW and Australian government guidance on climate risk assessment and adaptation.

Timescales

In climate impact assessment and adaptation planning it is important to select an appropriate timescale (a time interval over which climate projections are considered with reference a project, asset, or system design life). To capture near- and far-term climate impacts, this Resilience Plan utilises **2050** and **2090** timescales, against an historical baseline.



Source: NSW climate change adaptation strategy

Climate context

Climate projections

The table below outlines the climate projections for Westmead South, for 2050 and 2090, against the baseline historical condition. Projections for 2030 and 2070 are also given, for the variables: annual mean rainfall, severe fire danger days. Projections are taken from the NSW Government's *NSW and Australian Regional Climate Modelling* (NARCliM) and CSIRO's *Climate Change in Australia* for the East Coast Cluster (South); baseline climatic data has been taken from BoM (Parramatta North - Masons Drive):

Climate variable		Indictor	Baseline	RCP8.5 Climate Projections			
				2030	2050	2070	2090
Primary	Temperature	Annual mean max	23.3°C	23.9°C	25.1°C	25.3°C	27.1°C
		Days > 35°C per annum	10.9 days	14.3 days	19.1 days	19.8 days	34.1 days
	Precipitation	Annual mean rainfall	975.2mm	+1.87%	N/A	+10.18%	N/A
		Rainfall intensity	197mm	+10.1%	+10.7%	+17.2%	+25.0%
Secondary	Humidity	Mean annual, at max temperature	55%	-0.58%	-0.91%	-1.4%	-1.4%
	Drought	Frequency (droughts / 20-years)	1.3	1.9	2.0	2.0	2.0
		Duration (months / drought)	22 months	31 months	31 months	35 months	39 months
	Evapotranspiration		1400 to 1600	+4.1%	+7.2%	+10.5%	+14.3%
	Bushfire	Severe fire danger days (FFDI >50 / yr)	1.1 days	1.2 to 1.5 days	N/A	N/A	1.5 to 1.6 days

Climate context

Climate hazards

The table below gives an indication on the broad swathe of climate hazards that may increasingly impact communities and built forms in Australia towards 2090. The six hazards highlighted have been considered in the climate impact assessment for Westmead South:

Climate hazard			
	Bushfire weather & longer bushfire seasons		Landslide, erosion, subsidence
	Bushfire smoke & air quality impacts		Drought & water scarcity
	High wind events		Storms & hail
	Extreme heat & heatwaves		Lightning
	Rainfall & flooding (pluvial & fluvial)		Dust storms
	Coastal inundation & storm surge		Multi-hazard events

Climate context

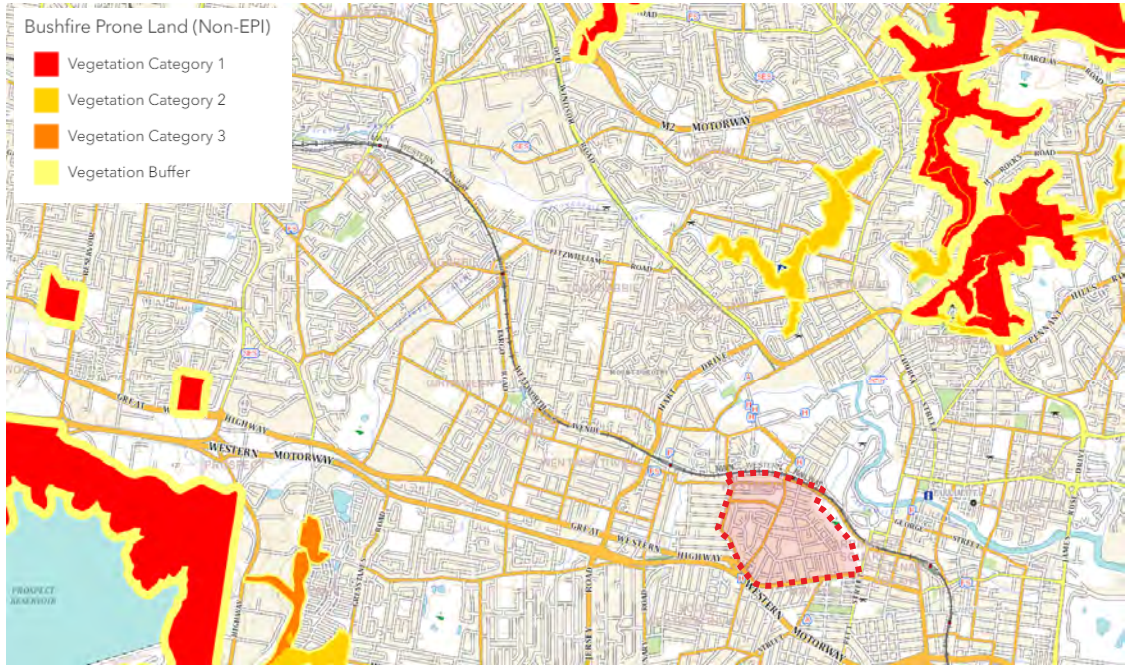
Climate hazards: Bushfires & air quality

- Greater Sydney is exposed to **recurrent bushfire smoke events**, impacting air quality and effecting community health and wellbeing.
- Severe bushfire weather days are projected to **increase in frequency to 2090**, with resultant uplift in bushfire smoke events.
- The site does not include bushfire prone land.

While no bushfire prone land is identified at Westmead South, prone land exists north at Parramatta Lake and west at Prospect Reservoir. More broadly, Sydney Basin is bound by bushfire prone land, rendering bushfire smoke a significant, ongoing hazard. Smoke conditions impact comfort and health, with particulates able to enter through building façade and mechanical systems. Poor air quality disproportionately impacts vulnerable groups such as the elderly and those with respiratory conditions. It can also damage mechanical systems and increase the frequency of false fire alarms.

Bushfire weather frequency is projected to increase in Sydney, lifting from 1.1 to 1.5 days of severe fire danger p.a. between the current and future 2090 condition.

Recent hazardous bushfire smoke events include the 2019-2020 summer, when 33 days of hazardous air quality were recorded in greater Sydney.



Source: NSW Planning Portal Spatial Viewer

Indicator	Baseline	2030	2050	2070	2090
Severe fire danger days p.a.	1.1 days	1.2 to 1.5 days	N/A	N/A	1.5 to 1.6 days

Climate context

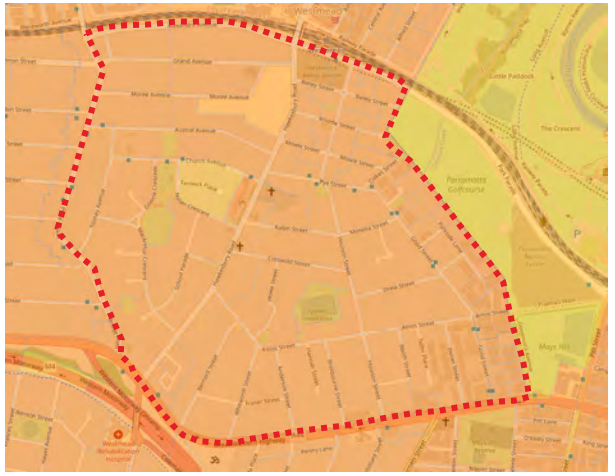
Climate hazards: Extreme heat & heatwaves

- Westmead South is currently exposed to **urban heat island effect**.
- Extreme heat conditions are projected to increase, with an **additional 23 days p.a. above 35°C** at Westmead South by 2090, above the current average of 10.9 days.
- Extreme heat disproportionately impacts vulnerable groups and poses significant risk to urban and built infrastructure systems.

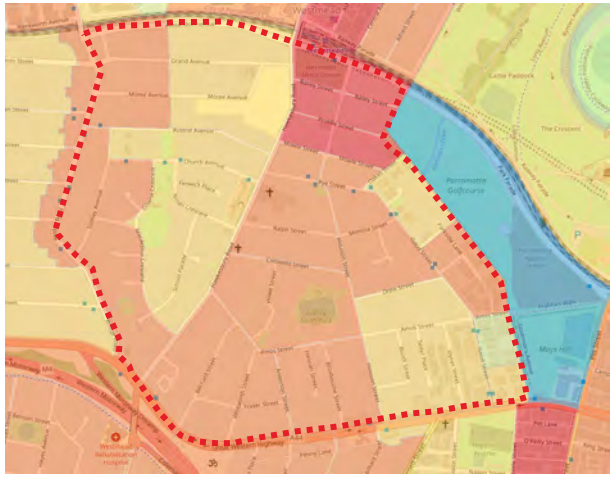
Average annual, mean min., and mean max. temperatures are projected to increase across Australia's East Coast to 2090, with an uplift in average mean max. at Westmead South of +1.8°C by 2050 and +3.8°C by 2090. Summers are projected to become increasingly hot, with an additional 23 days annually exceeding 35°C; this presents a tripling of hot days per annum, above the baseline condition.

Urban heat island (UHI) mapping (top right) illustrates that Westmead South is currently exposed to +3 to +6 °C variance in surface temperature against a non-urban, vegetated reference. Heat vulnerability index (HVI) mapping (lower right) indicates the area's communities experience varying vulnerability to heat, quantified across heat exposure, sensitivity, and adaptive capacity. Increase in average and max. temperatures to 2090 indicates that UHI effect increasingly impact Westmead South's vulnerable communities.

Indicator	Baseline	2030	2050	2070	2090
Annual mean max	23.3°C	23.9°C	25.1°C	25.3°C	27.1°C
Days > 35°C p.a.	10.9 days	14.3 days	19.1 days	19.8 days	34.1 days



Source: NSW Urban Heat Island to Modified Mesh Block 2016, SEED Map, NSW Dept. Planning and Environment 2019



Source: NSW Heat Vulnerability Index to ABS Statistical Area Level 1 2016, SEED Map, NSW Dept. Planning and Environment 2019

Climate context

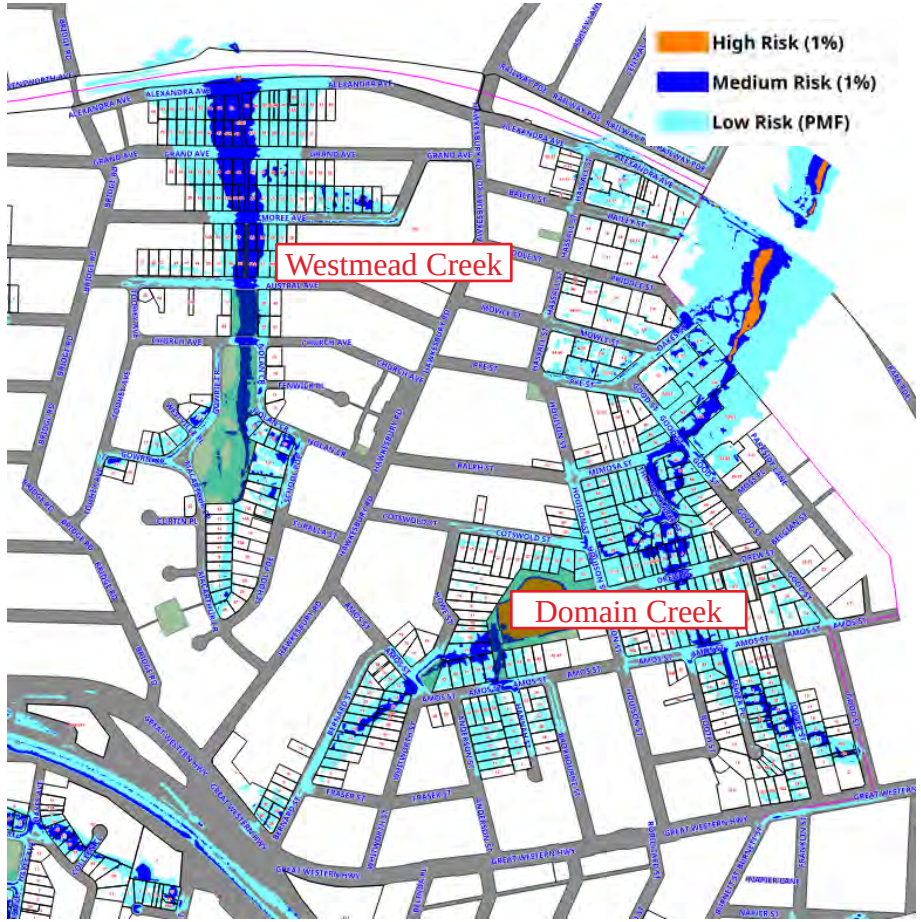
Climate hazards: Rainfall & flooding

- Westmead South has **existing overland flow and inundation** areas.
- **Rainfall intensity projected to increase** +10% by 2050, +25% by 2090.
- **Uplift in flood depth and extent** has been modelled for +10%, +30% changes in rainfall intensity.
- Urban form, hardscaping, and landscaping are relevant local factors.

Westmead Creek and Domain Creek catchments comprise most of Westmead South's area, feeding north to Parramatta River. In the 100-year annual recurrence interval (ARI) event, depths >1m are exhibited at Sydney Smith Park (Domain Creek), and depths >0.5m at Alexandra Ave., Grand Ave., and Moree Ave. (Westmead Creek). Flooding extent typically varies depending on the presence of impermeable surfaces, location of waterways, direction of underground and surface flows, and vegetation.

Rainfall events in the Sydney basin are projected to become more intense, likely leading to an increase in flash flooding in urban areas. In the Parramatta area, rainfall intensity is projected to increase by +10.7% by 2050, and +25.0% by 2090, above current climate conditions, during intense rainfall events. Average annual rainfall is also projected to increase for the 2050 and 2090 conditions.

The figure to the right illustrates flood risk level forWestmead South, for its existing condition. In **Appendix B: Flood mapping excerpts**, change in overland flow paths and flood extents for +10% and +30% intensity conditions (above 1% Annual Exceedance Probability (AEP)) are illustrated. Collectively, this indicates that overland flow paths and inundation will continue to pose a risk to Westmead South into the future, with increase in rainfall intensity likely exacerbating flood hazard levels for the community and the urban form.



Source: Cumberland City Council *Map 4 - Flood Risk Precincts Map*, 2021

Climate context

Climate hazards

Drought & water scarcity

- Greater Sydney is projected to experience **more droughts**, and droughts of **longer duration** toward 2090.
- Evapotranspiration is projected to increase, impacting landscaping and natural environments.

Increased drought frequency (+0.7 months / 20-year period) and drought intensity (+17 months / drought) in the Sydney Basin by 2090 is likely to result in more frequent and prolonged water restrictions. This may be accompanied by increased social and regulatory expectation for water efficiency and circularity.

Increase in evapotranspiration is unlikely to directly impact residents and businesses in Westmead South. However, it may impact landscaping and the water table, with increased water loss annually and flow on impacts to urban amenity, natural systems, and soil stability.

Indicator	Baseline	2030	2050	2070	2090
Frequency (droughts / 20-years)	1.3	1.9	2.0	2.0	2.0
Duration (months / drought)	22 months	31 months	31 months	35 months	39 months
Evapo-transpiration	1400 to 1600	+4.1%	+7.2%	+10.5%	+14.3%

Storms Hail & Extreme Wind

- Continued exposure to storms, hail and extreme wind, but a slight decline in frequency of East Coast Lows projected by 2090.
- Changes to surface winds are projected to be minor. Projected changes in extreme winds are not conclusive.

Climate projections suggest that the frequency of East Coast Lows (ECLs) impacting South-East Australia will decrease toward the end of the century. ECLs are typically associated with storm systems. This is distinct from rainfall intensity, however, with rainfall intensity during high rainfall events projected to increase.

Seasonal surface wind speeds are projected to change only a small degree in the near- and far-term. Projections for extreme wind conditions – winds that are disruptive or damaging – are not conclusive.

Resilience- Climate impact assessment

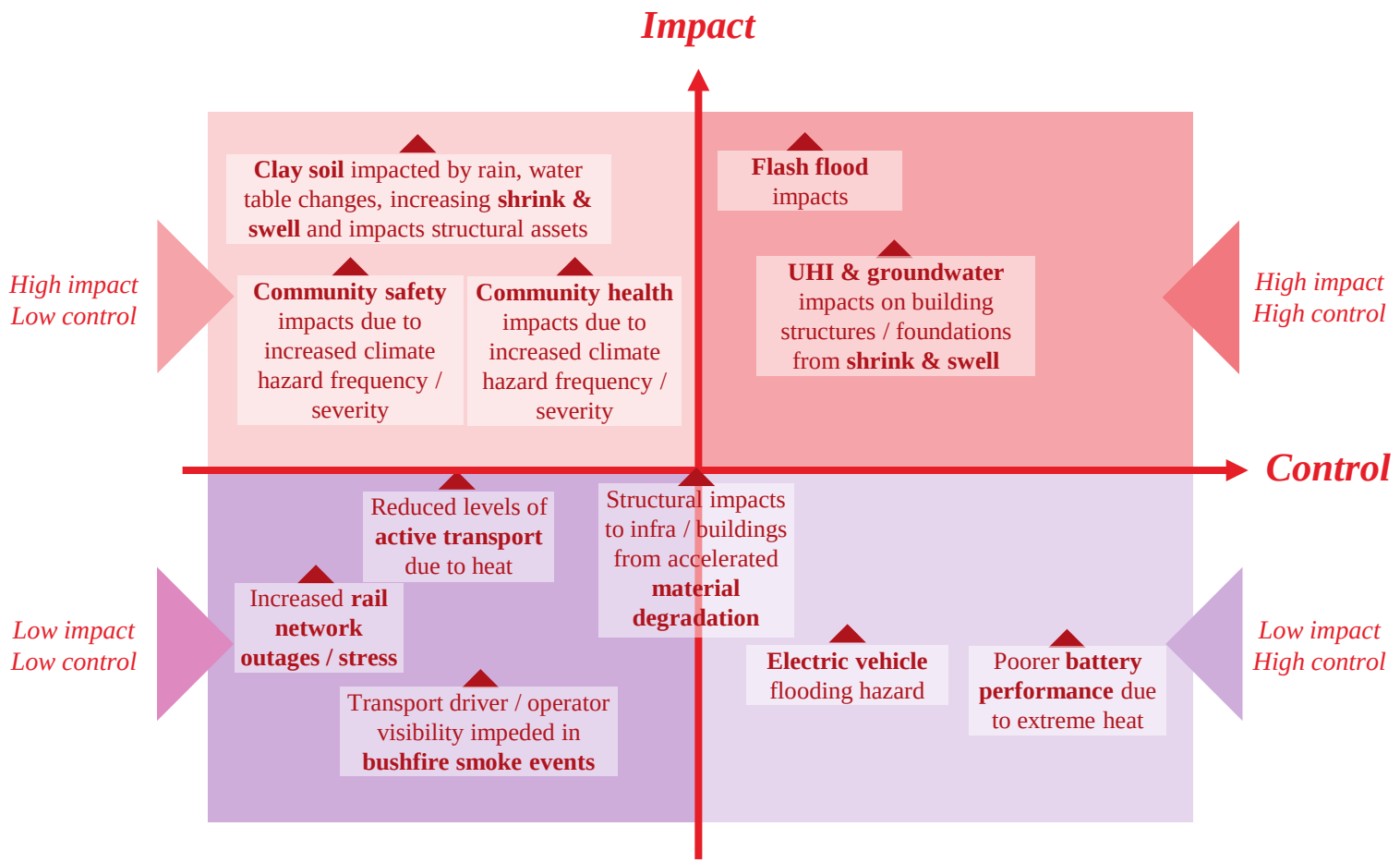
Climate impact assessment

Impact areas & workshop output

Climate impact areas were identified and workshopped with members of the masterplan design team on 31/08/2023, categorised on a matrix of impact severity and impact controllability (see right). This initial set of impacts is not exhaustive. Primary impact areas identified by participants were:

- **Community health and safety** impacts from broad climate hazards
- **Civil and structural** impacts from Urban Heat Island (UHI) effect, flooding, and soil movement
- **Transport network** impacts from bushfire smoke
- **Urban amenity and active transport** impacts from extreme heat
- **Battery and EV** impacts from flooding and extreme heat

Following the workshop, additional impact areas have been identified and assessed, applying the AS5334:2013 risk matrix to allocate hazard categories, impact statements, likelihoods (L) and consequences (C), and qualitative risk levels to each impact area. See **Appendix A: Impact Assessment Matrix** for the full list of impact areas and assessment results.



Climate impact assessment

Key findings

- **Extreme heat**, **heatwaves**, and increased **UHI effect** pose an **extreme risk** to Westmead South and its communities, for the 2050 and 2090 horizons.
- **Extreme heat** and its impact to indoor thermal comfort poses a **high risk**, for 2050 and 2090.
- **More intense rainfall events** and impacts to civil drainage, including unmanaged overland flow paths, pose a **high risk** to community safety and physical assets, for 2050 and 2090.

The climate impact profile for Westmead South, for 2050 and 2090, indicates that extreme heat and intense rainfall will present the most significant hazard to the precinct's buildings, infrastructure, urban form, and community. These hazard categories pose an increasing risk profile between the baseline, historical condition and the future time horizons considered.

- See **Appendix A: Impact Assessment Matrix** for the full results.

Note: for some impact items, the qualitative impact level is consistent between the baseline and 2050 and / or 2090 horizons. This does not necessarily indicate that impact level is unchanged, but that the magnitude of change between time horizons is not significant enough to trigger an uplift in rating.

Resilience- Resilience planning

Resilience planning

Adaptation

At a precinct level, adaptation to climate impacts can be broadly grouped into 3 types: (1) precinct adaptations (2) building adaptations and (3) adaptive capacity. The table below outlines adaptation options available for the Westmead South Masterplan, broken down by adaptation type and by climate hazard:

	Precinct adaptations	Building adaptations	Adaptive capacity
Bushfire & air quality **Low** to **Medium** impact level		• HVAC space provision, in critical buildings, for retrofit of high-grade filtration systems.	• Digital alert system or alert boards for hazardous weather conditions, including poor air quality alerts.
Extreme heat **Medium** to **Extreme** impact level	• Maximise street planting and urban greening to mitigate UHI effect. • Electricity redundancy / on-site renewable energy generation to mitigate risk of heat wave-induced blackouts. • High solar reflectance index surfacing to mitigate UHI effect (roads, carparks). • Dedicated public spaces that are thermally comfortable and open during heat waves.	• High solar reflectance index surfacing to mitigate UHI effect (roofing). • Site setback or % allocation to greening / rain gardens. • Size all HVAC systems for 2030 or 2050 climate design conditions. • Size all HVAC rooms to allow for increased plant size after 2050. • Uptake of passive design, e.g., through min. Green Star Buildings, Green Star Homes ratings, or PassivHaus principles. • Outdoor thermal comfort through landscaping, awnings, glare reduction.	• Digital alert system or alert boards for hazardous weather conditions, including forecast heat waves. • Develop / onboard community outreach programme to liaise with vulnerable communities about heat management risks and strategies. • Develop / onboard local / regional emergency heat management plan.

Resilience planning

Adaptation

	Precinct adaptations	Building adaptations	Adaptive capacity
Rainfall & flooding **Medium** to **High** impact level	• Permeable paving to improve water uptake. • Uplift in civil drainage requirements to account for uplift in rainfall intensity, per ARR Guidelines. • WSUD principles to manage overland flow paths and pollutant runoff. • Undertake / update precinct flood mapping, including for proposed masterplan, and for uplift in rainfall intensities.	• Uplift in hydraulic drainage requirements to account for uplift in rainfall intensity, per ARR Guidelines. • Curb-side WSUD applications. • On-site detention basins for lots close to overland flow routs. • Freeboard against selected AEP + rainfall intensity uplift, e.g., 200mm above 1%AEP + 19.7% intensity. • Bunding or elevation of all critical electrical equipment.	• Develop / onboard local / regional flood management plan.
Drought & water scarcity **Low** to **Medium** impact level	• Recycled water / purple pipe network, or provision for connection to future regional purple pipe network. • Selection of drought tolerant / native vegetation, considering 2050 and 2090 climates when selecting native species.	• On-site rainwater harvesting, connecting to non-potable water demands. • Grey water capture and reuse. • Highest efficiency water fixtures, and waterless fixtures where possible.	• Community outreach / education on minimising water usage.

Resilience planning

Adaptation

	Precinct adaptations	Building adaptations	Adaptive capacity
Storms, hail & extreme wind **Low** to **Medium** impact level	• Wind modelling of building massing to minimise street-level disruptive winds. • Public spaces to include landscaping elements (vegetation, walling) that offer respite to prevailing wind conditions.	• Gutter guards to minimise hail impacts to drainage. • Avoid planting of species likely to result in overhang / dead-drop over roofs.	• Digital alert system or alert boards for hazardous weather conditions, including incoming storm or hail systems. This could be tied to BoM alerts and / or built into public art systems (e.g., a visual barometer display and information panel).
Combined impacts **Low** to **Medium** impact level	• Precinct level strategy to maximise renewable energy generation and reduce reliance on grid. • Geotechnical assessment of site to assess presence of reactive soils. • Coordinate with major infrastructure providers (Sydney Metro, Sydney Water) to coordinate emergency management, resource redundancy, service downtime for typical shocks and stresses, etc.	• In case of reactive soils, require that developments liaise with durability / materials experts to manage exposure, e.g., through high SCM concrete mix, higher assumed groundwater table, etc.	• Free, periodic active transport workshops to improve resilience to transport network outages, e.g., free bike maintenance or bike training sessions. • Community outreach / education on improving adaptive capacity to network-level outages, e.g., information on local areas of respite in case of heat waves and blackouts.

Resilience planning

Adaptation implementation

To assist in adaptation selection and implementation for Westmead South, the following recommendations are made:

1. **Confirm adaptation priorities** based on:
    i. Impact level (i.e., climate impacts within the impact assessment that are high or extreme).
    ii. Capacity to be implemented precinct-wide, for maximum efficiency and benefit.
2. **Review and note additional co-benefits** (i.e., secondary positive effects) that adaptations may deliver, to inform business case. E.g.:
    i. Capacity to support other masterplan objectives around nature, the local economy, or social objectives.
    ii. Capacity to improve management of key transition risks.
3. **Nominate owners for priority adaptations** to assist in tracking adaptation and risk ownership.
4. **Utilise stakeholder engagement** to workshop adaptations and opportunities to build adaptive capacity, possibly engaging community members, local businesses, local interest groups, utility providers.

Resilience planning

Next-steps & ongoing monitoring

Adapting for future climate impacts has inherent uncertainty, with varying degrees of confidence within climate projections and intersection with local factors. Ongoing monitoring of impact areas and adaptations is critical to driving resilience. The graphic to the right outlines milestone actions to assist in this.

3-month milestone

- Ensure that agreed adaptations are included in masterplan design, where possible.
- Track feasibility & progress of adaptations, noting barriers to implementation (legislative, design, engineering, cost, stakeholder).
- **Responsible parties:** Design team, council

12-month milestone

- Ensure that resilience assessment and planning informs Westmead South DCP, where relevant, including adaptations and future operational / community initiatives.
- Confirm ongoing suitability of this Resilience Plan's impact assessment results & adaptations, recording new impact areas & potential adaptations for masterplanning or future works programs.
- Conduct review of any new local, state or national strategies or policies on resilience, identifying new learnings, initiatives or requirements applicable to Westmead South.
- **Responsible parties:** Design team, council (strategic planning role / sustainability and climate role)

Ongoing review

- Establish a review timeframe and nominate a responsible authority within Council to undertake a review of risks, risk ratings and adaptations.
- Track and document climate hazards events (flooding, heat waves) impacting the Westmead South area, including downtime for critical infrastructure and vulnerable populations.
- **Responsible parties:** Council, possibly including strategic planning role or a sustainability and climate role. This role may be temporary in the short-term, or a dedicated responsibility for a strategic planner or sustainability and climate sub-team. This would create efficiencies in monitoring & delivering climate resilience outcomes in tandem with decarbonisation outcomes, as the council works towards alignment with NSW state government net zero targets.

Resilience
Appendix A: Impact Assessment Matrix

Impact assessment matrix

Results

#	Impact statement	Direct / indirect	Baseline			2050			2090		
			L	C	Level	L	C	Level	L	C	Level
Bushfire & air quality											
B1	More frequent bushfire smoke events **impacting visibility** across precinct, reducing transport network reliability and safety.	Direct	Unlikely	Minor	Low	Unlikely	Minor	Low	Possible	Minor	Low
B2	More frequent bushfire smoke events posing **health and wellbeing** risk to community, notably vulnerable groups and people with respiratory conditions.	Direct	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.	Likely	Mode-rate	Med.
B3	More frequent bushfire smoke events impacting precinct **outdoor amenity and indoor comfort**, e.g., outdoor activity impacts, nuisance false fire alarms.	Direct	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.	Likely	Mode-rate	Med.
Extreme heat & heatwaves											
H1	More frequent & severe heat events posing **health and wellbeing** risk to community, notably vulnerable groups such as the elderly.	Direct	Likely	Major	High	Almost certain	Major	Extreme	Almost certain	Major	Extreme
H2	Increase in average & extreme heat conditions impacting **active transport** network and patronage, increasing reliance on public and private modes.	Direct	Likely	Minor	Med.	Almost certain	Minor	Med.	Almost certain	Minor	Med.
H3	More frequent & severe heat events damaging **landscaping and outdoor amenity and comfort**.	Direct	Unlikely	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
H4	More frequent & severe heat events impacting **indoor thermal comfort**, exceeding passive design systems, heat rejection, ventilation.	Direct	Likely	Mode-rate	Med.	Almost certain	Mode-rate	High	Almost certain	Mode-rate	High
H5	More frequent & severe extreme heat events impacting **electrical asset** efficiency and function, e.g., batteries, EV chargers, rooftop PV, substations.	Direct	Unlikely	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
H6	Increase in average & extreme heat conditions exacerbating existing **UHI effect**, impacting community health and wellbeing, notably vulnerable groups.	Direct	Likely	Major	High	Almost certain	Major	Extreme	Almost certain	Major	Extreme

Impact assessment matrix

Results

#	Impact statement	Direct / indirect	Baseline			2050			2090		
			L	C	Level	L	C	Level	L	C	Level
Rainfall & flooding											
R1	Increase in rainfall intensity **overwhelming civil drainage** and urban form, resulting in flash flooding and unmanaged overland flows, posing safety risk to community and physical risk to civil assets.	Direct	Unlikely	Major	Med.	Possible	Major	High	Possible	Major	High
R2	Increase in rainfall intensity **overwhelming hydraulic drainage**, resulting in unmanaged overflow, posing safety risk to critical building assets, e.g., substations, EV charging, batteries, pollutant control.	Direct	Unlikely	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
R3	Increase in rainfall intensity **overwhelming civil drainage** and urban form, increasing pollutant runoff to sensitive environmental receivers.	Direct	Unlikely	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
R4	Increase in short-term, localised flooding to arterial roads impeding safe **access and egress** by community & critical services, e.g., emergency services.	Direct & indirect	Rare	Major	Med.	Unlikely	Major	Med.	Unlikely	Major	Med.
Drought & water scarcity											
D1	Increase in drought frequency & duration regionally **restricting potable water supply** to community and infrastructure.	Indirect	Unlikely	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
D2	Increase in drought frequency & duration impacting **landscaping and amenity**.	Direct	Unlikely	Minor	Low	Possible	Minor	Low	Possible	Minor	Low

Impact assessment matrix

Results

#	Impact statement	Direct / indirect	Baseline			2050			2090		
			L	C	Level	L	C	Level	L	C	Level
Storms, hail & extreme wind											
S1	Prevailing wind conditions & storm fronts **disrupting outdoor comfort and amenity**, exacerbated by urban form, e.g., wind tunnelling.	Direct	Unlikely	Minor	Low	Possible *	Minor	Low*	Possible *	Minor	Low*
S2	Hail, wind & storm debris **blocking drainage**, resulting in unmanaged building overflow from hydraulic drains and unmanaged overland flows from civil drains.	Direct	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.	Possible	Mode-rate	Med.
Combined impacts											
X1	Combination of more intense rainfall events, more frequent and prolonged drought, and more frequent extreme heat events, **increasing soil shrink & swell** in reactive soils and damaging civil and structural elements, e.g., slabs, underground pipes, embankments, retaining walls.	Direct	TBC**	Mode-rate to major	TBC**	TBC**	Mode-rate to major	TBC**	TBC**	Mode-rate to major	TBC**
X2	More frequent extreme heat events, coupled with more intense rainfall events, **accelerating material degradation** of exposed elements, e.g., façade systems, road surfacing, adhesives.	Direct	Unlikely	Minor	Low	Unlikely	Minor	Low	Unlikely	Minor	Low
X3	Increased frequency & intensity of climate hazard events that result in **transport network outages** and resultant impacts to community.	Indirect	Mode-rate	Mode-rate	Med.	Likely	Mode-rate	Med.	Likely	Mode-rate	Med.

*Likelihood of disruptive winds arising at Westmead South will depend in part on urban form and building massing, and massing with reference to prevailing wind directions.

**Soil shrink and swell risk, and impact of climate variables, will directly depend on the presence & distribution of reactive soils within the precinct. It is recommended that soil test results be confirmed / tests undertaken to inform exposure assessment.

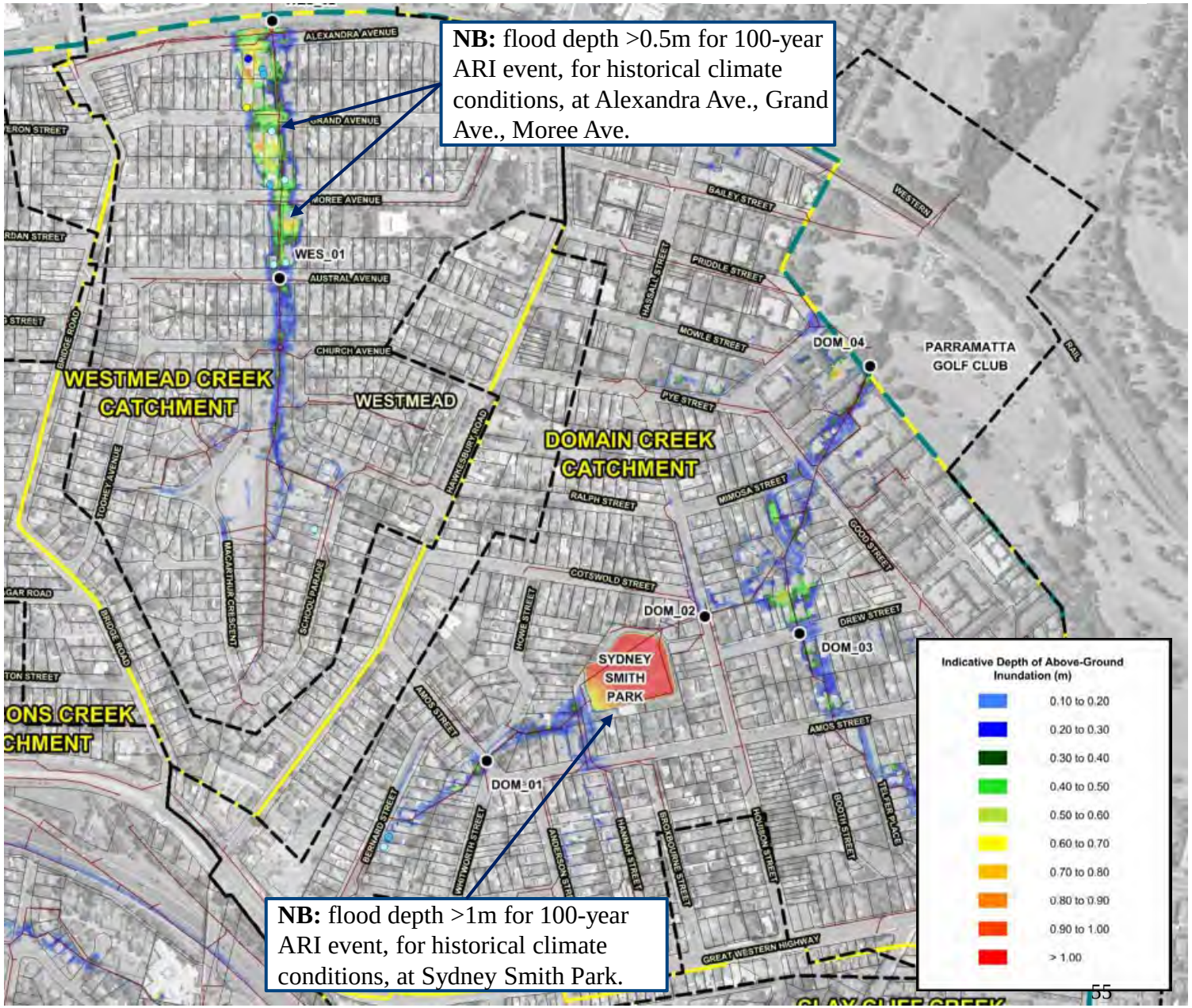
Resilience
Appendix B: Flood mapping excerpts

Climate context

Climate hazards: Rainfall & flooding

100-year ARI event for historical climate conditions
Source: *Holroyd City LGA Overland Flood Study*, figure 6.5, sheet 4 of 11: *TUFLOW model results 100-year ARI*

Indicator	Base-line	2030	2050	2070	2090
Annual mean rainfall	975.2mm	+1.87 %	N/A	+10.18%	N/A
Rainfall intensity	197mm	+10.1 %	+10.7 %	+17.2 %	+25.0 %



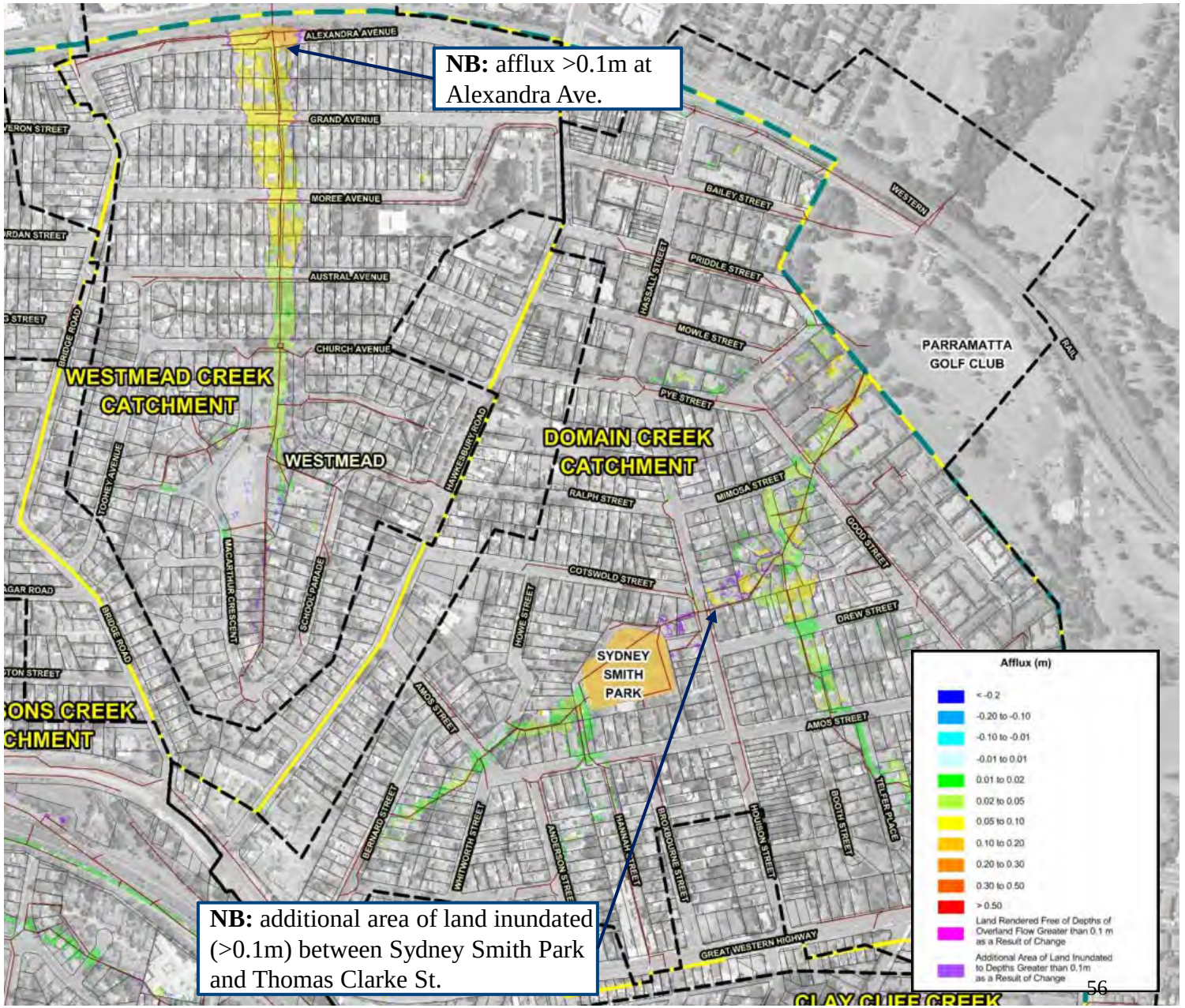
Climate context

Climate hazards: Rainfall & flooding

Afflux for +10% rainfall intensity over the 100-year ARI event. Afflux is increase in water level resulting from a change in conditions. Source: *Holroyd City LGA Overland Flood Study*, figure 6.12, sheet 4 of 11: *Sensitivity of flood behaviour to 10% increase in rainfall intensity 100-year ARI*

Note: Australian Rainfall & Runoff (ARR) Guidelines recommend considering +19.7% rainfall intensity for the RCP 8.5 future climate condition, for year 2090.

Indicator	Base-line	2030	2050	2070	2090
Annual mean rainfall	975.2mm	+1.87 %	N/A	+10.1 8%	N/A
Rainfall intensity	197mm	+10.1 %	+10.7 %	+17.2 %	+25.0 %



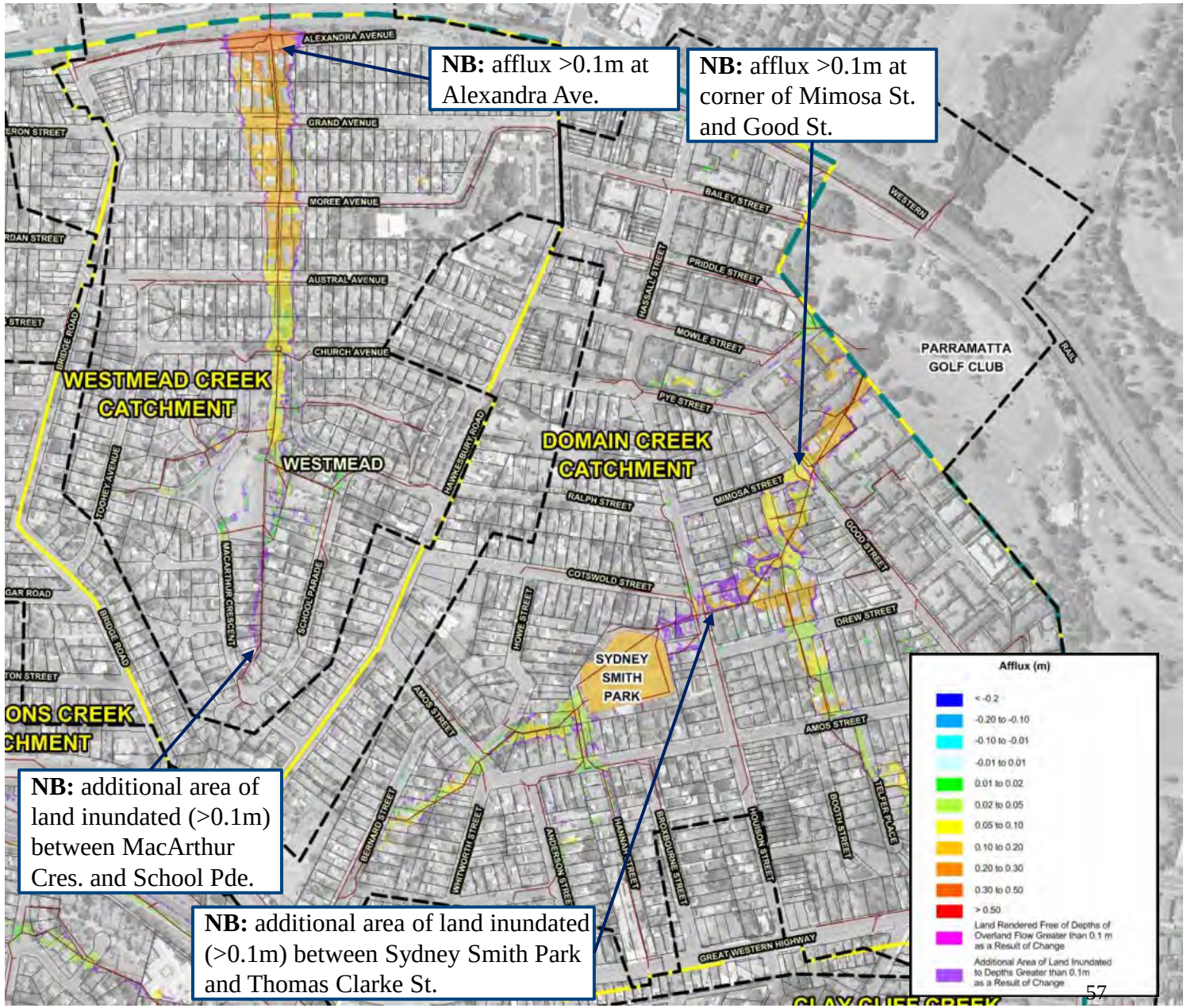
Climate context

Climate hazards: Rainfall & flooding

Afflux for +30% rainfall intensity over the 100-year ARI event. Afflux is increase in water level resulting from a change in conditions. Source: *Holroyd City LGA Overland Flood Study*, figure 6.12, sheet 4 of 11: *Sensitivity of flood behaviour to 30% increase in rainfall intensity 100-year ARI*

Note: Australian Rainfall & Runoff (ARR) Guidelines recommend considering +19.7% rainfall intensity for the RCP 8.5 future climate condition, for year 2090.

Indicator	Base-line	2030	2050	2070	2090
Annual mean rainfall	975.2mm	+1.87 %	N/A	+10.1 8%	N/A
Rainfall intensity	197mm	+10.1 %	+10.7 %	+17.2 %	+25.0 %

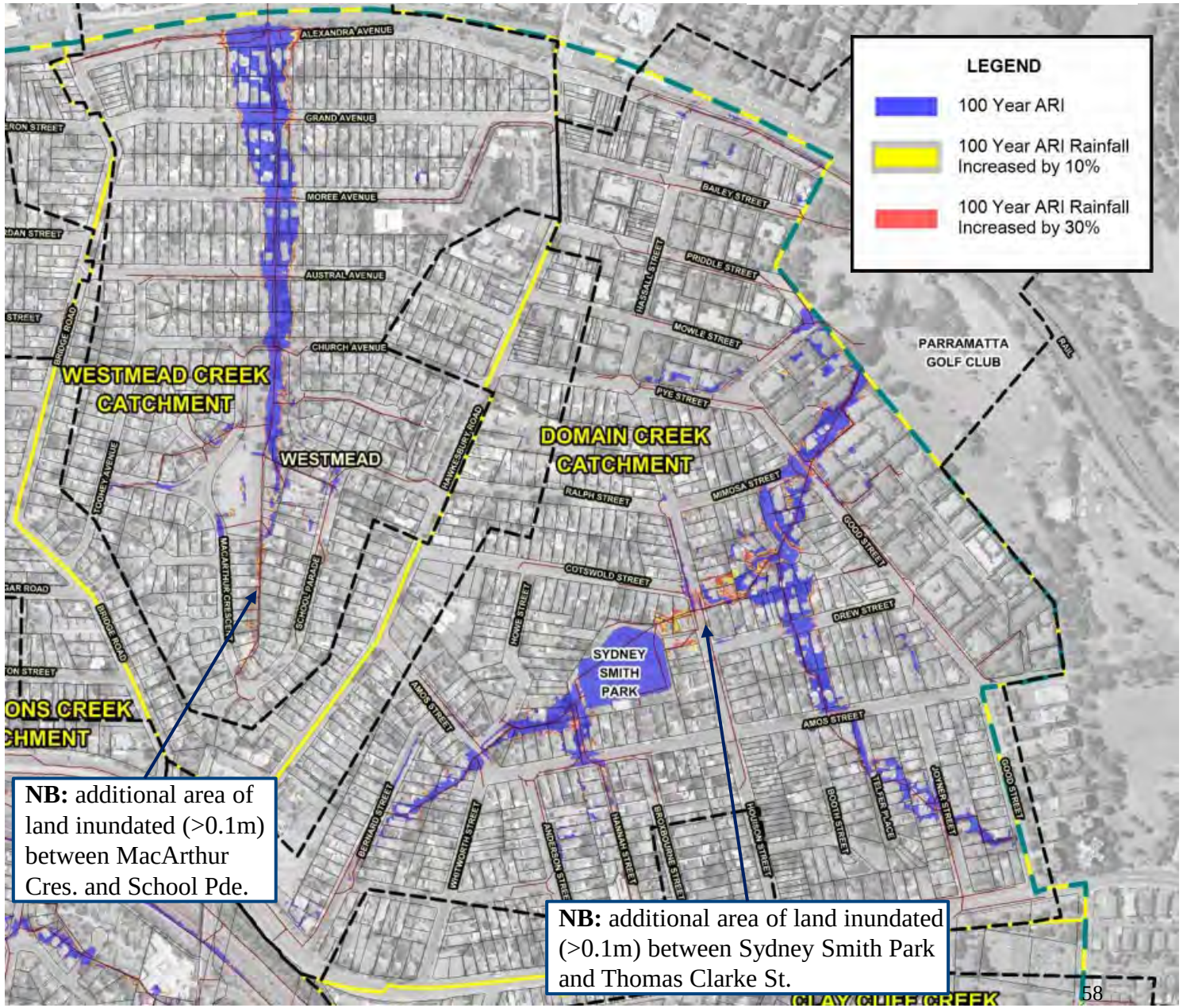


Climate context

Climate hazards: Rainfall & flooding

Change in flood extent for +10% and +30% rainfall intensity over the 100-year ARI event.
Source: *Holroyd City LGA Overland Flood Study*, figure 6.14, sheet 4 of 11: *Impact of Increased Rainfall Intensities on Extent of Flooding – 100-year ARI*

Indicator	Base-line	2030	2050	2070	2090
Annual mean rainfall	975.2mm	+1.87 %	N/A	+10.18%	N/A
Rainfall intensity	197mm	+10.1 %	+10.7 %	+17.2 %	+25.0 %



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